CVP-2005-00006
Rev. 0

Cleanup Verification Package for the 100-K-55:1 and 100-K-56:1 Pipelines and the 116-KW-4 and 116-KE-5 Heat Recovery Stations

Prepared for the U.S. Department of Energy
by Washington Closure Hanford

September 2005

EXECUTIVE SUMMARY

This cleanup verification package documents completion of remedial action for the 100-K-55:1 and 100-K-56:1 reactor cooling effluent underground pipelines, referred to herein as the 100-K-55:1 and 100-K-56:1 sites, as well as for the 116-KW-4 and 116-KE-5 heat recovery stations, referred to herein as the 116-KW-4 and 116-KE-5 sites. The 116-KW-4 and 116-KE-5 heat recovery stations were co-located and remediated with the 100-K-55:1 and 100-K-56:1 pipelines, respectively. These sites are located in the 100-KR-2 Operable Unit in the 100-K Area of the Hanford Site in southeastern Washington State. The 100-K-55 and 100-K-56 sites consisted of those process effluent pipelines that serviced the 105-KW and 105-KE Reactors, respectively. Both of these sites have been administratively divided into subunits based on the current extent of remediation. Portions of the pipelines remaining within the reactor security fencing and in proximity to active utility features have been delineated as the 100-K-55:2 and 100-K-56:2 pipelines, with the portions of the pipelines excluded from these boundaries identified as the 100-K-55:1 and 100-K-56:1 pipelines. This cleanup verification package addresses only the 100-K-55:1 and 100-K-56:1 subunits; the 100-K-55:2 and 100-K-56:2 subunits will be addressed within a separate cleanup verification package.

Site excavation and waste disposal are complete, and the exposed surfaces have been sampled and analyzed to verify attainment of the remedial action goals. Results of the sampling, laboratory analyses, and data evaluations for the 100-K-55:1, 100-K-56:1, 116-KW-4, and 116-KE-5 sites indicate that all remedial action objectives and goals for direct exposure, protection of groundwater, and protection of the Columbia River have been met (see Table ES-1).

The sites meet cleanup standards and have been reclassified as "interim closed out" in accordance with the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1989) and the Waste Site Reclassification Guideline TPA-MP-14 (RL-TPA-90-0001) (DOE-RL 1998). Copies of the waste site reclassification forms for each site are included as Attachments ES-1 through ES-4.

Table ES-1. Summary of Cleanup Verification Results for the 100-K-55:1, 100-K-56:1, 116-KW-4, and 116-KE-5 Sites. (2 Pages)

Regulatory Requirement	Remedial Action Goals	Results	Remedial Action Objectives Attained?	Ref.
Direct Exposure – Radionuclides	1. Attain 15 mrem/yr dose rate above background over 1,000 years.	1. Maximum dose rate calculated by RESRAD for the 100-K-55:1 site is 4.59 mrem/yr (not accounting for backfill). Maximum dose rate calculated by RESRAD for the 100-K-56:1 site is 9.95 mrem/yr (not accounting for backfill). No radionuclide COCs were identified for the 116-KW-4 or 116-KE-5 sites.	Yes	a, b
Direct Exposure – Nonradionuclides	1. Attain individual COC RAGs.	1. No nonradionuclide COCs were identified for the 100-K-55:1 or 100-K-56:1 sites. Individual concentrations of COPCs are below the RAGs at the 116-KW-4 and 116-KE-5 sites.	Yes	
Meet Nonradionuclide Risk Requirements	1. Hazard quotient of <1 for noncarcinogens.	1. No nonradionuclide COCs were identified for the 100-K-55:1 and 100-K-56:1 sites. Individual hazard quotient values for the 116-KW-4 and 116-KE-5 sites are less than 1.	Yes	c
	2. Cumulative hazard quotient of <1 for noncarcinogens.	2. No nonradionuclide COCs were identified for the 100-K-55:1 and 100-K-56:1 sites. Cumulative hazard quotients for the 116-KW-4 and 116-KE-5 sites are 1.0×10^{-3} and 3.4×10^{-2}, respectively.		c
	3. Excess cancer risk of $<1 \times 10^{-6}$ for individual carcinogens.	3. No nonradionuclide COCs were identified for the 100-K-55:1 and 100-K-56:1 sites. Excess cancer risk values for residual hexavalent chromium (the sole carcinogenic COPC) at the 116-KW-4 and 116-KE-5 sites are 1.1×10^{-7} and 1.6×10^{-7}, respectively.		c
	4. Attain a total excess cancer risk of $<1 \times 10^{-5}$ for carcinogens.	4. No nonradionuclide COCs were identified for the 100-K-55:1 and 100-K-56:1 sites. Total excess cancer risk values for the 116-KW-4 and 116-KE-5 sites are 1.1×10^{-7} and 1.6×10^{-7}, respectively.		c
Groundwater/River Protection – Radionuclides	1. Attain single-COC groundwater and river protection RAGs.	1. All single-COC groundwater and river RAGs have been attained.	Yes	d, e
	2. Attain National Primary Drinking Water Standards: 4 mrem/yr (beta/gamma) dose rate to target receptor/organs.	2. All organ-specific dose rates are below the 4 mrem/yr dose rate limit.		d, e

Table ES-1. Summary of Cleanup Verification Results for the 100-K-55:1, 100-K-56:1, 116-KW-4, and 116-KE-5 Sites. (2 Pages)

Regulatory Requirement	Remedial Action Goals	Results	Remedial Action Objectives Attained?	Ref.
	3. Meet drinking water standards for alpha emitters: the more stringent of the 15 pCi/L MCL or 1/25th of the derived concentration guide per DOE Order 5400.5.	3. No alpha-emitting COCs were identified for the 100-K-55:1, 100-K-56:1, 116-KW-4, or 116-KE-5 sites.		
	4. Meet total uranium standard of 21.2 pCi/L.[f]	4. Uranium was not identified as a COC for the 100-K-55:1, 100-K-56:1, 116-KW-4, or 116-KE-5 sites.		
Groundwater/River Protection – Nonradionuclides	1. Attain individual nonradionuclide groundwater and river cleanup requirements.	1. All the groundwater and river RAGs have been attained.	Yes	
Other supporting Information	1. 100-K-55:1 and overburden 95% UCL calculation (Appendix C).			g
	2. 100-K-56:1 95% UCL calculation (Appendix C).			h
	3. 100-K-55:1 and overburden sample variance calculation (Appendix C).			i
	4. 100-K-56:1 sample variance calculation (Appendix C).			j
	5. 100-K-55:1 and overburden verification sample location design (Appendix C).			k
	6. 100-K-56:1 verification sample location design (Appendix C).			L

[a] *100-K-55:1 Pipeline RESRAD Calculation,* 0100K-CA-V0046, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.
[b] *100-K-56:1 Pipeline RESRAD Calculation*, 0100K-CA-V0050, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.
[c] *116-KW-4 and 116-KE-5 Heat Recovery Stations Hazard Quotient and Carcinogenic Risk Calculations*, 0100K-CA-V0054, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.
[d] *100-K-55:1 Comparison to Drinking Water Standards (MCL) Calculation Brief,* 0100K-CA-V0047, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.
[e] *100-K-56:1 Comparison to Drinking Water Standards (MCL) Calculation,* 0100K-CA-V0051, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.
[f] Uranium limits selected in the *Amendment to the Interim Action Record of Decision for the 100-BC-1, 100-DR-1, and 100-HR-1 Operable Units, Hanford Site, Benton County, Washington* (ROD) (EPA 1997) and *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE-RL 2005b) were based on 1/25th of the derived concentration guidelines from DOE Order 5400.5. Since the time of ROD signature, the U.S. Environmental Protection Agency has promulgated a more restrictive MCL of 30 μg/L for total uranium (65 *Federal Register* 76708). Based on the isotopic distribution of uranium in the 100 Areas, the 30 μg/L MCL corresponds to 21.2 pCi/L. Concentration-to-activity calculations are documented in *Calculation of Total Uranium Activity Corresponding to a Maximum Contaminant Level for Total Uranium of 30 Micrograms per Liter in Groundwater*, 0100X-CA-V0038 (BHI 2001).
[g] *100-K-55:1 Pipeline Cleanup Verification 95% UCL Calculation*, 0100K-CA-V0045, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.
[h] *100-K-56:1 Pipeline Cleanup Verification 95% UCL Calculation*, 0100K-CA-V0049, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.
[i] *100-K-55 Pipeline and Overburden Variance Calculation*, 0100K-CA-V0041, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.
[j] *100-K-56:1 Pipeline Variance Calculation*, 0100K-CA-V0052, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.
[k] *100-KW-55 Pipelines Shallow, Deep, and Overburden Zone Sampling Plan*, 0100K-CA-V0039, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.
[L] *100-K-56:1 Pipelines Shallow and Deep Zone Sampling Plan*, 0100K-CA-V0053, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

COC = contaminant of concern
COPC = contaminant of potential concern
RAG = remedial action goal
MCL = maximum contaminant level (drinking water standard)
RESRAD = RESidual RADioactivity (dose model)
UCL = upper confidence limit

Attachment ES-1
Waste Site Reclassification Form

Date Submitted: 09/21/05 **Originator:** R. A. Carlson **Phone:** 373-1440	**Operable Unit(s):** 100-KR-2 **Waste Site ID:** 100-K-55:1 **Type of Reclassification Action:** Rejected ☐ Closed Out ☐ Interim Closed Out ☒ No Action ☐	**Control Number:** 2005-029 **Lead Agency:** EPA

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

Description of current waste site condition:

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

Basis for reclassification:

The 100-K-55:1 pipelines have been remediated to meet the cleanup standards specified in the 1997 *Amendment to the Interim Action Record of Decision for the 100-BC-1, 100-DR-1, and 100-HR-1 Operable Units, Hanford Site, Benton County, Washington,* U.S. Environmental Protection Agency, Region 10, Seattle, Washington (EPA/AMD/R10-97/044). Remedial actions were performed so as to not preclude any future uses (as bounded by the rural-residential scenario), to allow unrestricted use of shallow zone soils (i.e., surface to 4.6 m [15 ft] deep), and to protect groundwater and the Columbia River. Institutional controls are required for the site to prevent drilling or excavation into deep zone soils. The basis for reclassification is described in detail in the *Cleanup Verification Package for the 100-K-55:1 and 100-K-56:1 Pipelines and the 116-KW-4 and 116-KE-5 Heat Recovery Stations* (CVP-2005-00006), Washington Closure Hanford, Richland, Washington.

J. Zeisloft DOE-RL Project Manager	Signature	9/22/05 Date
NA Ecology Project Manager	Signature	Date
L. E. Gadbois EPA Project Manager	Signature	9-23-2005 Date

Attachment ES-2
Waste Site Reclassification Form

Date Submitted: 09/21/05 **Originator:** R. A. Carlson **Phone:** 373-1440	**Operable Unit(s):** 100-KR-2 **Waste Site ID:** 100-K-56:1 **Type of Reclassification Action:** Rejected ☐ Closed Out ☐ Interim Closed Out ☒ No Action ☐	**Control Number:** 2005-030 **Lead Agency:** EPA

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

Description of current waste site condition:

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

Basis for reclassification:

The 100-K-56:1 pipelines have been remediated to meet the cleanup standards specified in the 1997 *Amendment to the Interim Action Record of Decision for the 100-BC-1, 100-DR-1, and 100-HR-1 Operable Units, Hanford Site, Benton County, Washington,* U.S. Environmental Protection Agency, Region 10, Seattle, Washington (EPA/AMD/R10-97/044). Remedial actions were performed so as to not preclude any future uses (as bounded by the rural-residential scenario), to allow unrestricted use of shallow zone soils (i.e., surface to 4.6 m [15 ft] deep), and to protect groundwater and the Columbia River. Institutional controls are required for the site to prevent drilling or excavation into deep zone soils. The basis for reclassification is described in detail in the *Cleanup Verification Package for the 100-K-55:1 and 100-K-56:1 Pipelines and the 116-KW-4 and 116-KE-5 Heat Recovery Stations* (CVP-2005-00006), Washington Closure Hanford, Richland, Washington.

J. Zeisloft DOE-RL Project Manager	Signature	9/22/05 Date
NA Ecology Project Manager	Signature	Date
L. E. Gadbois EPA Project Manager	Laurene E Gadbois Signature	9-23-2005 Date

Attachment ES-3
Waste Site Reclassification Form

Date Submitted: 09/21/05 **Originator:** R. A. Carlson **Phone:** 373-1440	**Operable Unit(s):** 100-KR-2 **Waste Site ID:** 116-KW-4 **Type of Reclassification Action:** Rejected ☐ Closed Out ☐ Interim Closed Out ☒ No Action ☐	**Control Number:** 2005-031 **Lead Agency:** EPA

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

Description of current waste site condition:

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

Basis for reclassification:

The 116-KW-4 site has been remediated in conjunction with the co-located 100-K-55:1 pipelines to the level of cleanup standards specified in the 1997 *Amendment to the Interim Action Record of Decision for the 100-BC-1, 100-DR-1, and 100-HR-1 Operable Units, Hanford Site, Benton County, Washington,* U.S. Environmental Protection Agency, Region 10, Seattle, Washington (EPA/AMD/R10-97/044). Remedial actions were performed so as to not preclude any future uses (as bounded by the rural-residential scenario), to allow unrestricted use of shallow zone soils (i.e., surface to 4.6 m [15 ft] deep), and to protect groundwater and the Columbia River. This site does not have a deep zone; therefore, no deep zone institutional controls are required. The basis for reclassification is described in detail in the *Cleanup Verification Package for the 100-K-55:1 and 100-K-56:1 Pipelines and the 116-KW-4 and 116-KE-5 Heat Recovery Stations* (CVP-2005-00006), Washington Closure Hanford, Richland, Washington.

J. Zeisloft DOE-RL Project Manager	Signature	9/22/05 Date
NA Ecology Project Manager	Signature	Date
L. E. Gadbois EPA Project Manager	Laurence E Gadbois Signature	9-23-2005 Date

Attachment ES-4
Waste Site Reclassification Form

Date Submitted: 09/21/05 **Originator:** R. A. Carlson **Phone:** 373-1440	**Operable Unit(s):** 100-KR-2 **Waste Site ID:** 116-KE-5 **Type of Reclassification Action:** Rejected ☐ Closed Out ☐ Interim Closed Out ☒ No Action ☐	**Control Number:** 2005-032 **Lead Agency:** EPA

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

Description of current waste site condition:

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

Basis for reclassification:

The 116-KE-5 site has been remediated in conjunction with the co-located 100-K-56:1 pipelines to the level of cleanup standards specified in the 1997 *Amendment to the Interim Action Record of Decision for the 100-BC-1, 100-DR-1, and 100-HR-1 Operable Units, Hanford Site, Benton County, Washington,* U.S. Environmental Protection Agency, Region 10, Seattle, Washington (EPA/AMD/R10-97/044). Remedial actions were performed so as to not preclude any future uses (as bounded by the rural-residential scenario), to allow unrestricted use of shallow zone soils (i.e., surface to 4.6 m [15 ft] deep), and to protect groundwater and the Columbia River. This site does not have a deep zone; therefore, no deep zone institutional controls are required. The basis for reclassification is described in detail in the *Cleanup Verification Package for the 100-K-55:1 and 100-K-56:1 Pipelines and the 116-KW-4 and 116-KE-5 Heat Recovery Stations* (CVP-2005-00006), Washington Closure Hanford, Richland, Washington.

J. Zeisloft DOE-RL Project Manager	Signature	9/22/05 Date
NA Ecology Project Manager	Signature	Date
L. E. Gadbois EPA Project Manager	Laurence E Gadbois Signature	9-23-2005 Date

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ACRONYMS AND ABBREVIATIONS

COC	contaminant of concern
COPC	contaminant of potential concern
CVP	cleanup verification package
DQA	data quality assessment
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
NaI	sodium iodide
RAG	remedial action goal
RAO	remedial action objective
RDR/RAWP	remedial design report/remedial action work plan
RESRAD	RESidual RADioactivity (dose assessment model)
ROD	record of decision
SAP	sampling and analysis plan
UCL	upper confidence limit
WAC	*Washington Administrative Code*

1.0 INTRODUCTION

This cleanup verification package (CVP) documents that the 100-K-55:1 and 100-K-56:1 pipelines were remediated in accordance with the *Amendment to the Interim Action Record of Decision for the 100-BC-1, 100-DR-1, and 100-HR-1 Operable Units, Hanford Site, Benton County, Washington* (ROD) (EPA 1997). Remedial action objectives (RAOs) and remedial action goals (RAGs) for these sites are documented in the ROD (EPA 1997) and the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP) (DOE-RL 2005b). The ROD provides the U.S. Department of Energy, Richland Operations Office the authority, guidance, and objectives to conduct this remedial action. This CVP also documents that the 116-KW-4 and 116-KE-5 sites were remediated as part of remedial efforts for the 100-K-55:1 and 100-K-56:1 pipelines.

The remedy specified in the ROD and conducted for the 100-K-55:1 and 100-K-56:1 pipelines and co-located 116-KW-4 and 116-KE-5 sites included (1) excavating the sites to the extent required to meet specified soil cleanup levels, (2) disposing of contaminated excavation materials at the Environmental Restoration Disposal Facility (ERDF) in the 200 Area of the Hanford Site, and (3) backfilling the site with clean soil to average adjacent grade elevation. Excavation was driven by RAOs for direct exposure, protection of groundwater, and protection of the Columbia River. For the respective points of compliance, RAGs summarized in Table 1 were established for the contaminants of concern (COCs) in the RDR/RAWP (DOE-RL 2005b). Waste site COCs listed in Table 1 were identified in the *100 Area Remedial Action Sampling and Analysis Plan* (SAP) (DOE-RL 2001a) for the 100-K-55 and 100-K-56 pipelines. No documented COCs exist for the 116-KW-4 and 116-KE-5 sites but, based on operational knowledge, ethylene glycol was identified as the primary potential residual contaminant for these sites. In addition, residual concentrations of arsenic, barium, cadmium, hexavalent chromium, total chromium, mercury, and lead were also evaluated for these sites. The RAGs for these contaminants of potential concern (COPCs) are summarized in Table 2.

Table 1. 100-K-55:1 and 100-K-56:1 Remedial Action Goals.

COCs	Direct Exposure RAG[a]	Groundwater Protection RAG (pCi/L)[b]	Columbia River Protection RAG (pCi/L)[b]
Cesium-137	15 mrem/yr (cumulative)[a]	4 mrem/yr (cumulative)[b]	4 mrem/yr (cumulative)[b]
Europium-152			
Europium-154			

[a] Lookup values that correspond to the 15 mrem/yr dose rate are based on a generic site model and are presented in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP) (DOE-RL 2005b).
[b] Lookup values that correspond to the individual radionuclide 4 mrem/yr dose rate equivalent for beta- and gamma-emitter RAGs per National Drinking Water Standards as presented in the RDR/RAWP (DOE-RL 2005b) and Table 5 of this cleanup verification package.
COC = contaminant of concern
RAG = remedial action goal

Table 2. 116-KW-4 and 116-KE-5 Remedial Action Goals.

COPCs	Direct Exposure RAG (mg/kg)	Soil RAG for Groundwater Protection (mg/kg)	Soil RAG for Columbia River Protection (mg/kg)
Arsenic	20[a]	20[a]	20[a]
Barium	5,600[b]	132[c]	224
Cadmium	13.9[d]	0.81[c]	0.81[c]
Ethylene glycol	160,000[b]	3,200	6,400
Hexavalent chromium	2.1[e] 240[f]	8[g]	2[h]
Total chromium	80,000[b]	18.5[c]	18.5[c]
Lead	353[h]	10.2[c]	10.2[c]
Mercury	24[b]	0.33[c]	0.33[c]

[a] The cleanup level of 20 mg/kg has been agreed to by the Tri-Party project managers (DOE-RL 2005b).
[b] Noncarcinogenic cleanup level calculated from WAC 173-340-740(3), Method B, 1996.
[c] Where cleanup levels are less than background, cleanup levels default to background (WAC 173-340-700[4][d]) (1996).
[d] Value calculated based on the inhalation exposure pathway per WAC 173-340-750(4)(b)(ii)(A) or (B).
[e] *Calculation of Hexavalent Chromium Carcinogenic Risk*, 0100X-CA-V0031 (BHI 2000).
[f] WAC 173-340-750(3) Method B noncarcinogenic cleanup limit.
[g] Soil RAG based on "100 times groundwater cleanup" rule as presented in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP) (DOE-RL 2005b).
[h] Soil RAG based on 100 times dilution attenuation factor times surface water quality standard as presented in the RDR/RAWP (DOE-RL 2005b).
[i] A WAC 173-340-740(3) (1996) value for lead is not available. This value is based on the *Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children* (EPA 1994).
COPC = contaminant of potential concern
RAG = remedial action goal
WAC = *Washington Administrative Code*

2.0 SITE DESCRIPTION AND SUPPORTING INFORMATION

The 100-K-55 and 100-K-56 pipelines and the 116-KW-4 and 116-KE-5 sites are all part of the 100-KR-2 Operable Unit in the 100-K Area. The 100-K-55 pipelines consist of the gravity-flow process effluent pipelines that formerly serviced the 105-KW Reactor (Figure 1), terminating at the 116-K-1 Crib, the 116-K-2 Trench, and the 116-KW-3 retention basins. The 100-K-56 pipelines were the equivalent process effluent pipelines for the 105-KE Reactor (Figure 2), terminating at the 116-K-1 Crib, the 116-K-2 Trench, and the 116-KE-4 retention basins. These pipelines consisted primarily of carbon steel piping, ranging in size from 0.08 m (3 in.) to 1.83 m (72 in.). A 0.61-m (24-in.) process water pipeline connecting the two reactor buildings is also administratively part of the 100-K-55 and 100-K-56 sites.

Figure 1. Hanford Site Map and 100-K-55 and 116-KW-4 Site Plans.

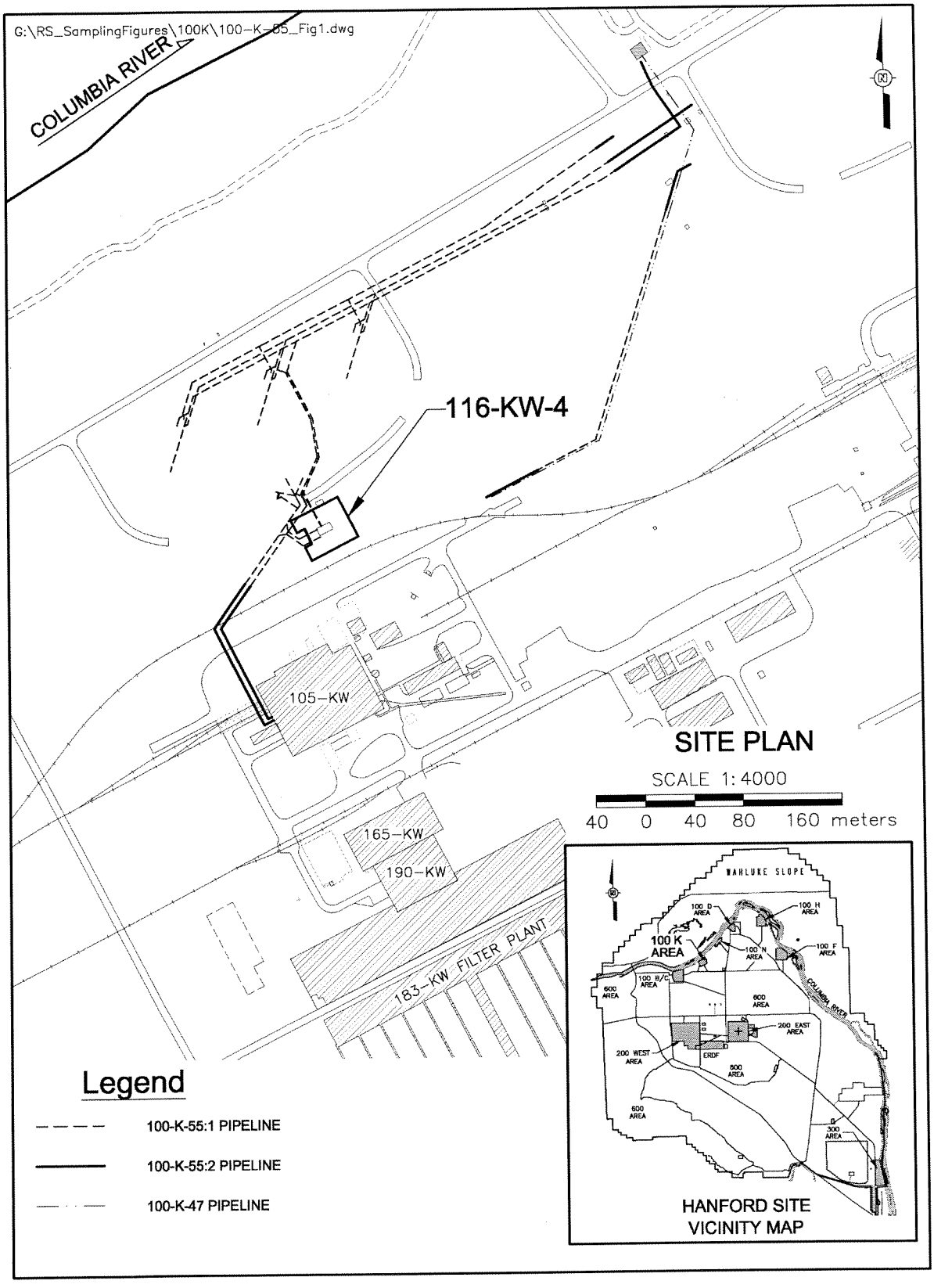
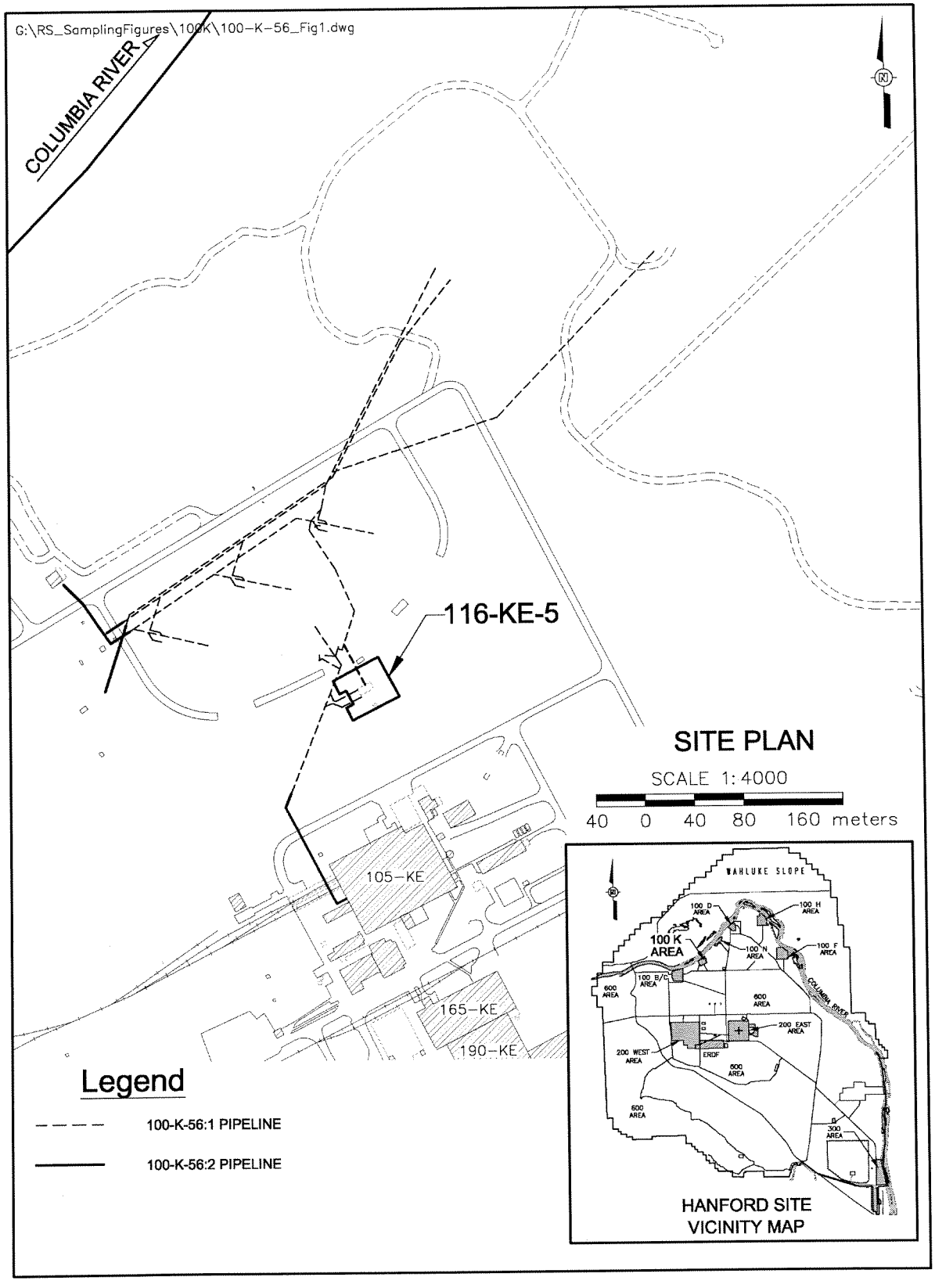


Figure 2. Hanford Site Map and 100-K-56 and 116-KE-5 Site Plans.



The 100-K-55 and 100-K-56 pipelines have been divided into subsites to address the current extent of remedial action. Remediation of the full lengths of the pipelines has not been completed in the interests of preserving reactor security fences and active subsurface utility features. The portions of the pipelines addressed within this CVP have been identified as the 100-K-55:1 and 100-K-56:1 pipelines, with administrative boundaries indicated in Figures 1 and 2. Closeout of the remaining 100-K-55:2 and 100-K-56:2 pipelines will be addressed separately.

The 116-KW-4 and 116-KE-5 sites consist of the former heat recovery stations associated with the 100-K-55 and 100-K-56 pipelines, respectively. The facilities at these sites consisted of heat exchangers using an ethylene glycol solution to recover heat for space heating and process requirements in 100-K Area facilities. The heat exchangers were removed from these facilities prior to remedial action, leaving residual piping at the sites.

3.0 REMEDIAL ACTION FIELD ACTIVITIES

3.1 EXCAVATION AND DISPOSAL

Remedial action activities at the 100-K reactor effluent pipelines began on December 9, 2002. Remediation of the pipelines involved excavation and staging of overburden material and removal of contaminated piping, debris, and soil. Contaminated materials were disposed at the ERDF.

Remedial action excavation was completed on April 15, 2005. Pre- and post-remediation topographic maps are shown in Figures 3 through 8. Note that the Waste Information Data System boundaries for the 116-KW-4 and 116-KE-5 sites are much larger than the actual footprint of the heat recovery facilities. The soil area beneath each of the former heat recovery stations was excavated in its entirety with the removal of the co-located pipelines. Approximately 55,960 m^2 (602,350 ft^2) of plan area was excavated, including excavation within the deep zone (greater than 4.6 m [15 ft] below ground surface) up to 8.8 m (29 ft) below ground surface where necessary to complete remediation. Approximately 86,551 metric tons (95,406 U.S. tons) of material from the sites was removed and disposed at the ERDF.

The active 100-K-47 concrete culvert shown in Figures 3 and 6 was not removed during remediation of the adjacent section of the 100-K-55:1 pipeline. Verification samples collected adjacent to the culvert (shallow zone sample areas E10 and F1 through F4 and deep zone sample areas B4 through B6, C7 through C9, D1, D2, and D10) did not indicate contamination associated with the culvert (see Appendix A).

Figure 3. Pre-Remediation Topographic Plan for the 100-K-55 Pipelines and 116-KW-4 Site.

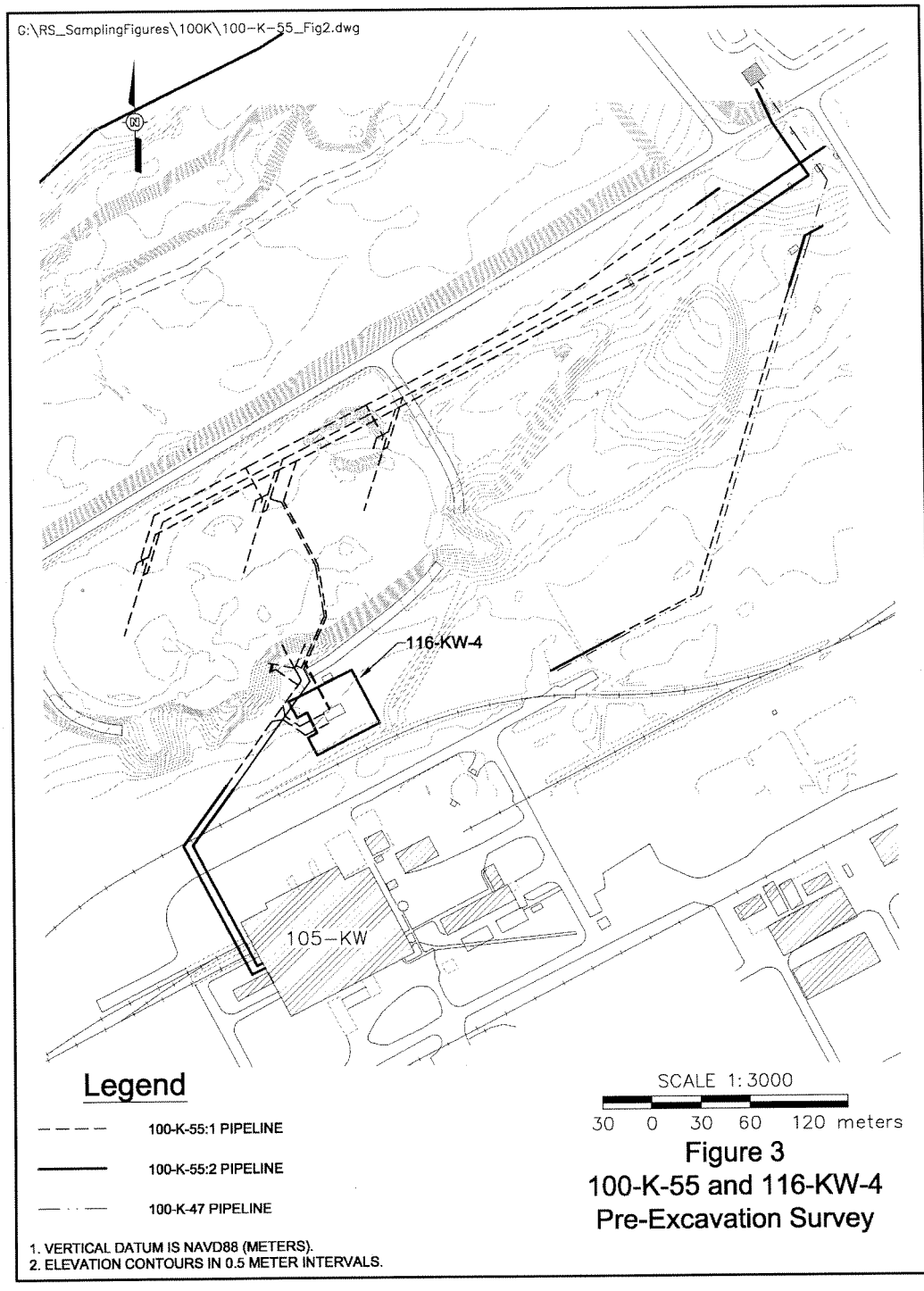


Figure 4. Pre-Remediation Topographic Plan for the Western 100-K-56 Pipelines and 116-KE-5 Site.

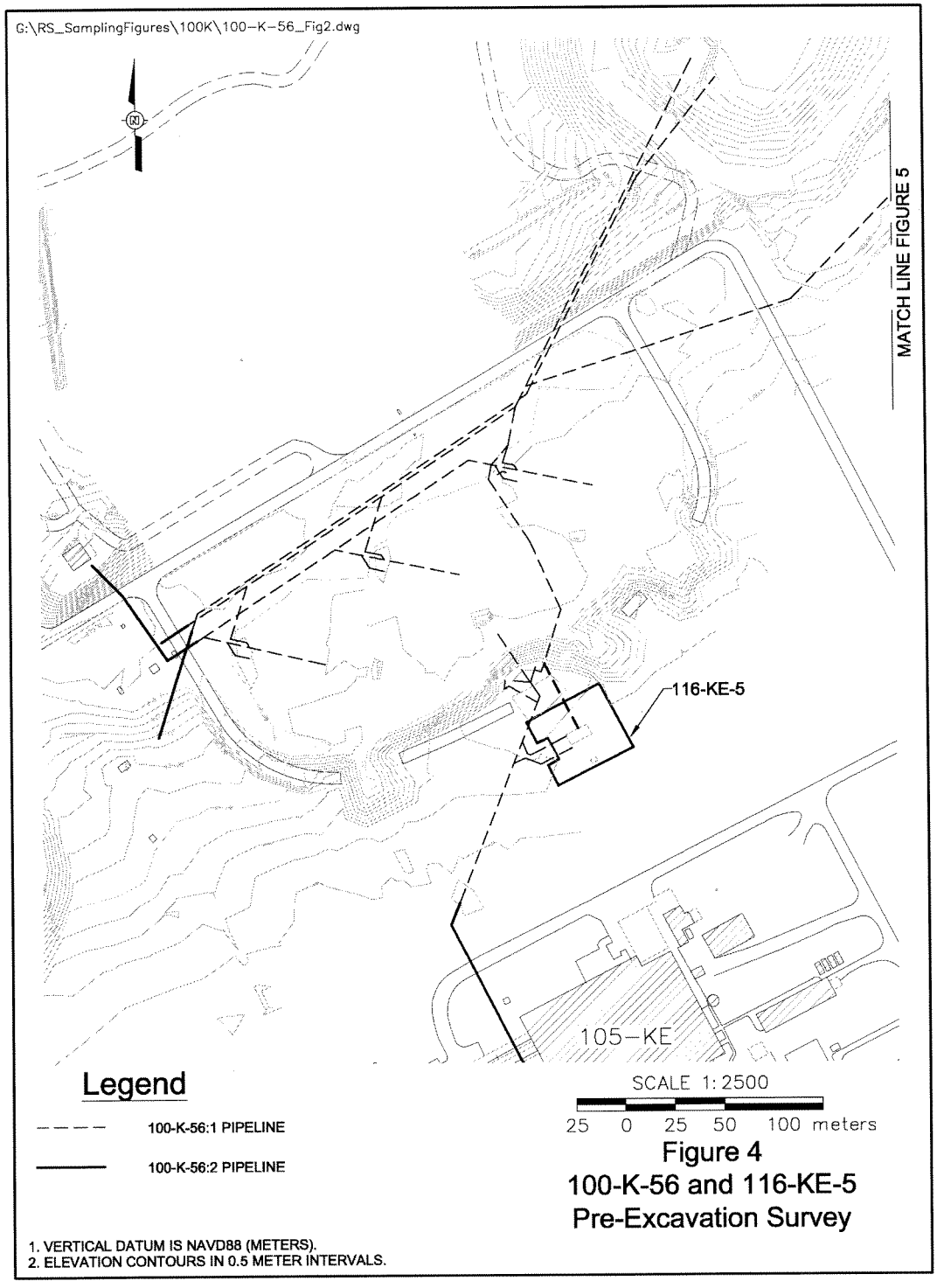


Figure 5. Pre-Remediation Topographic Plan for the Eastern 100-K-56 Pipelines.

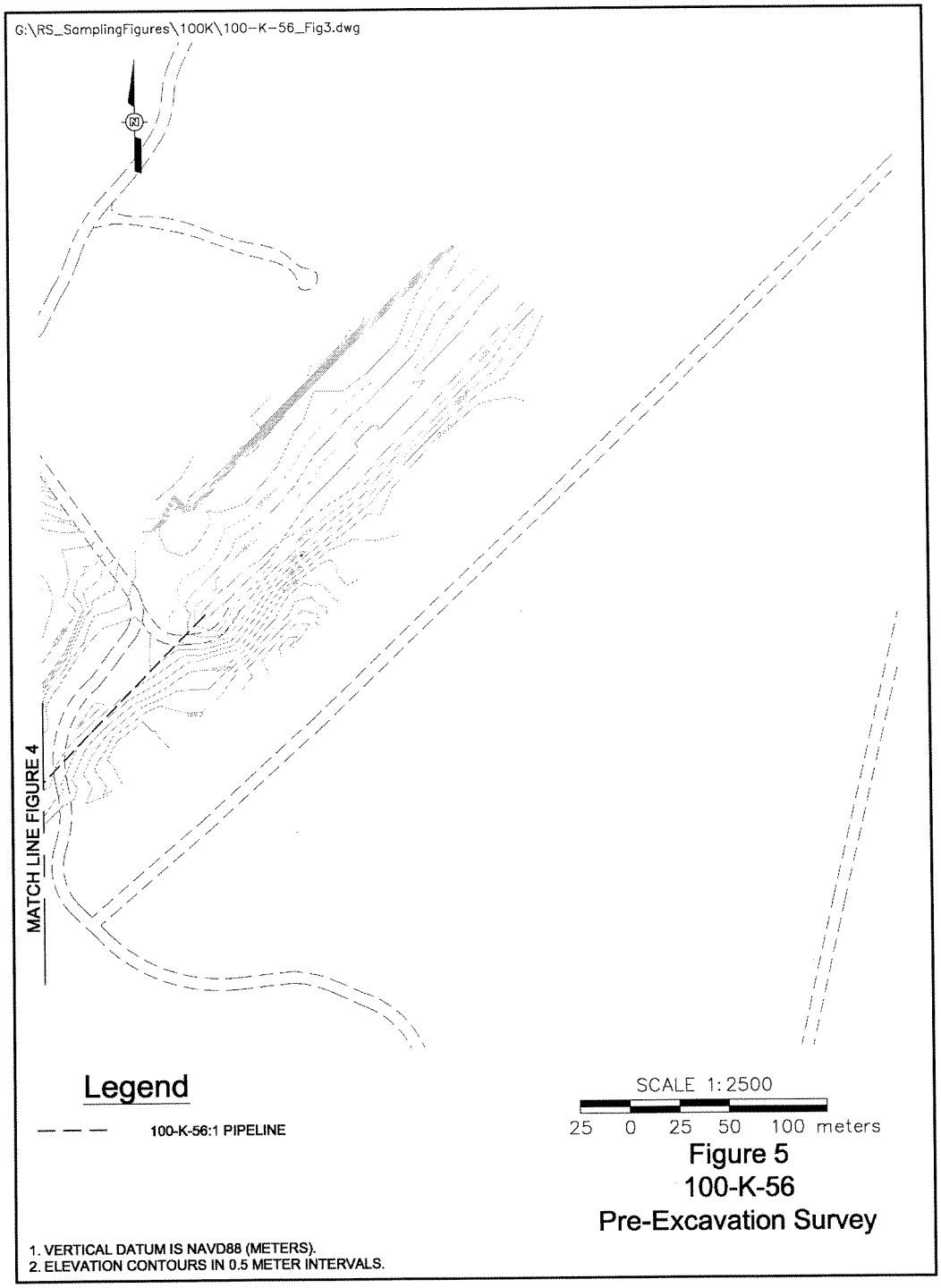


Figure 6. Post-Remediation Topographic Plan for the 100-K-55 Pipelines and 116-KW-4 Site.

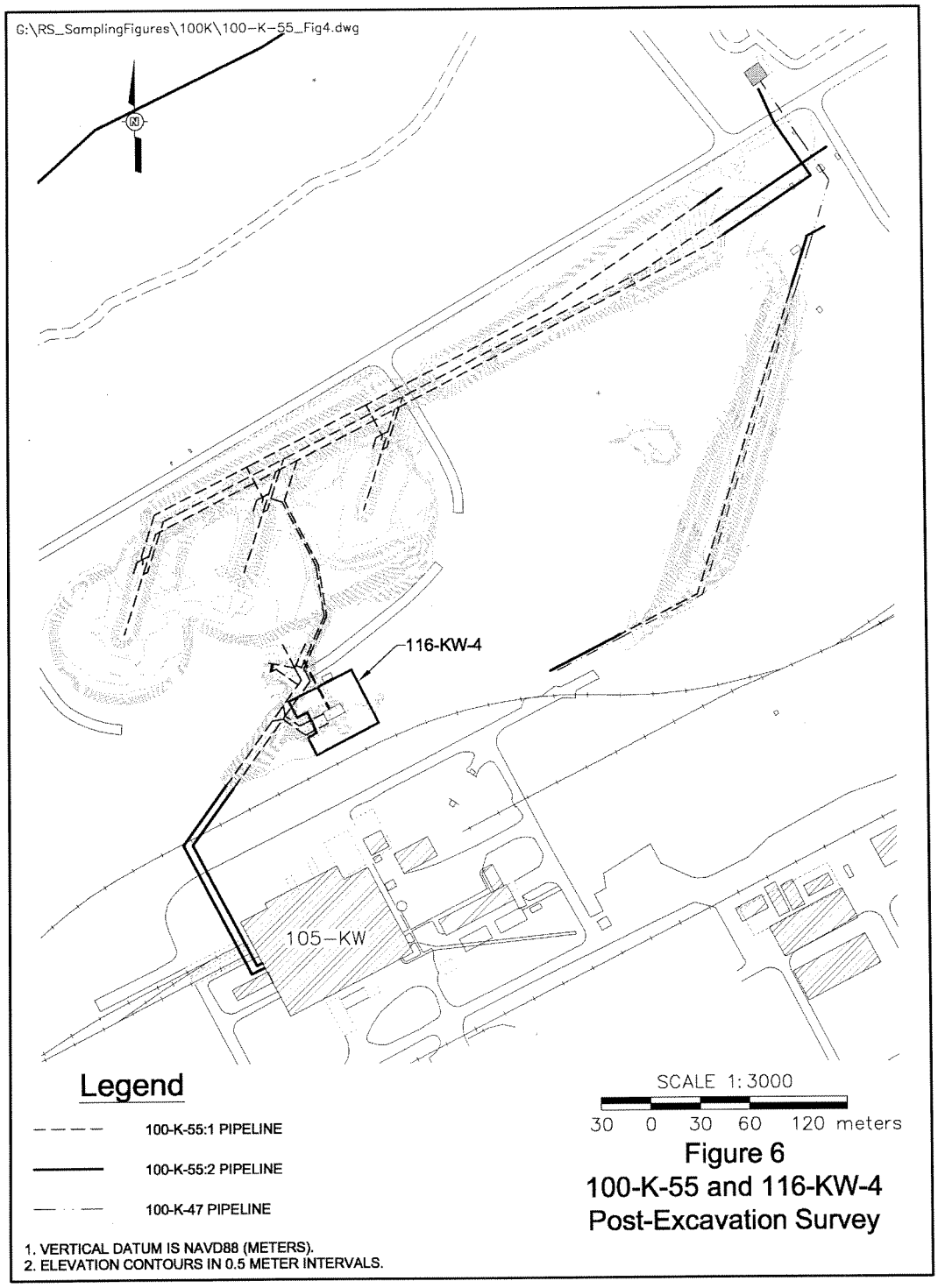


Figure 7. Post-Remediation Topographic Plan for the Western 100-K-56 Pipelines and 116-KE-5 Site.

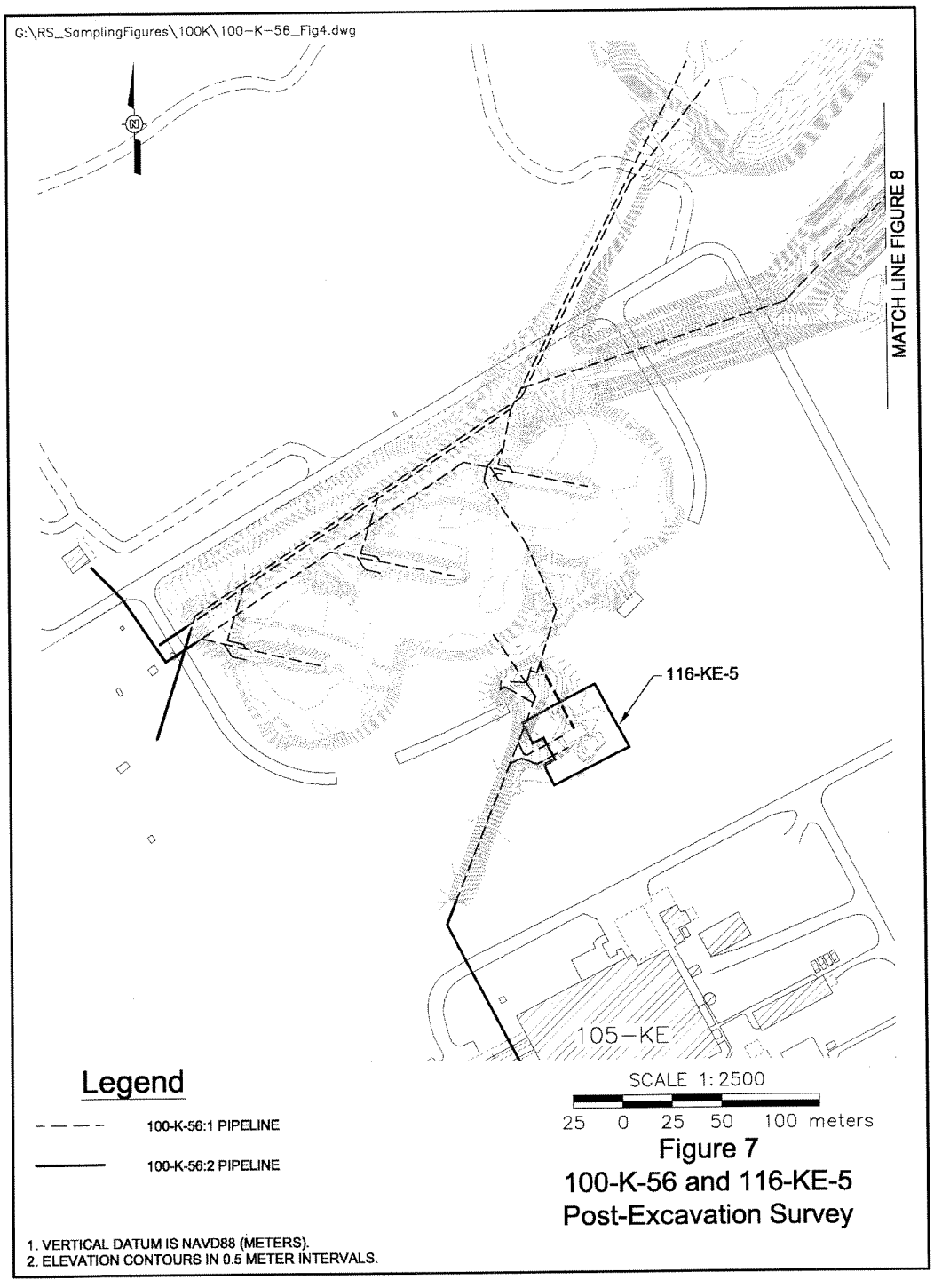
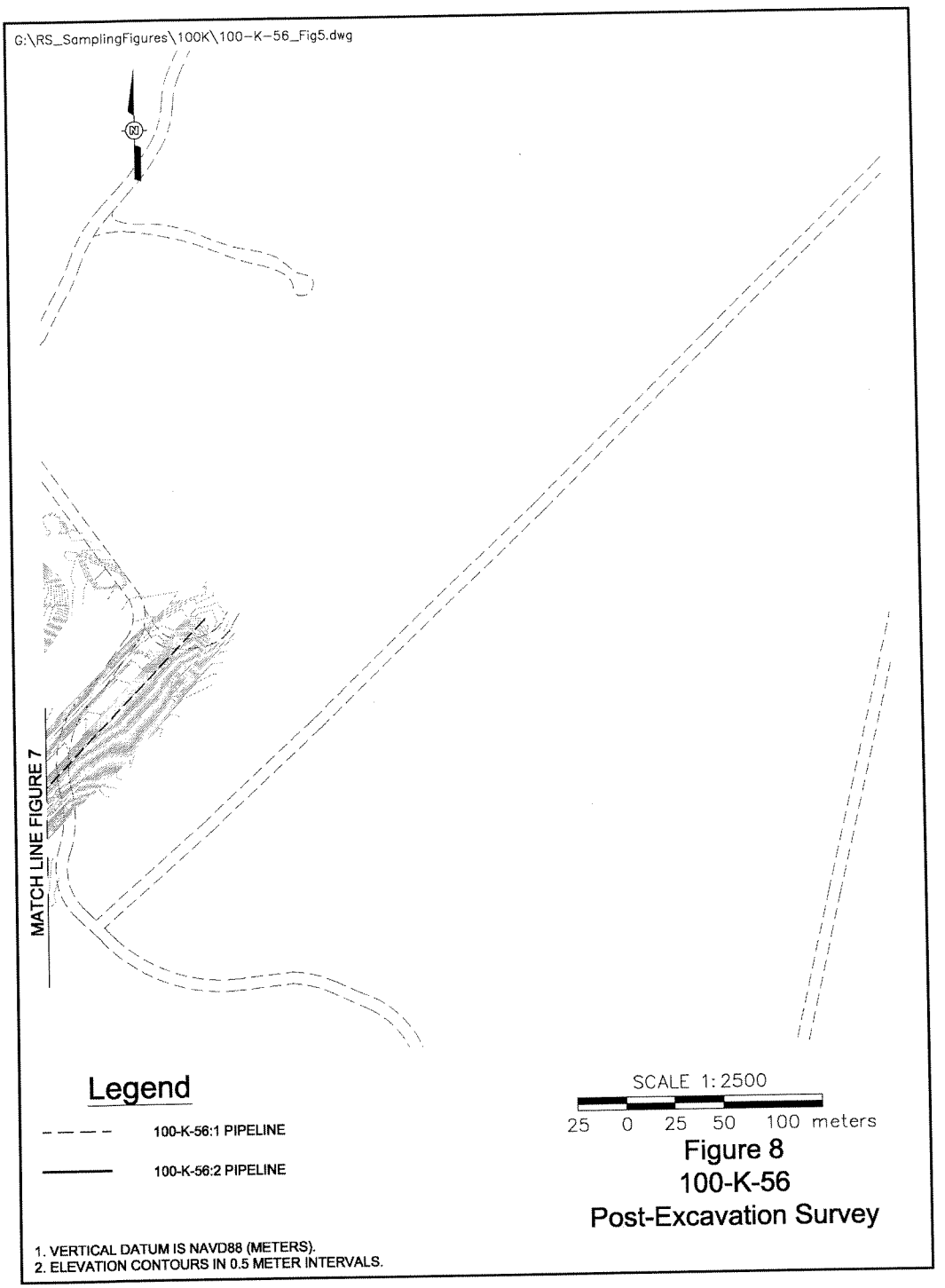


Figure 8. Post-Remediation Topographic Plan for the Eastern 100-K-56:1 Pipelines.



3.2 FIELD SCREENING AND VARIANCE SAMPLING

Radiological field screening was conducted during the site remedial actions as specified in the SAP (DOE-RL 2001a). Field screening was used to guide the excavation to quickly assess for the presence and level of contamination. Field screening for the sites included using a radiological data mapping system survey, hand-held sodium iodide (NaI) detectors, and gamma energy analyses of grab samples. The radiological mapping survey was performed over more than 50% of the site excavation surface area. The hand-held NaI detectors were used to screen excavated waste material and to screen for potential excavation wall and floor hot spots. Gamma energy analyses were used to support waste characterization and to corroborate the radiological mapping survey and hand-held NaI detector data.

Variance analysis was performed following field screening. The variance analysis quantifies the variability of residual contamination (see calculation brief in Appendix C). This information was used to determine the site-specific number of final cleanup verification samples to be collected. Initial analytical results indicated an area of excessive residual radionuclide contamination in area E9 of the 100-K-56:1 remediation footprint (sample J037K1 at node E9-14). Additional remediation was performed and a second sample (J03JN1) collected at the sampling node pursuant to the SAP (DOE-RL 2005a). The analytical results for the first sample were replaced with those for the second sample for the purposes of variance calculations (Appendix C).

The results of the variance analysis indicated that the number of verification samples to be taken for each shallow zone and overburden decision subunit of the 100-K-55:1 and 100-K-56:1 sites was less than the default number of four specified in the SAP (DOE-RL 2005a); therefore, four final verification samples were collected from each shallow zone and overburden decision subunit. The default number of three (DOE-RL 2005a) verification samples was collected from each deep zone decision subunit.

Variance analysis was not performed separately for the 116-KW-4 and 116-KE-5 sites, as the excavated footprints of these sites were considered within analyses of the 100-K-55:1 and 100-K-56:1 sites, respectively.

3.3 CLEANUP VERIFICATION SAMPLING AND ANALYSIS

Final cleanup verification sampling was conducted from January 26, 2005, to June 23, 2005 (BHI 2005b, 2005c), following variance analysis. The final verification samples were submitted to offsite laboratories for analysis using approved U.S. Environmental Protection Agency (EPA) analytical methods as required per the SAP (DOE-RL 2005a). Each verification sample was composed of a composite sample formed by combining soil collected at the required number of randomly selected locations within each sampling area (excluding the quality assurance/quality control samples).

The division of the 100-K-55:1 and 100-K-56:1 site excavations into decision units (i.e., shallow zone and deep zone) as shown on the sample design figures (Appendix C) is a function of the applicable RAGs. The direct exposure, groundwater protection, and river protection RAGs are applicable to soils within 4.6 m (15 ft) of the ground surface (i.e., shallow zone and overburden soil). The groundwater protection and river protection RAGs are applicable to soils greater than 4.6 m (15 ft) below the ground surface (i.e., deep zone).

The 100-K-55:1 and 100-K-56:1 sites consisted of shallow zone, deep zone, and overburden decision units. The shallow zone consisted of the excavation sidewalls and floors that were less than 4.6 m (15 ft) below ground surface. The deep zone consisted of the portions of the excavation sidewalls and excavation floor that were more than 4.6 m (15 ft) below ground surface. The shallow zone decision units for the 100-K-55:1 and 100-K-56:1 sites contained six and five decision subunits, respectively, divided into four sampling areas per decision subunit. The deep zone decision units for the 100-K-55:1 and 100-K-56:1 sites contained four and three decision subunits, respectively, divided into three sampling areas per decision subunit. The combined overburden decision unit for the sites contained 12 subunits, divided into four sampling areas per decision subunit. All sampling areas were further divided into 16 sampling nodes each as shown in the sample design methodology and sample location figures presented in the calculation briefs for variance analysis and sample design in Appendix C.

In addition to the statistical verification samples collected, one discrete verification sample was collected in each of the footprints of the 116-KW-4 and 116-KE-5 sites, and analyzed for COPCs associated with these sites. A total of six discrete verification samples were also collected within the footprints of the 116-KW-3 and 116-KE-4 retention basins at the former points of discharge to the 100-K-55 and 100-K-56 pipelines. These samples were analyzed for the COCs associated with the retention basins. All discrete samples were collected from shallow zone soils (the 116-KW-3, 116-KW-4, 116-KE-4, and 116-KE-5 sites do not contain a deep zone) at locations shown in the figures included with the sample designs in Appendix C.

4.0 CLEANUP VERIFICATION DATA EVALUATION

This section presents the evaluation and modeling of the 100-K-55:1, 100-K-56:1, 116-KW-4, and 116-KE-5 cleanup verification data for comparison with the data quality criteria and RAGs.

4.1 DATA QUALITY ASSESSMENT PROCESS

A data quality assessment (DQA) is performed to compare the verification sampling approach and resulting analytical data with the sampling and data quality requirements specified by the project objectives and performance specifications.

The DQA for the 100-K-55:1, 100-K-56:1, 116-KW-4, and 116-KE-5 sites determined that the data are of the right type, quality, and quantity to support site verification decisions within specified error tolerances. All analytical data were found to be acceptable for decision-making purposes. The evaluation also verified that the sample design was sufficient to support clean site verification. The cleanup verification sample analytical data are stored in the Hanford Environmental Information System and are summarized in Appendix A. The detailed DQA is presented in Appendix B.

4.2 CONTAMINANTS OF CONCERN 95% UPPER CONFIDENCE LIMIT

The primary statistical calculation to support cleanup verification is the 95% upper confidence limit (UCL) on the arithmetic mean of the data. The 95% UCL values for each COC are computed for each decision unit (e.g., for the shallow and deep zones for each site, as appropriate). Prior to calculating the 95% UCL, the individual sample results are reviewed and, as appropriate, adjusted per the SAP (DOE-RL 2005a). This process is summarized below.

Verification sampling summary statistics (95% UCL values) for the 100-K-55:1 and 100-K-56:1 pipelines are listed in Table 3. Individual sample cleanup verification results are presented in Appendix A.

Table 3. 100-K-55:1 and 100-K-56:1 Cleanup Verification Data Set.

COCs	95% UCL Statistical Values (pCi/g)			Hanford Site Background[b] (pCi/g)	Cleanup Verification Data Set[c] (pCi/g)		
	Shallow Zone	Deep Zone	Overburden[a]		Shallow Zone	Deep Zone	Overburden
100-K-55:1[d]							
Cesium-137	0.27	0.82	0.30	1.1	0.27	0.82	0 (<BG)
Europium-152	0.73	0.74	0.30	NA	0.73	0.74	0.30
Europium-154	0.12	0.12	0.086	0.033	0.12	0.12	0.053
100-K-56:1[d]							
Cesium-137	0.61	1.32	0.30	1.1	0.61	1.32	0 (<BG)
Europium-152	1.7	13.7	0.30	NA	1.7	13.7	0.30
Europium-154	0.14	1.87	0.086	0.033	0.14	1.87	0.053

[a] Overburden material from the 100-K-55:1 and 100-K-56:1 pipelines was considered as one decision unit.
[b] Represents the 90th percentile of the lognormal distribution (DOE-RL 1996).
[c] For overburden, anthropogenic background (DOE-RL 1996) and naturally occurring background is subtracted from all radionuclides. For other decision units (e.g., shallow zone and deep zone), only naturally occurring background (uranium) is subtracted. Refer to the 95% UCL calculation brief in Appendix C for additional details on determination of statistical values.
[d] Laboratory data, including the minimum detectable activities for the individual cleanup verification samples, are included in Appendix A and the 95% UCL calculation briefs in Appendix C.
BG = background
COC = contaminant of concern
NA = not applicable
UCL = upper confidence limit

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

Statistical calculations are presented in the 100-K-55:1 95% UCL calculation and the 100-K-56:1 95% UCL calculation (Appendix C), with results shown in Table 3. The columns on the left side of Table 3 are the COCs and the 95% statistical values before subtraction of background. The fifth column of Table 3 presents the background where values exist, and the last three columns present the statistical values adjusted for background, if appropriate, which becomes the cleanup verification data set used for RESidual RADioactivity (RESRAD) modeling.

Additional cleanup verification data collected at the points of discharge from the 116-KW-3 and 116-KE-4 retention basins is provided in Table 4. These locations are considered focused, worst-case locations, and, as such, are evaluated as discrete points separate from the statistical data set. The first two columns of Table 4 present the COCs for the retention basins (which are inclusive of the effluent pipeline COCs) and maximum analytical results, and the final column presents the background concentration where values exist.

Verification sampling of the 116-KW-4 and 116-KE-5 sites was based on a focused, rather than statistical, sampling design. As such, statistical analysis (e.g., calculation of a 95% UCL value) is inappropriate, and evaluation of the data sets is based on the maximum detected concentration of each COPC as reported in Table 5. The first two columns of Table 5 present the COPCs and maximum analytical results, and the final column presents the background concentration where values exist. Reported results are not adjusted for background for any of the contaminants listed, as comparison against background is considered in evaluation of RAG attainment in Section 5.0.

The results of discrete sampling at the 100-K-55:1 and 100-K-56:1 sites within the footprints of the former 116-KW-3 and 116-KE-4 retention basins are provided in Appendix A.

Table 4. Maximum Concentrations at the Former 116-KW-3 and 116-KE-4 Retention Basin Discharge Points.

COCs	Maximum Values (pCi/g)	Hanford Site Background[a] (pCi/g)
116-KW-3 Radionuclides[b]		
Cesium-137	0.61	NA
Cobalt-60	0.11	NA
Europium-152	1.3	NA
Europium-154	0.19	NA
Plutonium-239/240	ND	NA
Strontium-90	0.366	NA
Uranium-233/234	0.70	1.10
Uranium-235	0.094	0.11
116-KW-3 Nonradionuclides[b]		
Hexavalent chromium	ND	NA
116-KE-4 Radionuclides[b]		
Cesium-137	0.31	NA
Cobalt-60	0.15	NA
Europium-152	3.11	NA
Europium-154	0.33	NA
Plutonium-239/240	ND	NA
Strontium-90	0.496	NA
Uranium-233/234	0.454	1.10
Uranium-235	0.027	0.11
116-KE-4 Nonradionuclides[b]		
Hexavalent chromium	0.94	NA

[a] Represents the 90th percentile of the lognormal distribution (DOE-RL 1996).
[b] Laboratory data, including the practical quantitation limits for the individual cleanup verification samples, are included in Appendix A.
COC = contaminant of potential concern
NA = not applicable
ND = not detected

Table 5. 116-KW-4 and 116-KE-5 Cleanup Verification Data Set.

COPCs	Maximum Values (mg/kg)	Hanford Site Background[a] (mg/kg)
116-KW-4[b]		
Ethylene glycol	ND	NA
Arsenic	2.6	20[c]
Barium	59.3	132
Cadmium	ND	0.81[d]
Chromium (total)	12.1	18.5
Hexavalent chromium	0.24	NA
Lead	4.5	10.2
Mercury	0.02	0.33
116-KE-5[b]		
Ethylene glycol	59	NA
Arsenic	3.7	20[c]
Barium	100	132
Cadmium	ND	0.81[d]
Chromium (total)	30	18.5
Hexavalent chromium	0.33	NA
Lead	11.3	10.2
Mercury	0.10	0.33

[a] Represents the 90th percentile of the lognormal distribution (DOE-RL 2001b).
[b] Laboratory data, including the practical quantitation limits for the individual cleanup verification samples, are included in Appendix A.
[c] The cleanup level of 20 mg/kg has been agreed to by the Tri-Party project managers (DOE-RL 2005b).
[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).
COPC = contaminant of potential concern
NA = not applicable
ND = not detected

4.3 SITE-SPECIFIC CLEANUP VERIFICATION MODEL

The statistical values summarized in Table 3 were evaluated and used to develop site-specific cleanup verification models. The 100-K-55:1 and 100-K-56:1 site cleanup verification models comprise two depth intervals: (1) the shallow zone and overburden and (2) the deep zone. The site-specific cleanup verification model for all COCs assumes the worst case described in the RDR/RAWP (DOE-RL 2005b), where the deep zone statistical concentrations continue at the same concentrations to groundwater. Schematic cross sections of this site-specific cleanup verification model are included in the RESRAD calculations in Appendix C. The elements of the RESRAD modeling are described in Section 4.4.

4.4 RESRAD MODELING

The individual radionuclide cleanup verification statistical values (Table 3) were entered into the RESRAD computer code, Version 6.22 (ANL 2004), to estimate the residential dose rate and the impact on groundwater and the Columbia River from residual COC concentrations. The direct radiation exposure dose rate to the resident living in his or her basement (rural-residential scenario) was conservatively estimated by substituting (for analysis purposes) a case where the resident is standing on level ground with the soil containing concentrations representative of residual (i.e., post-cleanup) shallow zone soils. This is conservative because it ignores the potential shielding effects of concrete basement walls and any clean backfill between residual soils and the basement walls.

The RESRAD modeling methodologies, results, input values, and the site-specific cleanup verification model are included in the RESRAD calculation brief (Appendix C). The drinking water dose rate calculations based on the RESRAD estimated groundwater radionuclide concentrations are shown in the comparison to drinking water standards calculation brief (Appendix C). Specific results from the calculations are discussed as part the RAG-attainment evaluation (Section 5.0).

5.0 EVALUATION OF REMEDIAL ACTION GOAL ATTAINMENT

This section demonstrates that remedial actions at the 100-K-55:1, 100-K-56:1, 116-KW-4, and 116-KE-5 sites have achieved the applicable RAGs. Sections 5.1, 5.2, and 5.3 address attainment of direct exposure RAGs, groundwater protection RAGs, and Columbia River protection RAGs, respectively. Section 5.4 documents application of the *Washington Administrative Code* (WAC) 173-340-740(7)(e) three-part test, which is required for nonradionuclide COCs only.

5.1 DIRECT EXPOSURE SOIL REMEDIAL ACTION GOALS ATTAINED

5.1.1 Radionuclides

The results of the combined RESRAD dose rate estimates for the 100-K-55:1 site shallow and deep zone all-pathways scenarios are presented in Figure 9. The results of the combined RESRAD dose rate estimates for the 100-K-56:1 site shallow and deep zone all-pathways scenarios are presented in Figure 10. The results of the RESRAD dose rate estimate for overburden material under all-pathways scenarios are presented in Figure 11. No radionuclide COCs were identified for the 116-KW-4 and 116-KE-5 sites separate from the associated pipeline sites. The dose rates presented represent the dose contributions from soils at relevant time periods.

Figure 9. Combined Shallow and Deep Zone Dose Rate Estimates for the 100-K-55:1 Site (All Radionuclides, All Pathways).

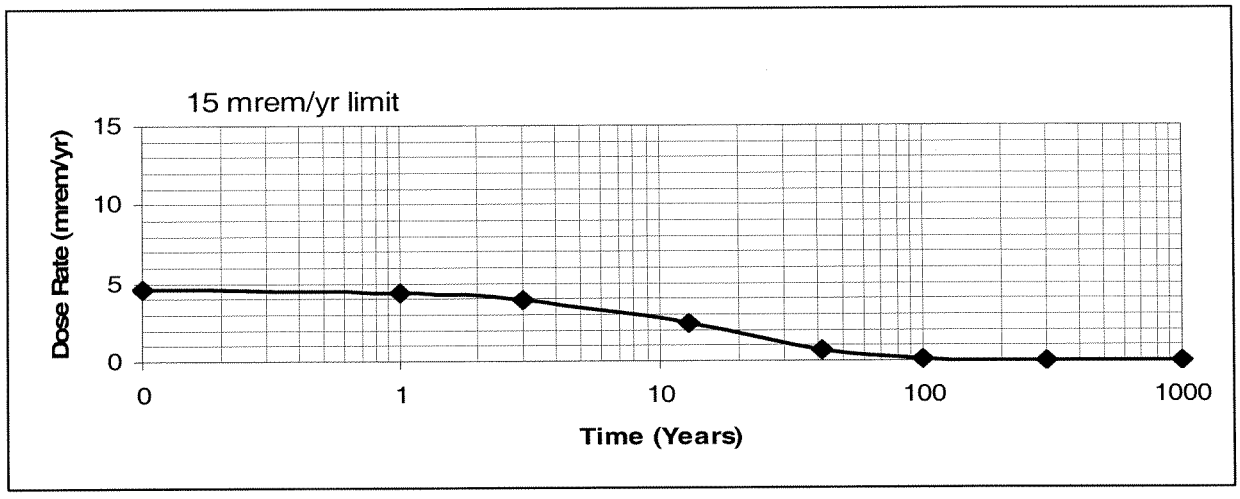


Figure 10. Combined Shallow and Deep Zone Dose Rate Estimates for the 100-K-56:1 Site (All Radionuclides, All Pathways).

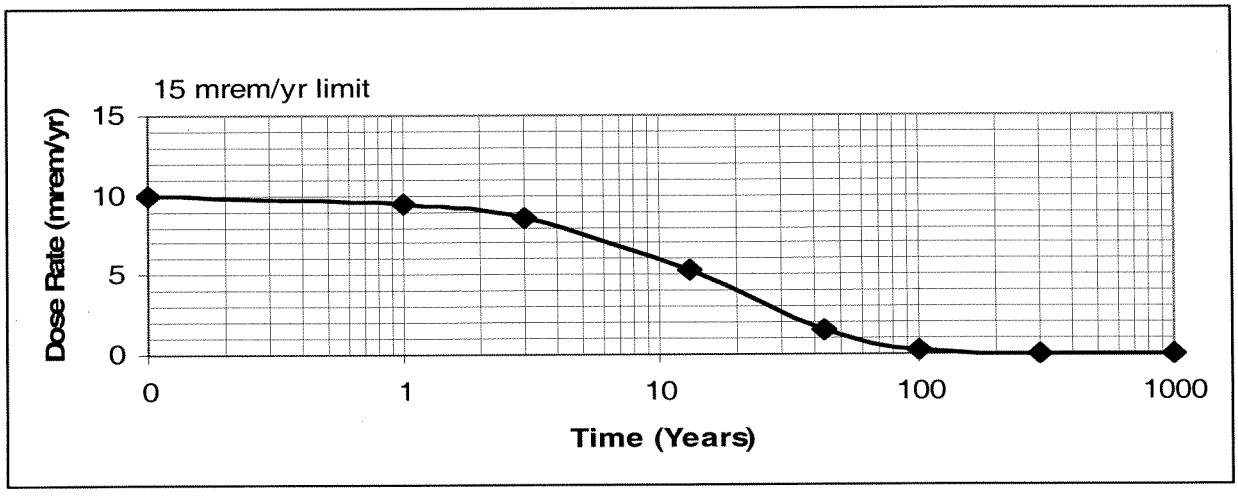
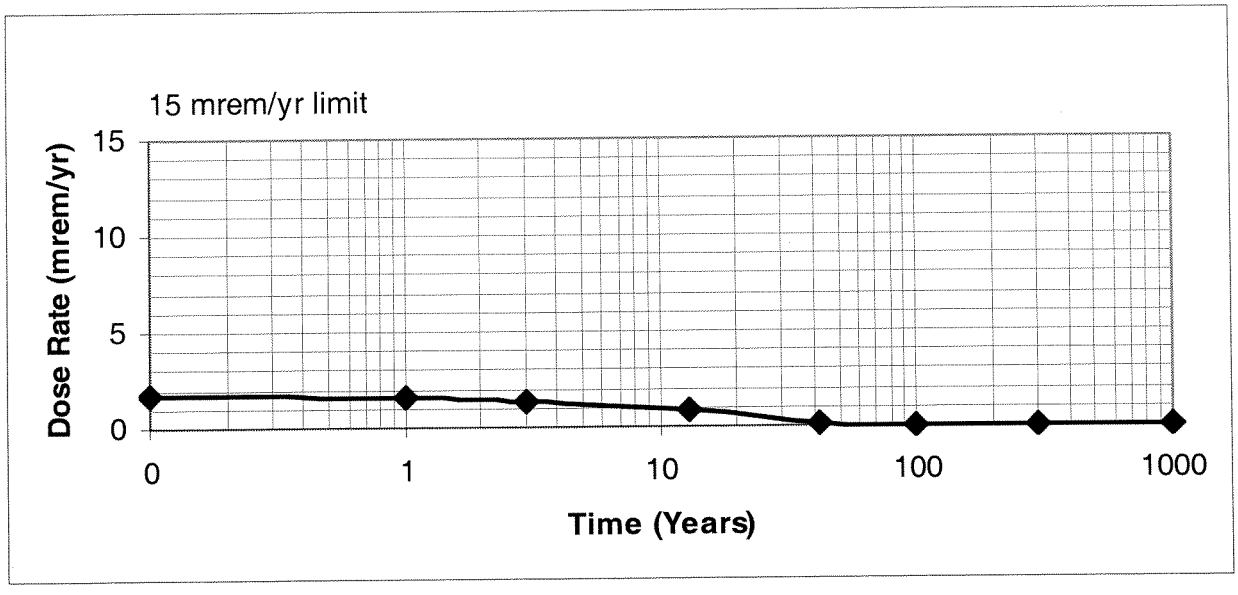


Figure 11. Overburden Dose Rate Estimates for the 100-K-55:1 and 100-K-56:1 Sites (All Radionuclides, All Pathways).



The dose rate for the 100-K-55:1 site is largest at present (year 2005), at 4.59 mrem/yr, decreasing to 9.77 x 10^{-11} mrem/yr in 1,000 years for the shallow zone and deep zone. The dose rate for the 100-K-56:1 site is also largest at present (year 2005), at 9.95 mrem/yr, decreasing to 3.90 x 10^{-10} mrem/yr in 1,000 years for the shallow and deep zones combined. The estimated dose rate in the year 2018 is 2.41 mrem/yr for the 100-K-55:1 site and 5.34 mrem/yr for the 100-K-56:1 site. The 2018 date corresponds to the original 30-year site cleanup schedule of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1989). The dose rate for the combined overburden soils from the 100-K-55:1 and 100-K-56:1 sites is largest at present (year 2005), at 1.66 mrem/yr, decreasing to 0.804 mrem/yr in 2018 and to 5.39 x 10^{-16} mrem/yr in 1,000 years. All dose rate estimates are less than the 15 mrem/yr RAG. The RESRAD computations are presented in detail in the RESRAD calculation briefs summarized in Appendix C.

Residual radionuclide concentrations detected in the discrete samples taken in the footprints of the former 116-KW-3 and 116-KE-4 retention basins are consistent with the residual concentrations reported in the CVPs for those sites (BHI 2004, 2005d).

5.1.2 Nonradionuclides

5.1.2.1 Direct Comparison to RAGs. Ethylene glycol, the primary COC for the 116-KW-4 and 116-KE-5 heat recovery stations, was not detected in the discrete sample taken from the 116-KW-4 site and was detected at a concentration of 59 mg/kg in the discrete sample taken from the 116-KE-5 site. This residual concentration meets the RAG of 160,000 mg/kg. In addition, the discrete samples collected from these sites were also analyzed for arsenic, barium, cadmium, total chromium, hexavalent

chromium, mercury, and lead. Detected concentrations of all of these metals (shown in Table 5) were below background levels or direct exposure RAGs.

No nonradionuclide COCs were identified for the 100-K-55:1 or 100-K-56:1 pipelines, but hexavalent chromium concentrations were evaluated at discrete locations at the points of discharge from the 116-KW-3 and 116-KE-4 retention basins. As shown in Table 4, hexavalent chromium was not detected in the samples collected at the former discharge points from the 116-KW-3 retention basins. Concentrations of hexavalent chromium detected at the former discharge points of the 116-KW-4 retention basins are below the direct exposure RAG and consistent with the residual concentrations for the entire basin footprint (BHI 2005d).

5.1.2.2 Noncarcinogenic Hazard Quotient RAG Attained. For noncarcinogenic COCs, WAC 173-340-740(5)(a) and (b) specify the evaluation of the hazard quotient, which is given as daily intake divided by a reference dose (DOE-RL 2005a). No nonradionuclide COCs were identified for the 100-K-55:1 or 100-K-56:1 pipelines; therefore, requirements for the determination of hazard quotient values are not applicable. The hazard quotient values for the 116-KW-4 and 116-KE-5 sites were based on the concentrations of metals detected above background levels and ethylene glycol reported in Table 5. The only constituent detected above background for the 116-KW-4 site was hexavalent chromium; a hazard quotient of 1.0×10^{-3} was determined for residual concentrations of this constituent (Appendix C). A cumulative hazard quotient of 3.4×10^{-2} was calculated for the 116-KE-5 site based on the residual concentrations of ethylene glycol, hexavalent chromium, total chromium, and lead (Appendix C). The hazard quotients for both of these sites are below 1.0.

5.1.2.3 Carcinogenic Risk RAG Attained. For individual nonradionuclide carcinogenic COCs, the WAC 173-340-750(3) Method B cleanup limits are based on an incremental cancer risk of 1×10^{-6}. The cumulative excess cancer risk for all nonradionuclide carcinogenic COCs must be less than 1×10^{-5} (EPA et al. 1998). No nonradionuclide COCs were identified for the 100-K-55:1 or 100-K-56:1 pipelines; therefore, requirements for the determination of excess risk values are not applicable. The only carcinogenic constituent detected at the 116-KW-4 and 116-KE-5 sites was hexavalent chromium, which contributes to excess risk values of 1.1×10^{-7} and 1.6×10^{-7} for these sites, respectively (Appendix C). These values are below the risk limit for individual constituents (1×10^{-6}) and the cumulative excess cancer RAG of 1×10^{-5}.

5.2 GROUNDWATER REMEDIAL ACTION GOALS ATTAINED

5.2.1 Radionuclides

The estimated groundwater concentrations for all of the radionuclide COCs contributed by the 100-K-55:1 and 100-K-56:1 site soils are shown in the RESRAD calculation briefs (Appendix C). Table 6 shows the total peak concentration predicted for each radionuclide COC and provides the individual RAGs for comparison. No COC is predicted to exceed the RAGs; therefore, the RAGs are attained. No radionuclide COCs were identified for the 116-KW-4 and 116-KE-5 sites.

Table 6. Estimated Peak Radionuclide Groundwater Concentrations Compared to Remedial Action Goals.

Radionuclide	Peak Concentration (pCi/L)	RAG (pCi/L)	RAGS Attained? (Yes/No)
100-K-55:1			
Cesium-137	4.49×10^{-2}	60[a]	Yes
Europium-152	0[b]	200[a]	Yes
Europium-154	0[b]	60[a]	Yes
100-K-56:1			
Cesium-137	5.41×10^{-1}	60[a]	Yes
Europium-152	0[b]	200[a]	Yes
Europium-154	0[b]	60[a]	Yes

[a] Lookup value corresponding to a dose rate of 4 mrem/yr.
[b] These radionuclides are not predicted to reach groundwater in 1,000 years.
RAG = remedial action goal

Figures 12 and 13 show individual organ dose rates for beta- and gamma-emitting radionuclides predicted over 1,000 years as calculated in the drinking water standards calculation briefs (Appendix C) for the 100-K-55:1 and 100-K-56:1 sites, respectively. None of the organ dose rates are predicted to exceed the 4 mrem/yr standard over 1,000 years.

Figure 12. Dose Rates to Organs from Groundwater Impacted by the 100-K-55:1 Site.

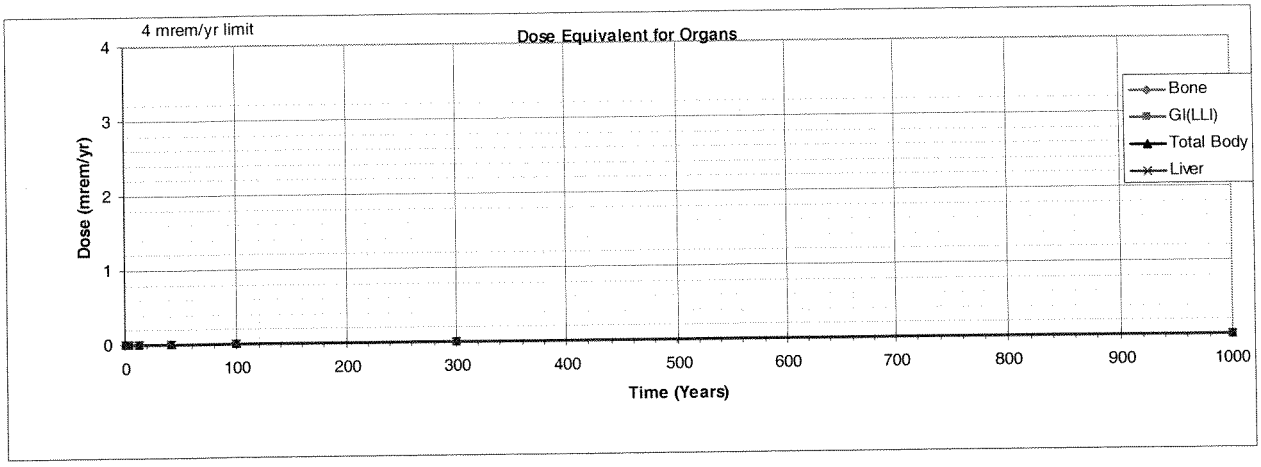
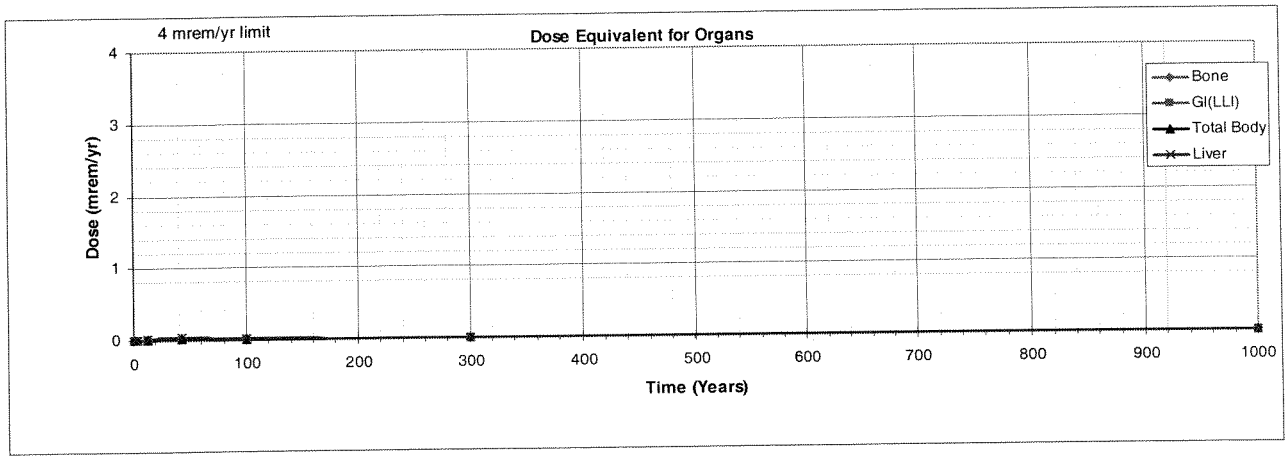


Figure 13. Dose Rates to Organs from Groundwater Impacted by the 100-K-56:1 Site.



5.2.2 Nonradionuclides

Ethylene glycol, the primary COC for the 116-KW-4 and 116-KE-5 heat recovery stations, was not detected in the discrete sample taken from the 116-KW-4 site and was detected at a concentration of 59 mg/kg in the discrete sample taken from the 116-KE-5 site, achieving the 3,200 mg/kg soil RAG for groundwater protection. Detected concentrations of metals at the two sites (Table 5) were below background levels or soil RAGs for the protection of groundwater (Table 2) with the exception of total chromium and lead concentrations at the 116-KE-5 site. Residual concentrations of these metals slightly exceed soil RAGs for the protection of groundwater. However, based on the soil-partitioning coefficient (K_d) values for these metals and the results of the *100 Area Analogous Sites RESRAD Calculations* (BHI 2005a), these metals will not reach groundwater within a 1,000-year time frame.

No nonradionuclide COCs were identified for the 100-K-55:1 or 100-K-56:1 pipelines, but hexavalent chromium concentrations were evaluated at discrete locations at the points of discharge from the 116-KW-3 and 116-KE-4 retention basins. As shown in Table 4, hexavalent chromium was not detected in the samples collected at the former discharge points from the 116-KW-3 retention basins. Concentrations of hexavalent chromium detected at the former discharge points of the 116-KW-4 retention basins are below the soil RAG for groundwater protection and consistent with the residual concentrations for the entire basin footprint (BHI 2005d).

5.3 COLUMBIA RIVER REMEDIAL ACTION GOALS ATTAINED

5.3.1 Radionuclides

The river protection RAGs for radionuclides are identical to the groundwater protection RAGs. The RESRAD modeling results were compared to the groundwater protection RAGs in Table 6.

The results indicated that radionuclides are not predicted to reach groundwater (and by extension not predicted to reach the Columbia River) at levels above 4 mrem/yr; therefore, the Columbia River protection RAGs have been attained.

5.3.2 Nonradionuclides

As described in Section 5.2.2, ethylene glycol and other COPCs either were not detected at the 116-KW-4 site or were detected at concentrations below background with the exception of hexavalent chromium, which was detected at a concentration below the soil RAG for river protection. The residual concentration of ethylene glycol detected at the 116-KE-5 site satisfies the 6,400 mg/kg soil RAG for river protection. Residual concentrations of lead and total chromium exceed their respective soil RAGs for river protection but, as described in Section 5.2.2, these constituents are not predicted to reach groundwater (and thus the Columbia River) within a 1,000-year time frame. Residual concentrations of all other metals for the 116-KE-5 site are below background levels or soil RAGs for river protection.

No nonradionuclide COCs were identified for the 100-K-55:1 or 100-K-56:1 pipelines, but hexavalent chromium concentrations were evaluated at discrete locations at the points of discharge from the 116-KW-3 and 116-KE-4 retention basins. As shown in Table 4, hexavalent chromium was not detected in the samples collected at the former discharge points from the 116-KW-3 retention basins. Concentrations of hexavalent chromium detected at the former discharge points of the 116-KW-4 retention basins are below the soil RAG for protection of the Columbia River and consistent with the residual concentrations for the entire basin footprint (BHI 2005d).

5.4 WAC 173-340 THREE-PART TEST FOR NONRADIONUCLIDES

The WAC 173-340-740(7)(e) three-part test is required for nonradionuclide statistical verification data sets. No nonradionuclide COCs were identified for the 100-K-55:1 and 100-K-56:1 sites, and evaluation of RAG attainment for the 116-KW-4 and 116-KE-5 sites was based on discrete rather than statistical sample results. The WAC 173-340-740(7)(e) three-part test is therefore not applicable to any of these data sets.

6.0 RADIONUCLIDE RISK INFORMATION

The radionuclide RAG for direct exposure is derived from the ROD (EPA 1997) and is expressed in terms of an allowable radiation dose rate above background (i.e., 15 mrem/yr). The RAG evaluation (Section 5.0) involved using the RESRAD model to estimate total annual radiation dose rates for 1,000 years for comparison to the RAG. Radiation presents a carcinogenic risk, and the RESRAD model also calculates the excess lifetime cancer risk associated with the estimated radiation dose rates using the EPA's Health Effects Assessment Summary Tables (update dated April 16, 2001, "Update of Radionuclide Carcinogenicity Slope Factors," available on the Internet at www.epa.gov/radiation/heast). The "National Oil and Hazardous Substances Pollution Contingency Plan" (40 *Code of Federal Regulations* 300) presents a target range for residual risk of 10^{-4} to 10^{-6}.

Figures 14, 15, and 16 illustrate excess lifetime cancer risk for the shallow zone as estimated using the RESRAD model for the 100-K-55:1 site, the 100-K-56:1 site, and the combined overburden for both sites, respectively. Because of radioactive decay, the risk decreases over time. The estimated risks for the 100-K-55:1 and 100-K-56:1 sites and their combined overburden is largest at present (year 2005), with estimates of 5.45×10^{-5}, 1.20×10^{-4}, and 1.83×10^{-5}, respectively. These values decrease to 1.56×10^{-15}, 6.03×10^{-15}, and 3.58×10^{-21}, respectively, in 1,000 years. The estimated risk values in 2018 are 2.97×10^{-5} for the 100-K-55:1 site, 6.66×10^{-5} for the 100-K-56:1 site, and 8.97×10^{-6} for the combined overburden material. The 2018 date corresponds to the original 30-year site cleanup schedule of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1989).

Figure 14. Combined Radionuclide Excess Lifetime Cancer Risk for the 100-K-55:1 Shallow and Deep Zone Decision Units.

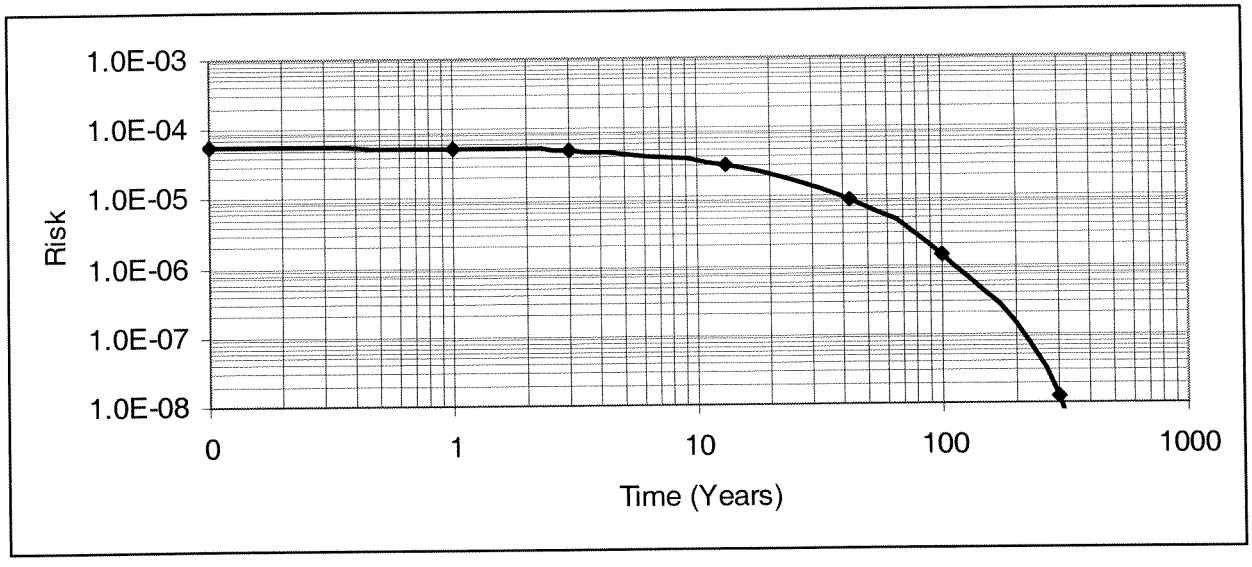


Figure 15. Combined Radionuclide Excess Lifetime Cancer Risk for the 100-K-56:1 Shallow and Deep Zone Decision Units.

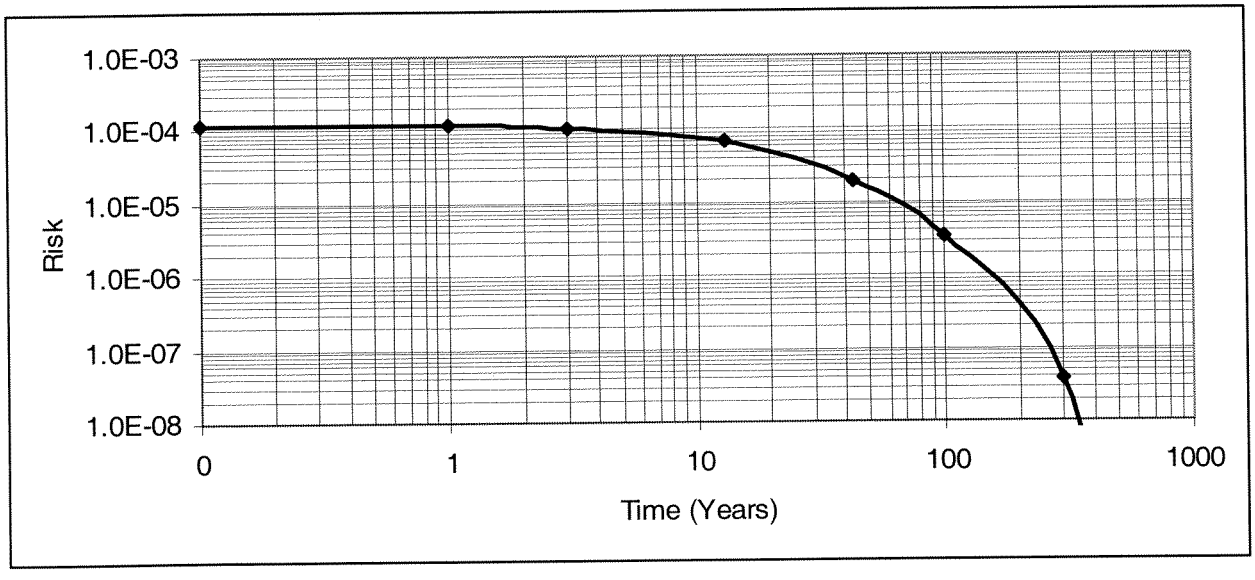
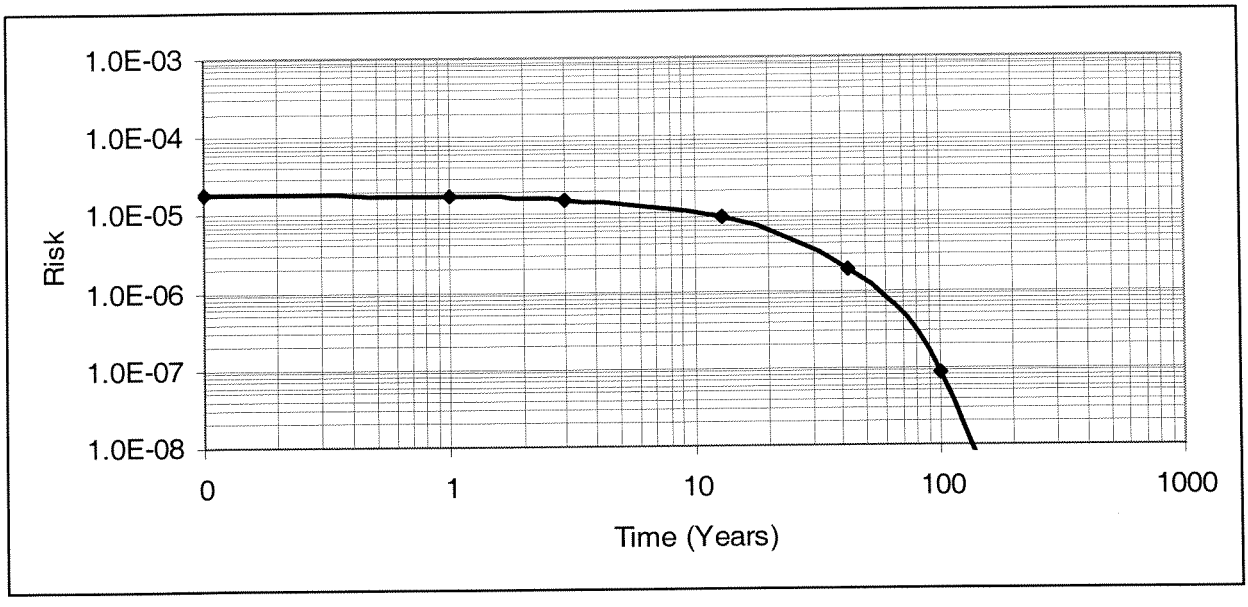


Figure 16. Radionuclide Excess Lifetime Cancer Risk for the 100-K-55:1 and 100-K-56:1 Sites Overburden Material.



7.0 STATEMENT OF PROTECTIVENESS

This CVP demonstrates that remedial actions at the 100-K-55:1, 100-K-56:1, 116-KW-4, and 116-KE-5 sites have achieved the RAOs and corresponding RAGs established in the ROD (EPA 1997) and the RDR/RAWP (DOE-RL 2005b). The contaminated materials from these sites have been excavated and disposed at the ERDF. The remaining soils at the sites have been sampled, analyzed, and modeled, and the results do not preclude any future uses (as bounded by the rural-residential scenario), allow unrestricted use of shallow zone soils, and pose no threat to groundwater or the Columbia River. Institutional controls are required for the 100-K-55:1 and 100-K-56:1 sites to prevent drilling or excavation into deep zone soils. The 100-K-55:1, 100-K-56:1, 116-KW-4, and 116-KE-5 sites are verified to be remediated in accordance with the ROD (EPA 1997) and may be backfilled.

8.0 REFERENCES

40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan," *Code of Federal Regulations*, as amended.

65 FR 76708, "National Primary Drinking Water Regulations; Radionuclides; Final Rule," *Federal Register*, Vol. 65, No. 236, p. 76708, December 7, 2000.

ANL, 2004, *RESRAD for Windows*, Version 6.22, Argonne National Laboratory, Environmental Assessment Division, Argonne, Illinois.

BHI, 2000, *Calculation of Hexavalent Chromium Carcinogenic Risk*, 0100X-CA-V0031, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

BHI, 2001, *Calculation of Total Uranium Activity Corresponding to a Maximum Contaminant Level for Total Uranium of 30 Micrograms per Liter in Groundwater*, 0100X-CA-V0038, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

BHI, 2004, *Cleanup Verification Package for 116-KW-3 Retention Basin*, CVP-2004-00001, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

BHI, 2005a, *100 Area Analogous Sites RESRAD Calculations*, 0100X-CA-V0050, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

BHI, 2005b, *100K Remedial Sampling Logbook*, EL-1572-2, Bechtel Hanford, Inc., Richland, Washington.

BHI, 2005c, *100K Remedial Sampling Logbook*, EL-1572-3, Bechtel Hanford, Inc., Richland, Washington.

BHI, 2005d, *Cleanup Verification Package for the 116-KE-4 Retention Basin*, CVP-2005-00002, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, U.S. Department of Energy, Washington, D.C.

DOE-RL, 1996, *Hanford Site Background: Part 2, Soil Background for Radionuclides*, DOE/RL-96-12, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1998, *Tri-Party Agreement Handbook Management Procedures*, RL-TPA-90-0001, Guideline Number TPA-MP-14, "Maintenance of the Waste Information Data System (WIDS)," U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 2001a, *100 Area Remedial Action Sampling and Analysis Plan*, DOE/RL-96-22, Rev. 3, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 2001b, *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes,* DOE/RL-92-24, Rev. 4, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 2005a, *100 Area Remedial Action Sampling and Analysis Plan*, DOE/RL-96-22, Rev. 4, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 2005b, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, DOE/RL-96-17, Rev. 5, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order,* 2 vols., as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

Ecology, 1994, *Natural Background Soil Metals Concentrations in Washington State,* Publication No. 94-115, Washington State Department of Ecology, Olympia, Washington.

EPA, 1994, *Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children*, EPA/540/R-93/081, Publication No. 9285.7, U.S. Environmental Protection Agency, Washington D.C.

EPA, 1997, *Amendment to the Interim Action Record of Decision for the 100-BC-1, 100-DR-1, and 100-HR-1 Operable Units, Hanford Site, Benton County, Washington*, EPA/AMD/R10-97/044, U.S. Environmental Protection Agency, Region 10, Seattle, Washington.

EPA, Ecology, and RL, 1998, *Environmental Restoration Contractor Meeting Minutes-Remedial Action and Waste Disposal Unit Manager's Meeting – 100 Area*, Draft, dated July 6, 1998, U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Richland Operations Office, Richland, Washington.

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

APPENDIX A

SUMMARY OF VERIFICATION SOIL SAMPLING AND ANALYTICAL RESULTS

Table A-1. 100-K-55:1 Deep Zone Cleanup Verification Data.

Sampling Area	HEIS Number	Sample Date	Cesium-137			Europium-152			Europium-154		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
A1	J02H20	02/15/05	2.88E+00		5.7E-02	1.9E-01	U	1.9E-01	1.7E-01	U	1.7E-01
Duplicate of J02H20	J02HW9	02/15/05	3.85E+00		4.4E-02	2.05E-01		1.1E-01	1.1E-01	U	1.1E-01
D2	J02H14	01/26/05	4.1E-02	U	4.1E-02	1.4E-01	U	1.4E-01	1.5E-01	U	1.5E-01
Duplicate of J02H14	J02H15	01/26/05	3.5E-02	U	3.5E-02	9.7E-02	U	9.7E-02	1.3E-01	U	1.3E-01
A2	J02H19	02/15/05	4.5E-02	U	4.5E-02	6.39E-01		1.0E-01	1.7E-01	U	1.7E-01
A3	J02H18	02/15/05	8.2E-02		5.4E-02	1.16E+00		9.7E-02	2.3E-01	U	2.3E-01
B4	J02H17	02/15/05	1.49E-01		5.5E-02	1.00E+00		9.9E-02	2.9E-01	U	2.9E-01
B5	J02H07	01/26/05	3.0E-02	U	3.0E-02	7.4E-02	U	7.4E-02	8.5E-02	U	8.5E-02
B6	J02H08	01/26/05	3.6E-02	U	3.6E-02	8.8E-02	U	8.8E-02	1.1E-01	U	1.1E-01
C7	J02H09	01/26/05	6.5E-02		3.4E-02	3.03E-01		7.9E-02	1.2E-01	U	1.2E-01
C8	J02H10	01/26/05	3.1E-02	U	3.1E-02	7.8E-02	U	7.8E-02	9.9E-02	U	9.9E-02
C9	J02H11	01/26/05	5.90E-01		2.4E-02	1.85E+00		4.2E-02	2.88E-01		5.8E-02
D10	J02H12	01/26/05	3.8E-02	U	3.8E-02	1.0E-01	U	1.0E-01	1.4E-01	U	1.4E-01
D1	J02H13	01/26/05	8.9E-02		1.0E-01	1.24E-01		3.5E-02	1.1E-01	U	1.1E-01

NOTE: The following acronyms and abbreviations apply to all tables in this appendix.
HEIS = Hanford Environmental Information system
MDA = minimum detectable activity
PQL = practical quantitation limit
Q = qualifier
U = undetected

Table A-2. 100-K-55:1 Shallow Zone Cleanup Verification Data.

Sampling Area	HEIS Number	Sample Date	Cesium-137			Europium-152			Europium-154		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
A4	J02HK9	02/23/05	3.51E-01		5.5E-02	1.26E+00		1.0E-01	2.48E-01		1.6E-01
Duplicate of J02HK9	J02HL0	02/23/05	5.39E-01		5.3E-02	2.04E+00		1.1E-01	1.7E-01	U	1.7E-01
F4	J02HN0	02/28/05	3.0E-02	U	3.0E-02	7.0E-02	U	7.0E-02	1.1E-01	U	1.1E-01
Duplicate of J02HN0	J02HN1	02/28/05	3.4E-02	U	3.4E-02	1.2E-01	U	1.2E-01	1.3E-01	U	1.3E-01
A1	J02HK6	02/23/05	2.9E-02	U	3.4E-02	8.1E-02		7.3E-02	9.5E-02	U	9.5E-02
A2	J02HK7	02/23/05	4.1E-02	U	4.1E-02	1.4E-01		1.4E-01	1.5E-01	U	1.5E-01
A3	J02HK8	02/23/05	1.42E-01		3.6E-02	4.62E-01		7.8E-02	1.1E-01	U	1.1E-01
B5	J02HL1	02/23/05	6.3E-02		3.6E-02	1.82E-01		7.4E-02	1.3E-01	U	1.3E-01
B6	J02HL2	02/23/05	3.2E-02	U	3.2E-02	1.16E-01		7.5E-02	1.0E-01	U	1.0E-01
B7	J02HL3	02/23/05	4.0E-02	U	4.0E-02	1.3E-01		1.3E-01	1.6E-01	U	1.6E-01
B8	J02HL4	02/23/05	2.26E-01		4.7E-02	6.4E-01		7.8E-02	1.3E-01	U	1.3E-01
C9	J02HL5	02/23/05	3.4E-02	U	3.4E-02	6.6E-02		7.5E-02	1.0E-01	U	1.0E-01
C10	J02HL6	02/23/05	2.90E-01		5.5E-02	3.09E-01		1.0E-01	1.6E-01	U	1.6E-01
C1	J02HL7	02/23/05	3.20E-01		4.3E-02	7.07E-01		8.5E-02	1.3E-01	U	1.3E-01
C2	J02HL8	02/23/05	2.34E-01		4.0E-02	2.79E-01		8.4E-02	1.1E-01	U	1.1E-01
D3	J02HL9	02/24/05	4.4E-02		3.5E-02	1.4E-01		9.2E-02	1.4E-01	U	1.4E-01
D4	J02HM0	02/24/05	3.7E-02		2.8E-02	1.61E-01		8.2E-02	1.3E-01	U	1.3E-01
D5	J02HM1	02/24/05	6.1E-01		4.5E-02	2.28E-01		9.3E-02	1.6E-01	U	1.6E-01
D6	J02HM2	02/24/05	3.98E-01		7.7E-02	3.87E+00		1.3E-01	5.21E-01		1.7E-01
E7	J02HM3	02/24/05	5.7E-01		4.3E-02	3.15E-01		7.9E-02	1.1E-01	U	1.1E-01
E8	J02HM4	02/24/05	2.05E-01		3.8E-02	1.4E-01	U	1.4E-01	1.6E-01	U	1.6E-01
E9	J02HM5	02/24/05	8.44E-01		6.3E-02	1.07E+00		1.2E-01	1.9E-01	U	1.9E-01
E10	J02HM6	02/24/05	6.3E-02	U	6.3E-02	8.2E-02	U	8.2E-02	1.2E-01	U	1.2E-01
F1	J02HM7	02/24/05	3.6E-02	U	3.6E-02	1.2E-01	U	1.2E-01	1.4E-01	U	1.4E-01
F2	J02HM8	02/24/05	3.1E-02	U	3.1E-02	7.5E-02	U	7.5E-02	1.1E-01	U	1.1E-01
F3	J02HM9	02/24/05	3.3E-02	U	3.3E-02	7.8E-02	U	7.8E-02	1.3E-01	U	1.3E-01

Table A-3. 100-K-56:1 Deep Zone Cleanup Verification Data.

Sampling Area	HEIS Number	Sample Date	Cesium-137			Europium-152			Europium-154		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
A1	J037K9	6/15/05	4.57E+00		1.0E-01	3.14E+01		3.5E-01	4.08E+00		3.1E-01
A2	J037L0	6/15/05	2.83E+00		8.5E-02	1.02E+01		1.5E-01	1.42E+00		1.4E-01
A3	J037L1	6/15/05	2.16E+01		1.2E-01	8.83E+00		3.7E-01	1.18E+00		2.3E-01
B4	J037L2	6/15/05	5.40E+00		9.2E-02	5.23E+00		1.5E-01	5.68E-01		1.7E-01
B5	J037L3	6/15/05	2.86E+01		1.1E-01	1.04E+01		2.4E-01	1.78E+00		1.7E-01
B6	J037L4	6/16/05	8.49E-01		3.6E-02	5.06E-01		9.4E-02	1.4E-01	U	1.4E-01
C7	J037L5	6/16/05	1.15E-01		4.9E-02	1.0E-01	U	1.0E-01	1.3E-01	U	1.3E-01
C8	J037L6	6/16/05	3.28E+00		8.6E-02	8.48E+00		1.6E-01	1.31E+00		1.9E-01
C9	J037L7	6/16/05	9.24E-01		5.1E-02	1.55E+00		1.2E-01	1.8E-01	U	1.8E-01
Duplicate of J037L7	J037L8	6/16/05	4.5E-02	U	4.5E-02	1.2E-01	U	1.2E-01	1.6E-01	U	1.6E-01

Table A-4. 100-K-56:1 Shallow Zone Cleanup Verification Data.

Sampling Area	HEIS Number	Sample Date	Cesium-137			Europium-152			Europium-154		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
A1	J03D45	6/23/05	1.21E-01		4.6E-02	3.42E-01		7.0E-02	1.3E-01	U	1.3E-01
Duplicate of J03D45	J03D46	6/23/05	1.17E-01		4.8E-02	4.89E-01		8.9E-02	1.6E-01	U	1.6E-01
A2	J03D47	6/23/05	1.44E-01		4.0E-02	1.41E+00		1.2E-01	2.2E-01	U	2.2E-01
A3	J03D48	6/23/05	3.10E-01		5.0E-02	4.10E-01		1.0E-01	1.7E-01	U	1.7E-01
A4	J03D49	6/23/05	1.50E-01		4.0E-02	1.5E-01	U	1.5E-01	1.1E-01	U	1.1E-01
B5	J03D50	6/23/05	2.38E+00		7.2E-02	1.48E+00		1.3E-01	2.4E-01	U	2.4E-01
B6	J03D51	6/23/05	2.62E-01		3.5E-02	1.3E-01	U	1.3E-01	1.0E-01	U	1.0E-01
B7	J03D52	6/23/05	2.05E+00		6.2E-02	2.17E+00		1.1E-01	4.7E-01	U	4.7E-01
B8	J03D53	6/23/05	3.9E-02	U	3.9E-02	9.4E-02	U	9.4E-02	1.3E-01	U	1.3E-01
C9	J03D54	6/23/05	2.8E-02	U	2.8E-02	1.1E-01	U	1.1E-01	1.0E-01	U	1.0E-01
C10	J03D55	6/23/05	3.98E-01		3.7E-02	7.7E-02	U	7.7E-02	1.0E-01	U	1.0E-01
C1	J03D56	6/23/05	1.96E-01		5.3E-02	1.1E-01	U	1.1E-01	1.5E-01	U	1.5E-01
C2	J03D57	6/23/05	9.3E-02		3.4E-02	1.1E-01	U	1.1E-01	1.0E-01	U	1.0E-01
D3	J03D58	6/23/05	3.0E-02	U	3.0E-02	7.0E-02	U	7.0E-02	1.0E-01	U	1.0E-01
D4	J03D59	6/23/05	3.3E-02	U	3.3E-02	1.0E-01	U	1.0E-01	1.2E-01	U	1.2E-01
D5	J03D60	6/23/05	4.0E-02	U	4.0E-02	1.1E-01	U	1.1E-01	1.3E-01	U	1.3E-01
D6	J03D61	6/23/05	4.42E-01		4.3E-02	1.6E-01	U	1.6E-01	1.1E-01	U	1.1E-01
E7	J03D62	6/23/05	3.81E-01		8.7E-02	1.04E+01		1.6E-01	1.1E+00	U	1.1E+00
E8	J03D63	6/23/05	7.3E-02		3.9E-02	3.42E-01		9.9E-02	1.6E-01	U	1.6E-01
E9	J03D64	6/23/05	2.86E-01		4.8E-02	2.40E-01		1.0E-01	1.4E-01	U	1.4E-01
E10	J03D65	6/23/05	9.3E-02		3.6E-02	1.2E-01	U	1.2E-01	9.6E-02	U	9.6E-02

Table A-5. Overburden Cleanup Verification Data. (2 Pages)

Sampling Area	HEIS Number	Sample Date	Cesium-137			Europium-152			Europium-154		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
A4	J02HN7	02/18/05	1.61E+00		5.4E-02	2.65E-01		8.5E-02	1.2E-01	U	1.2E-01
Duplicate of J02HN7	J02HN8	02/18/05	1.80E+00		3.9E-02	2.03E-01		8.2E-02	1.2E-01	U	1.2E-01
F4	J02HR8	03/01/05	1.48E-01		4.0E-02	1.14E-01		8.3E-02	1.3E-01	U	1.3E-01
Duplicate of J02HR8	J02HR9	03/01/05	2.00E-01		4.0E-02	1.2E-01	U	1.2E-01	1.2E-01	U	1.2E-01
K4	J02HV9	02/17/05	3.9E-02	U	3.9E-02	9.5E-02	U	9.5E-02	1.4E-01	U	1.4E-01
Duplicate of J02HV9	J02HW0	02/17/05	4.5E-02	U	4.5E-02	1.4E-01	U	1.4E-01	1.7E-01	U	1.7E-01
A1	J02HN4	02/18/05	2.94E-01		4.1E-02	1.59E-01		7.5E-02	1.3E-01	U	1.3E-01
A2	J02HN5	02/18/05	1.94E-01		4.4E-02	1.44E+00		8.4E-02	3.27E-01		1.4E-01
A3	J02HN6	02/18/05	3.95E-01		4.3E-02	1.5E-01	U	1.5E-01	1.5E-01	U	1.5E-01
B5	J02HN9	03/03/05	3.44E-01		4.4E-02	2.03E-01		8.4E-02	1.2E-01	U	1.2E-01
B6	J02HP0	03/03/05	8.1E-02		3.7E-02	1.61E-01		8.9E-02	1.5E-01	U	1.5E-01
B7	J02HP1	03/03/05	5.60E-01		5.3E-02	1.12E+00		8.9E-02	1.6E-01	U	1.6E-01
B8	J02HP2	03/03/05	2.19E-01		3.9E-02	1.2E-01	U	1.2E-01	1.4E-01	U	1.4E-01
C9	J02HP3	02/22/05	4.4E-02		3.0E-02	1.2E-01	U	1.2E-01	1.2E-01	U	1.2E-01
C10	J02HP4	02/22/05	5.3E-02		3.5E-02	2.17E-01		7.2E-02	1.1E-01	U	1.1E-01
C1	J02HP5	02/22/05	8.2E-02		3.6E-02	1.21E-01		7.7E-02	1.3E-01	U	1.3E-01
C2	J02HP6	02/22/05	3.38E-01		4.1E-02	1.5E-01	U	1.5E-01	1.4E-01	U	1.4E-01
D3	J02HP7	02/22/05	2.86E-01		3.0E-02	4.82E-01		7.1E-02	1.3E-01	U	1.3E-01
D4	J02HP8	02/22/05	6.1E-02		3.6E-02	1.26E-01		8.1E-02	1.2E-01	U	1.2E-01
D5	J02HP9	02/22/05	1.05E-01		3.7E-02	1.5E-01	U	1.5E-01	1.4E-01	U	1.4E-01
D6	J02HR0	02/22/05	1.52E-01		3.5E-02	1.4E-01	U	1.4E-01	1.4E-01	U	1.4E-01
E7	J02HR1	03/01/05	1.08E-01		3.6E-02	2.65E-01		1.0E-01	1.6E-01	U	1.6E-01
E8	J02HR2	03/01/05	1.62E+00		5.0E-02	1.24E+00		1.0E-01	2.3E-01	U	2.3E-01
E9	J02HR3	03/01/05	1.36E-01		4.5E-02	4.65E-01		1.0E-01	1.8E-01	U	1.8E-01
E10	J02HR4	03/01/05	1.69E-01		4.5E-02	5.96E-01		1.0E-01	1.7E-01	U	1.7E-01
F1	J02HR5	03/01/05	1.92E-01		3.8E-02	4.08E-01		7.8E-02	1.4E-01	U	1.4E-01
F2	J02HR6	03/01/05	3.6E-02		3.6E-02	1.0E-01	U	1.0E-01	1.3E-01	U	1.3E-01
F3	J02HR7	03/01/05	7.6E-02		3.4E-02	1.2E-01	U	1.2E-01	1.5E-01	U	1.5E-01
G5	J02HT0	03/02/05	5.3E-02	U	5.3E-02	1.3E-01	U	1.3E-01	1.4E-01	U	1.4E-01
G6	J02HT1	03/02/05	3.6E-02	U	3.6E-02	8.6E-02	U	8.6E-02	1.2E-01	U	1.2E-01
G7	J02HT2	03/02/05	5.1E-02	U	5.1E-02	1.1E-01	U	1.1E-01	1.6E-01	U	1.6E-01
G8	J02HT3	03/02/05	2.58E-01		3.1E-02	5.63E-01		7.2E-02	1.1E-01	U	1.1E-01
H9	J02HT4	03/02/05	2.06E-01		3.1E-02	3.33E-01		6.0E-02	9.7E-02	U	9.7E-02
H10	J02HT5	03/02/05	2.56E-01		4.4E-02	1.91E-01		8.2E-02	1.2E-01	U	1.2E-01
H1	J02HT6	03/02/05	1.40E-01		4.1E-02	7.60E-01		7.3E-02	1.83E-01		1.1E-01
H2	J02HT7	03/02/05	3.58E-01		3.9E-02	1.3E-01	U	1.3E-01	1.5E-01	U	1.5E-01
I3	J02HT8	02/18/05	1.26E-01		3.0E-02	1.1E-01	U	1.1E-01	1.4E-01	U	1.4E-01
I4	J02HT9	02/18/05	3.34E-01		3.3E-02	1.2E-01	U	1.2E-01	1.5E-01	U	1.5E-01

Table A-5. Overburden Cleanup Verification Data. (2 Pages)

Sampling Area	HEIS Number	Sample Date	Cesium-137			Europium-152			Europium-154		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
I5	J02HV0	02/18/05	3.3E-02	U	3.3E-02	8.1E-02	U	8.1E-02	1.2E-01	U	1.2E-01
I6	J02HV1	02/18/05	8.3E-02		3.0E-02	1.1E-01	U	1.1E-01	1.3E-01	U	1.3E-01
J7	J02HV2	02/17/05	3.62E-01		3.4E-02	7.4E-02	U	7.4E-02	1.1E-01	U	1.1E-01
J8	J02HV3	02/17/05	5.1E-02		2.0E-02	4.3E-02		5.0E-02	7.8E-02	U	7.8E-02
J9	J02HV4	02/17/05	1.51E-01		2.6E-02	9.4E-02	U	9.4E-02	1.0E-01	U	1.0E-01
J10	J02HV5	02/17/05	4.59E-01		4.7E-02	2.55E-01		9.4E-02	1.7E-01	U	1.7E-01
K1	J02HV6	02/17/05	1.44E-01		3.3E-02	8.3E-02	U	8.3E-02	1.2E-01	U	1.2E-01
K2	J02HV7	02/17/05	3.1E-02		2.9E-02	1.4E-01	U	1.4E-01	1.5E-01	U	1.5E-01
K3	J02HV8	02/17/05	4.2E-02	U	4.2E-02	1.0E-01	U	1.0E-01	1.6E-01	U	1.6E-01
L5	J02HW1	02/17/05	3.7E-02	U	3.7E-02	9.3E-02	U	9.3E-02	1.3E-01	U	1.3E-01
L6	J02HW2	02/17/05	3.2E-02	U	3.2E-02	7.4E-02	U	7.4E-02	1.0E-01	U	1.0E-01
L7	J02HW3	02/17/05	3.7E-02	U	3.7E-02	1.3E-01	U	1.3E-01	1.4E-01	U	1.4E-01
L8	J02HW4	02/17/05	3.6E-02	U	3.6E-02	9.3E-02	U	9.3E-02	1.3E-01	U	1.3E-01

Table A-6. Discrete Samples Beneath the Former 100-K-55:1 and 100-K-56:1 Pipelines Within the Footprint of the 116-KW-3 and 116-KE-4 Retention Basins.

HEIS No.	Cesium-137			Cobalt-60			Europium-152			Europium-154			Plutonium-239/240			Strontium-90		
	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
116-KW-3																		
J02HX1	1.3E-01		5.8E-02	6.0E-02	U	6.0E-02	4.5E-01		1.0E-01	2.0E-01	U	2.0E-01	0.0E+00	U	1.6E-01	1.19E-01	U	2.6E-01
J02HX2	6.1E-01		5.3E-02	1.1E-01		3.1E-02	1.3E+00		9.6E-02	1.9E-01		1.3E-01	1.2E-01	U	1.8E-01	3.66E-01		1.8E-01
J02HX3	4.2E-02	U	4.2E-02	5.2E-02	U	5.2E-02	1.3E-01	U	1.3E-01	1.8E-01	U	1.8E-01	6.1E-02	U	1.6E-01	1.57E-01	U	1.7E-01
116-KE-4																		
J030D3	2.3E-01		5.6E-02	1.5E-01		5.0E-02	1.93E+00		1.1E-01	3.3E-01		1.8E-01	2.4E-01	U	6.2E-01	2.38E-01		2.1E-01
J030D4	3.1E-01		8.2E-02	1.2E-01		6.4E-02	3.11E+00		1.3E-01	3.3E-01		1.8E-01	7.9E-02	U	3.0E-01	4.96E-01		2.5E-01
J030D5	6.1E-02		4.5E-02	5.6E-02		4.9E-02	6.08E-01		8.8E-02	1.5E-01	U	1.5E-01	3.6E-02	U	2.8E-01	4.32E-01		2.2E-01

HEIS No.	Uranium-233/234			Uranium-235			Hexavalent Chromium		
	pCi/g	Q	MDA	pCi/g	Q	MDA	mg/kg	Q	PQL
116-KW-3									
J02HX1	7.0E-01		1.4E-01	4.5E-02		1.7E-01	2E-01	U	2E-01
J02HX2	5.1E-01		1.4E-01	4.4E-02		1.7E-01	2E-01	U	2E-01
J02HX3	6.2E-01		1.5E-01	9.4E-02		1.8E-01	2E-01	U	2E-01
116-KE-4									
J030D3	3.80E-01		1.7E-01	2.7E-02		2.1E-01	2.2E-01	U	2.2E-01
J030D4	3.94E-01		2.0E-01	0.0E+00	U	2.4E-01	2.4E-01		2.1E-01
J030D5	4.54E-01		2.3E-01	0.0E+00	U	2.8E-01	9.4E-01		2.1E-01

Table A-7. Discrete Samples Beneath the Former Locations of the Heat Recovery Stations.

HEIS No.	Arsenic			Barium			Cadmium			Total Chromium			Mercury			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
116-KW-4																		
J02HX4	2.6E+00		2.9E-01	5.93E+01		2.0E-02	1.6E-01	U	1.6E-01	1.21E+01		1.6E-01	2E-02		1E-02	4.5E+00		7.6E-01
116-KE-5																		
J030D6	3.7E+00		3.0E-01	1.0E+02		2.0E-02	1.9E-01	U	4.0E-02	3.0E+01		4.0E-02	1.0E-01		2.0E-02	1.1E+01		1.9E-01

HEIS No.	Hexavalent Chromium			Ethylene Glycol		
	mg/kg	Q	PQL	mg/kg	Q	PQL
116-KW-4						
J02HX4	2.4E-01		2.1E-01	1.0E+01	U	1.0E+01
116-KE-5						
J030D6	3.3E-01		2.1E-01	5.9E+01		1.0E+01

APPENDIX B

DATA QUALITY ASSESSMENT

B1.0 DATA QUALITY ASSESSMENT FOR THE 100-K-55:1 AND 100-K-56:1 PIPELINES AND THE 116-KW-4 AND 116-KE-5 HEAT RECOVERY STATIONS

B1.1 OVERVIEW

The data quality assessment (DQA) completes the data life cycle (i.e., planning, implementation, and assessment) that was initiated by the data quality objectives process. The DQA includes a review of the field logbook information (BHI 2005a, 2005b) to verify sample location, date, and time. It also involves the scientific and statistical evaluation of the data to determine if they are of the right type, quality, and quantity to support their intended use for closeout decisions (EPA 2000).

This DQA was performed in accordance with BHI-EE-01, *Environmental Investigations Procedures*. Specific data quality objectives for the site are found in the *100 Area Remedial Action Sampling and Analysis Plan* (SAP) (DOE-RL 2005a). The DQA is based on the guidelines presented in *Guidance for Data Quality Assessment* (EPA 2000). Statistical tests used in this DQA were performed as specified in the SAP and the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP) (DOE-RL 2005b).

Prior to performing statistical tests, the field logbooks (BHI 2005a, 2005b), sample designs (Appendix C), and sample analytical data are evaluated. A portion of the cleanup verification sample analytical data are validated for compliance requirements (DOE-RL 2005a). Data evaluation is performed to determine if the laboratory carried out all steps required by the SAP and the laboratory contract governing the conduct of analysis and reporting of the data. This evaluation also examines the available laboratory data to determine if an analyte is present or absent in a sample and the degree of overall uncertainty associated with that determination. Data validation is done in accordance with validation procedures (BHI 2000a, 2000b) as part of data evaluation. After data evaluation and validation, the appropriate statistical test is performed on the adjusted raw analytical data (Appendix C) to determine statistical values for each contaminant. The cleanup verification sample analytical data are stored in the Hanford Environmental Information System and are summarized in Appendix A.

For the 100-K-55:1, 100-K-56:1, 116-KW-4, and 116-KE-5 sites, 140 samples in 20 sample delivery groups (SDGs) have been evaluated in the following sections.

B1.2 LABORATORY QUALITY MEASURES

All verification samples are subject to laboratory-specific quality assurance (QA) requirements, including instrument procurement, maintenance, calibration, and operation. Additional laboratory quality control (QC) checks are performed, as

appropriate, for the analytical method at a rate of 1 per SDG, or 1 in 20, whichever is more frequent. Laboratory internal QC checks include the following:

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

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

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

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

Laboratories are also subject to periodic and random assessments of the laboratory performance, systems, and overall program. These assessments are performed by the Washington Closure Hanford QA group to ensure that the laboratories are performing within laboratory contract requirements.

B1.3 DATA VALIDATION

After sampling was completed, all of the fixed-base laboratory data from two SDGs (H2997 and H3218), were validated by a third-party validator to Level C per BHI-EE-01, Procedure 2.5, "Data Package Validation Process." Level C validation procedures are specified in *Data Validation Procedure for Radiochemical Analysis* (BHI 2000b) and *Data Validation Procedure for Chemical Analysis* (BHI 2000a).

Use of level C validation procedures were included in the review of the following items, as appropriate, for each analytical method:

- Sample holding times
- Method blanks
- MS recovery

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

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

The adequacy of laboratory QA/QC was evaluated for precision, accuracy, completeness, and RDLs pursuant to the SAP (DOE-RL 2005a). The organization performing the data validation reported that, of the data given formal validation, the laboratory met the standards for performance for precision (±30%), accuracy (±30%), and completeness (>90%). Comparison of the RDL with the respective MDA or PQL is discussed in Section B1.4.

The validated SDG H2997 contains 10 samples (J02H07, J02H08, J02H09, J02H10, J02H11, J02H012, J02H13, J02H14, J02H15, and J02H16). A summary of deficiencies noted during validation of SDG H2997 follows.

- **Radionuclides.** The validation DQA noted no major deficiencies.

Because of a high RPD in the duplicate analysis for thorium-228 (54%), all thorium-228 results were qualified as estimates and flagged "J." Data flagged "J" indicate that the associated concentration is an estimate, but the data are usable for decision-making purposes. All other validated results are considered accurate within the standard error associated with the methods.

- **Nonradionuclides.** SDG H2997 did not contain nonradionuclide analysis.

The validated SDG H3218 contains 10 samples (J037K9, J037L0, J037L1, J037L2, J037L3, J037L4, J037L5, J037L6, J037L7, and J037L8). A summary of deficiencies noted during validation of SDG H2997 follows.

- **Radionuclides.** The validation DQA noted no major deficiencies.

  Because of a high RPD in the duplicate analysis for thorium-228 (38%), all thorium-228 results were qualified as estimates and flagged "J." Data flagged "J" indicate that the associated concentration is an estimate, but the data are usable for decision-making purposes. All other validated results are considered accurate within the standard error associated with the methods.

- **Nonradionuclides.** SDG H3218 did not contain nonradionuclide analysis.

B1.4 LABORATORY DATA EVALUATION

The following paragraphs include the results of the data evaluation of 20 verification sample SDGs.

The context for assessing the data includes evaluating the sample data using the statistical methodology of the SAP (DOE-RL 2005a) (included in the calculation brief excerpts in Appendix C) and a comparison of analytical results to the parameters as specified in the SAP. This section summarizes the results of the comparison and presents an evaluation of the affected data.

Sample Holding Times. All of the method-specific holding times were met for all samples.

Method Blanks. The method blank is used to evaluate false-positive results in samples due to contamination during handling at the laboratory.

Radionuclides. No target analytes were detected in the method blanks.

Nonradionuclides. In the method blank for SDG H3032, barium was detected at 0.04 mg/kg. The RDL for barium is 2.0 mg/kg and the low-level detection in the method blank does not compromise any sample data.

In the method blank for SDG H3112, barium was detected at 0.12 mg/kg and total chromium was detected at 0.06 mg/kg. The RDLs for these analytes are 2.0 mg/kg and 1.0 mg/kg, respectively. There is no impact to sample data from these detections in the method blank.

RDL Comparison. Reported analytical detection levels for nondetected analytes were compared to the RDLs specified in the SAP (DOE-RL 2005a). When detected results were obtained, evaluation of detection limits was not performed. The data validation and supplemental data evaluation noted any analyses in which the detection limit (MDA or PQL) was above the SAP RDLs for nondetected analytes.

Radionuclides. All of the reported MDAs are sufficiently less than the remedial action goals (RAGs), and the data are of sufficient quality for decision-making purposes. All values meet applicable RAGs as demonstrated in the calculation briefs (Appendix C) and discussed in this cleanup verification package.

Nonradionuclides. All of the reported method detection limits are less than applicable RAGs, and the data are of sufficient quality for decision-making purposes.

Precision and Accuracy Evaluation. Analytical accuracy and precision were evaluated by examination of the RPD of the main and duplicate samples. Only the contaminants of concern (COCs) detected at five times the detection limit (or greater) are used for data analysis with respect to accuracy and precision.

Radionuclides. In SDG H3067, the duplicate analysis produced four analytes whose RPDs were above acceptance criteria (cesium-137 [155%], radium-228 [55%], europium-154 [60%], and europium-155 [55%]). The high RPDs observed in this SDG were for analytes that were detected at relatively low levels where sample heterogeneity has more impact on RPD analysis.

In SDG H3218, the duplicate analysis for thorium-228 had an RPD above the acceptance criteria at 38%. Third-party validation was performed on SDG H3218 and resulted in all of the associated thorium-228 results being qualified as estimates with "J" flags.

Duplicate samples are produced using field collected materials. The natural heterogeneity of these materials adds to the elevated RPDs of the duplicate analysis. This variability is expected and does not indicate a problem with the analytical system. RPDs of analytes detected at low concentrations (less than five times the detection limit) are also not considered to be indicative of the analytical system performance. Where elevated RPDs are observed, it is typical to consider the data to be estimated as the validator has done in SDG H3218. Estimated data is useable for decision-making purposes.

B1.5 FIELD QUALITY ASSURANCE/QUALITY CONTROL

Field QA/QC measures were used to assess potential sources of error and cross contamination of soil samples that could bias results. Field QA/QC samples listed in the field logbooks (BHI 2005a, 2005b) are summarized in Table B-1. All main and QA/QC sample results are presented in Appendix A.

Table B-1. Summary of Field Quality Control Samples.

Sample Area	Main Sample	Equipment Blank[a]	Duplicate	Split
A1	J03D45	NA	J03D46	J03D86
A1	J02H20	NA	J02HW9	J02HX0
A4	J02HK9	NA	J02HL0	J02HN2
A4	J02HN7	NA	J02HN8	J02HW5
C9	J037L7	NA	J037L8	J037L9
D2	J02H14	J02H15	J02H15	J02H21
F4	J02HR8	NA	J02HR9	J02HW6
F4	J025N0	NA	J025N1	J025N3
K4	J02HV9	NA	J02HW0	J02HW7

[a]The sampling plans did not call for equipment blanks.
NA = not applicable

A single equipment blank sample was collected, sample J02H15. The equipment blank was analyzed by gamma spectroscopy for potassium-40, cobalt-60, cesium-137, radium-226, radium-228, europium-152, europium-154, europium-155, thorium-228, thorium-232, uranium-235, uranium-238, and americium-241. Low-level detections for potassium-40, radium-226, radium-228, thorium-228, and thorium-232 were observed. All of the detected analytes are significantly below cleanup levels. The data is suitable for the intended purpose of demonstrating cleanup verification and no further qualification is required.

Field duplicate samples were collected to provide a relative measure of the degree of local heterogeneity in the sampling medium, unlike laboratory duplicates that are used to evaluate precision in the analytical process. The field duplicates are evaluated by computing the RPD of the duplicate samples for each COC. Only analytes with values above five times the detection limits for both the main and duplicate samples are compared. Only one duplicate pair produced an elevated RPD. The duplicate pair J02HK9/J02HL0 had an RPD of 47% for europium-152. This result is typical of the heterogeneity found in the sample matrixes and does not indicate a problem with the analytical system. All other field duplicate results were acceptable. The data are suitable for the intended purpose of cleanup verification. The 95% upper confidence limit (UCL) calculation briefs in Appendix C provide details on duplicate pair evaluation and RPD calculation.

Split samples were collected to provide a relative measure of the degree of variability in the sampling, sample handling, and analytical techniques used by commercial laboratories. The field main and split samples are evaluated by computing the RPD of the split samples for each COC to determine the usability of the verification data. The U.S. Environmental Protection Agency Contract Laboratory Program duplicate sample comparison methodology, *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (EPA 1994), is used as an initial test of the data

from the splits. Only analytes that had values above five times the contractual RDL for both the main and split sample were compared. The RPD calculation produced three instances of elevated RPDs. The split pair J02HK9/J02HN2 had an RPD of 63% for europium-152. The split pair J037L7/J037L9 had an RPD of 47.5% for cesium-137 and 51.3% for europium-152. These results are typical of the heterogeneity found in the sample matrices and does not indicate a problem with either of the laboratories analytical systems. All other split sample pairs are within acceptable control limits. The 95% UCL calculation briefs in Appendix C provide details on split pair RPD calculation.

B1.6 SUITABILITY OF DATA

The DQA for the 100-K-55:1, 100-K-56:1, 116-KW-4, and 116-KE-5 sites determined that the data are of the right type, quality, and quantity to support site cleanup verification decisions within specified error tolerances. The evaluation verified that the sample design was sufficient for the purpose of clean site verification. All analytical data were found to be acceptable for decision-making purposes, and the raw data are acceptable for calculating the required statistical values.

B2.0 REFERENCES

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

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

BHI, 2005a, *100K Remedial Sampling Logbook*, EL-1572-2, Bechtel Hanford, Inc., Richland, Washington.

BHI, 2005b, *100K Remedial Sampling Logbook*, EL-1572-3, Bechtel Hanford, Inc., Richland, Washington.

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

DOE-RL, 2005a, *100 Area Remedial Action Sampling and Analysis Plan*, DOE/RL-96-22, Rev. 4, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 2005b, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, DOE/RL-96-17, Rev. 5, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

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

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

APPENDIX C

RESRAD INPUT PARAMETERS AND CALCULATION BRIEF EXCERPTS

RESRAD INPUT PARAMETERS FOR THE 100-K-55:1 SHALLOW ZONE

1RESRAD, Version 6.22 T« Limit = 0.5 year 04/05/2005 12:39 Page 1
Summary : 100-K-55 Shallow Zone Cleanup Verification
File : 100-K-55_Shallow_Zone.RAD

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

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

0 Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Cs-137+D	3.190E-05	3.190E-05	DCF2(1)
B-1	Eu-152	2.210E-04	2.210E-04	DCF2(2)
B-1	Eu-154	2.860E-04	2.860E-04	DCF2(4)
B-1	Gd-152	2.430E-01	2.430E-01	DCF2(5)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Cs-137+D	5.000E-05	5.000E-05	DCF3(1)
D-1	Eu-152	6.480E-06	6.480E-06	DCF3(2)
D-1	Eu-154	9.550E-06	9.550E-06	DCF3(4)
D-1	Gd-152	1.610E-04	1.610E-04	DCF3(5)
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-34				
D-34	Eu-152 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(2,1)
D-34	Eu-152 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(2,2)
D-34	Eu-152 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(2,3)
D-34				
D-34	Eu-154 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(4,1)
D-34	Eu-154 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(4,2)
D-34	Eu-154 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(4,3)
D-34				
D-34	Gd-152 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(5,1)
D-34	Gd-152 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(5,2)
D-34	Gd-152 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(5,3)
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)
D-5				
D-5	Eu-152 , fish	5.000E+01	5.000E+01	BIOFAC(2,1)
D-5	Eu-152 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(2,2)
D-5				
D-5	Eu-154 , fish	5.000E+01	5.000E+01	BIOFAC(4,1)
D-5	Eu-154 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(4,2)
D-5				
D-5	Gd-152 , fish	2.500E+01	2.500E+01	BIOFAC(5,1)
D-5	Gd-152 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(5,2)

1RESRAD, Version 6.22 T« Limit = 0.5 year 04/05/2005 12:39 Page 3
Summary : 100-K-55 Shallow Zone Cleanup Verification
File : 100-K-55_Shallow_Zone.RAD

Site-Specific Parameter Summary

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	2.498E+04	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	2.220E+01	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	2.040E+02	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	1.500E+01	2.500E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	3.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.300E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	4.200E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	3.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Cs-137	2.710E-01	0.000E+00	---	S1(1)
R012	Initial principal radionuclide (pCi/g): Eu-152	7.270E-01	0.000E+00	---	S1(2)
R012	Initial principal radionuclide (pCi/g): Eu-154	1.200E-01	0.000E+00	---	S1(4)
R012	Concentration in groundwater (pCi/L): Cs-137	not used	0.000E+00	---	W1(1)
R012	Concentration in groundwater (pCi/L): Eu-152	not used	0.000E+00	---	W1(2)
R012	Concentration in groundwater (pCi/L): Eu-154	not used	0.000E+00	---	W1(4)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.600E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone field capacity	2.000E-01	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	2.500E+02	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	4.050E+00	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	3.400E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	9.100E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1.600E-01	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	7.600E-01	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1.000E+06	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	1.000E-03	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	1.600E+00	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	4.000E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	2.500E-01	2.000E-01	---	EPSZ
R014	Saturated zone field capacity	1.500E-01	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	5.530E+03	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	1.250E-03	2.000E-02	---	HGWT
R014	Saturated zone b parameter	4.050E+00	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	1.000E-03	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	4.600E+00	1.000E+01	---	DWIBWT

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	2.500E+02	2.500E+02	---	UW
R015	Number of unsaturated zone strata	0	1	---	NS
R016	Distribution coefficients for Cs-137				
R016	Contaminated zone (cm**3/g)	5.000E+01	1.000E+03	---	DCNUCC(1)
R016	Saturated zone (cm**3/g)	5.000E+01	1.000E+03	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.489E-05	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for Eu-152				
R016	Contaminated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCC(2)
R016	Saturated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.124E-05	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for Eu-154				
R016	Contaminated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCC(4)
R016	Saturated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.124E-05	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)
R016	Distribution coefficients for daughter Gd-152				
R016	Contaminated zone (cm**3/g)	-1.000E+00	-1.000E+00	8.249E+02	DCNUCC(5)
R016	Saturated zone (cm**3/g)	-1.000E+00	-1.000E+00	8.249E+02	DCNUCS(5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.727E-06	ALEACH(5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)
R017	Inhalation rate (m**3/yr)	7.300E+03	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	1.000E-04	1.000E-04	---	MLINH
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	8.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	6.000E-01	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	2.000E-01	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	1.100E+02	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	2.700E+00	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	1.000E+02	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	3.600E+01	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	1.970E+01	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	9.000E-01	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	7.300E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	7.300E+02	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	1.000E+00	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	1.000E+00	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	1.000E+00	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	5.000E-01	5.000E-01	---	FR9
R018	Contamination fraction of plant food	-1	-1	0.500E+00	FPLANT
R018	Contamination fraction of meat	-1	-1	0.100E+01	FMEAT
R018	Contamination fraction of milk	-1	-1	0.100E+01	FMILK
R019	Livestock fodder intake for meat (kg/day)	6.800E+01	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	5.500E+01	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	5.000E+01	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	1.600E+02	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	5.000E-01	5.000E-01	---	LSI

Site-Specific Parameter Summary (continued)

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

Site-Specific Parameter Summary (continued)

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

Summary of Pathway Selections

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

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Summary : 100-K-55 Shallow Zone Cleanup Verification
File : 100-K-55_Shallow_Zone.RAD

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	24982.00 square meters	Cs-137	2.710E-01
Thickness:	22.20 meters	Eu-152	7.270E-01
Cover Depth:	0.00 meters	Eu-154	1.200E-01

0

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

t (years):	0.000E+00	1.000E+00	3.000E+00	1.300E+01	4.200E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	4.594E+00	4.366E+00	3.946E+00	2.411E+00	6.601E-01	8.879E-02	7.062E-04	7.089E-11
M(t):	3.063E-01	2.911E-01	2.631E-01	1.607E-01	4.400E-02	5.919E-03	4.708E-05	4.726E-12

OMaximum TDOSE(t): 4.594E+00 mrem/yr at t = 0.000E+00 years

RESRAD INPUT PARAMETERS FOR THE 100-K-55:1 DEEP ZONE

Summary : 100-K-55 Deep Zone Cleanup Verification
File : 100-K-55_Deep_Zone.RAD

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

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

Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Cs-137+D	3.190E-05	3.190E-05	DCF2(1)
B-1	Eu-152	2.210E-04	2.210E-04	DCF2(2)
B-1	Eu-154	2.860E-04	2.860E-04	DCF2(4)
B-1	Gd-152	2.430E-01	2.430E-01	DCF2(5)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Cs-137+D	5.000E-05	5.000E-05	DCF3(1)
D-1	Eu-152	6.480E-06	6.480E-06	DCF3(2)
D-1	Eu-154	9.550E-06	9.550E-06	DCF3(4)
D-1	Gd-152	1.610E-04	1.610E-04	DCF3(5)
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-34				
D-34	Eu-152 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(2,1)
D-34	Eu-152 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(2,2)
D-34	Eu-152 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(2,3)
D-34				
D-34	Eu-154 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(4,1)
D-34	Eu-154 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(4,2)
D-34	Eu-154 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(4,3)
D-34				
D-34	Gd-152 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(5,1)
D-34	Gd-152 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(5,2)
D-34	Gd-152 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(5,3)
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)
D-5				
D-5	Eu-152 , fish	5.000E+01	5.000E+01	BIOFAC(2,1)
D-5	Eu-152 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(2,2)
D-5				
D-5	Eu-154 , fish	5.000E+01	5.000E+01	BIOFAC(4,1)
D-5	Eu-154 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(4,2)
D-5				
D-5	Gd-152 , fish	2.500E+01	2.500E+01	BIOFAC(5,1)
D-5	Gd-152 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(5,2)

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Summary : 100-K-55 Deep Zone Cleanup Verification
File : 100-K-55_Deep_Zone.RAD

Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	2.498E+04	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	1.760E+01	2.000E+00	---	THICKO
R011	Length parallel to aquifer flow (m)	2.040E+02	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	1.500E+01	2.500E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	3.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.300E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	4.200E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	3.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Cs-137	8.250E-01	0.000E+00	---	S1(1)
R012	Initial principal radionuclide (pCi/g): Eu-152	7.350E-01	0.000E+00	---	S1(2)
R012	Initial principal radionuclide (pCi/g): Eu-154	1.250E-01	0.000E+00	---	S1(4)
R012	Concentration in groundwater (pCi/L): Cs-137	not used	0.000E+00	---	W1(1)
R012	Concentration in groundwater (pCi/L): Eu-152	not used	0.000E+00	---	W1(2)
R012	Concentration in groundwater (pCi/L): Eu-154	not used	0.000E+00	---	W1(4)
R013	Cover depth (m)	4.600E+00	0.000E+00	---	COVERO
R013	Density of cover material (g/cm**3)	1.500E+00	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.600E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone field capacity	2.000E-01	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	2.500E+02	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	4.050E+00	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	3.400E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	9.100E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1.600E-01	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	7.600E-01	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1.000E+06	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	1.000E-03	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	1.600E+00	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	4.000E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	2.500E-01	2.000E-01	---	EPSZ
R014	Saturated zone field capacity	1.500E-01	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	5.530E+03	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	1.250E-03	2.000E-02	---	HGWT
R014	Saturated zone b parameter	4.050E+00	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	1.000E-03	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	4.600E+00	1.000E+01	---	DWIBWT

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	2.500E+02	2.500E+02	---	UW
R015	Number of unsaturated zone strata	0	1	---	NS
R016	Distribution coefficients for Cs-137				
R016	Contaminated zone (cm**3/g)	5.000E+01	1.000E+03	---	DCNUCC(1)
R016	Saturated zone (cm**3/g)	5.000E+01	1.000E+03	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.662E-05	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for Eu-152				
R016	Contaminated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCC(2)
R016	Saturated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.418E-05	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for Eu-154				
R016	Contaminated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCC(4)
R016	Saturated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.418E-05	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)
R016	Distribution coefficients for daughter Gd-152				
R016	Contaminated zone (cm**3/g)	-1.000E+00	-1.000E+00	8.249E+02	DCNUCC(5)
R016	Saturated zone (cm**3/g)	-1.000E+00	-1.000E+00	8.249E+02	DCNUCS(5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.440E-06	ALEACH(5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)
R017	Inhalation rate (m**3/yr)	7.300E+03	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	1.000E-04	1.000E-04	---	MLINH
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	8.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	6.000E-01	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	2.000E-01	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS

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Summary : 100-K-55 Deep Zone Cleanup Verification
File : 100-K-55_Deep_Zone.RAD

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	1.100E+02	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	2.700E+00	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	1.000E+02	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	3.600E+01	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	1.970E+01	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	9.000E-01	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	7.300E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	7.300E+02	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	1.000E+00	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	1.000E+00	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	1.000E+00	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	5.000E-01	5.000E-01	---	FR9
R018	Contamination fraction of plant food	-1	-1	0.500E+00	FPLANT
R018	Contamination fraction of meat	-1	-1	0.100E+01	FMEAT
R018	Contamination fraction of milk	-1	-1	0.100E+01	FMILK
R019	Livestock fodder intake for meat (kg/day)	6.800E+01	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	5.500E+01	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	5.000E+01	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	1.600E+02	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	5.000E-01	5.000E-01	---	LSI

Site-Specific Parameter Summary (continued)

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

Site-Specific Parameter Summary (continued)

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

Summary of Pathway Selections

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

```
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 Summary : 100-K-55 Deep Zone Cleanup Verification
 File    : 100-K-55_Deep_Zone.RAD

     Contaminated Zone Dimensions          Initial Soil Concentrations, pCi/g
     ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ          ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
       Area:  24982.00 square meters              Cs-137     8.250E-01
  Thickness:     17.60 meters                    Eu-152     7.350E-01
Cover Depth:      4.60 meters                    Eu-154     1.250E-01
0
                                  Total Dose TDOSE(t), mrem/yr
                              Basic Radiation Dose Limit = 1.500E+01 mrem/yr
            Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)
            ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
   t (years):  0.000E+00  1.000E+00  3.000E+00  1.300E+01  4.200E+01  1.000E+02  3.000E+02  1.000E+03
    TDOSE(t):  3.710E-25  2.431E-04  7.802E-04  2.794E-03  4.656E-03  2.907E-03  8.574E-05  2.685E-11
        M(t):  2.473E-26  1.621E-05  5.201E-05  1.863E-04  3.104E-04  1.938E-04  5.716E-06  1.790E-12
0Maximum TDOSE(t):  4.658E-03 mrem/yr   at t =   43.40 ñ 0.09 years
0
                  Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                  As mrem/yr and Fraction of Total Dose At t = 4.340E+01 years
0                                   Water Independent Pathways (Inhalation excludes radon)
0            Ground          Inhalation          Radon           Plant           Meat            Milk            Soil
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
 Nuclide  mrem/yr  fract.  mrem/yr  fract.  mrem/yr  fract.  mrem/yr  fract.  mrem/yr  fract.  mrem/yr  fract.  mrem/yr  fract.
 Nuclide
 ÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄ
 Cs-137  4.105E-29 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
 Eu-152  3.882E-26 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
 Eu-154  8.724E-27 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
 ïïïïïïï ïïïïïïïïï ïïïïïï  ïïïïïïïïï ïïïïïï  ïïïïïïïïï ïïïïïï  ïïïïïïïïï ïïïïïï  ïïïïïïïïï ïïïïïï  ïïïïïïïïï ïïïïïï  ïïïïïïïïï ïïïïïï
 Total   4.758E-26 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
0
                  Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
                                  As mrem/yr and Fraction of Total Dose At t = 4.340E+01 years
0                                                   Water Dependent Pathways
0            Water           Fish            Radon           Plant           Meat            Milk            All Pathways*
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
 Nuclide  mrem/yr  fract.  mrem/yr  fract.  mrem/yr  fract.  mrem/yr  fract.  mrem/yr  fract.  mrem/yr  fract.  mrem/yr  fract.
 Nuclide
 ÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄ
 Cs-137  1.233E-03 0.2648  1.624E-03 0.3486  0.000E+00 0.0000  1.376E-04 0.0295  9.378E-04 0.2013  7.253E-04 0.1557  4.658E-03 1.0000
 Eu-152  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  3.882E-26 0.0000
 Eu-154  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  8.724E-27 0.0000
 ïïïïïïï ïïïïïïïïï ïïïïïï  ïïïïïïïïï ïïïïïï  ïïïïïïïïï ïïïïïï  ïïïïïïïïï ïïïïïï  ïïïïïïïïï ïïïïïï  ïïïïïïïïï ïïïïïï  ïïïïïïïïï ïïïïïï
 Total   1.233E-03 0.2648  1.624E-03 0.3486  0.000E+00 0.0000  1.376E-04 0.0295  9.378E-04 0.2013  7.253E-04 0.1557  4.658E-03 1.0000
0*Sum of all water independent and dependent pathways.
```

RESRAD INPUT PARAMETERS FOR THE 100-K-55:1 AND 100-K-56:1 COMBINED OVERBURDEN

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Summary : 100-K-55 Overburden Cleanup Verification
File : 100-K-55_Overburden.RAD

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Part I: Mixture Sums and Single Radionuclide Guidelines

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Summary : 100-K-55 Overburden Cleanup Verification
File : 100-K-55_Overburden.RAD

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

Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Cs-137+D	3.190E-05	3.190E-05	DCF2(1)
B-1	Eu-152	2.210E-04	2.210E-04	DCF2(2)
B-1	Eu-154	2.860E-04	2.860E-04	DCF2(4)
B-1	Gd-152	2.430E-01	2.430E-01	DCF2(5)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Cs-137+D	5.000E-05	5.000E-05	DCF3(1)
D-1	Eu-152	6.480E-06	6.480E-06	DCF3(2)
D-1	Eu-154	9.550E-06	9.550E-06	DCF3(4)
D-1	Gd-152	1.610E-04	1.610E-04	DCF3(5)
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-34	Eu-152 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(2,1)
D-34	Eu-152 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(2,2)
D-34	Eu-152 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(2,3)
D-34	Eu-154 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(4,1)
D-34	Eu-154 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(4,2)
D-34	Eu-154 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(4,3)
D-34	Gd-152 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(5,1)
D-34	Gd-152 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(5,2)
D-34	Gd-152 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(5,3)
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)
D-5	Eu-152 , fish	5.000E+01	5.000E+01	BIOFAC(2,1)
D-5	Eu-152 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(2,2)
D-5	Eu-154 , fish	5.000E+01	5.000E+01	BIOFAC(4,1)
D-5	Eu-154 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(4,2)
D-5	Gd-152 , fish	2.500E+01	2.500E+01	BIOFAC(5,1)
D-5	Gd-152 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(5,2)

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Summary : 100-K-55 Overburden Cleanup Verification
File : 100-K-55_Overburden.RAD

Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	4.640E+04	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	2.220E+01	2.000E+00	---	THICKO
R011	Length parallel to aquifer flow (m)	1.890E+02	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	1.500E+01	2.500E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	3.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.300E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	4.200E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	3.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Eu-152	3.040E-01	0.000E+00	---	S1(2)
R012	Initial principal radionuclide (pCi/g): Eu-154	5.260E-02	0.000E+00	---	S1(4)
R012	Concentration in groundwater (pCi/L): Eu-152	not used	0.000E+00	---	W1(2)
R012	Concentration in groundwater (pCi/L): Eu-154	not used	0.000E+00	---	W1(4)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVERO
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.600E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone field capacity	2.000E-01	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	2.500E+02	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	4.050E+00	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	3.400E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	9.100E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1.600E-01	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	7.600E-01	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1.000E+06	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	1.000E-03	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	1.600E+00	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	4.000E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	2.500E-01	2.000E-01	---	EPSZ
R014	Saturated zone field capacity	1.500E-01	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	5.530E+03	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	1.250E-03	2.000E-02	---	HGWT
R014	Saturated zone b parameter	4.050E+00	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	1.000E-03	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	4.600E+00	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	2.500E+02	2.500E+02	---	UW

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R015	Number of unsaturated zone strata	0	1	---	NS
R016	Distribution coefficients for Eu-152				
R016	Contaminated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCC(2)
R016	Saturated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.124E-05	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for Eu-154				
R016	Contaminated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCC(4)
R016	Saturated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.124E-05	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)
R016	Distribution coefficients for daughter Cs-137				
R016	Contaminated zone (cm**3/g)	5.000E+01	1.000E+03	---	DCNUCC(1)
R016	Saturated zone (cm**3/g)	5.000E+01	1.000E+03	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.489E-05	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for daughter Gd-152				
R016	Contaminated zone (cm**3/g)	-1.000E+00	-1.000E+00	8.249E+02	DCNUCC(5)
R016	Saturated zone (cm**3/g)	-1.000E+00	-1.000E+00	8.249E+02	DCNUCS(5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.727E-06	ALEACH(5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)
R017	Inhalation rate (m**3/yr)	7.300E+03	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	1.000E-04	1.000E-04	---	MLINH
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	8.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	6.000E-01	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	2.000E-01	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	1.100E+02	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	2.700E+00	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	1.000E+02	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	3.600E+01	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	1.970E+01	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	9.000E-01	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	7.300E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	7.300E+02	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	1.000E+00	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	1.000E+00	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	1.000E+00	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	5.000E-01	5.000E-01	---	FR9
R018	Contamination fraction of plant food	-1	-1	0.500E+00	FPLANT
R018	Contamination fraction of meat	-1	-1	0.100E+01	FMEAT
R018	Contamination fraction of milk	-1	-1	0.100E+01	FMILK
R019	Livestock fodder intake for meat (kg/day)	6.800E+01	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	5.500E+01	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	5.000E+01	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	1.600E+02	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	5.000E-01	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	1.000E-04	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	9.000E-01	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	1.000E+00	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	1.000E+00	1.000E+00	---	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	7.000E-01	7.000E-01	---	YV(1)
R19B	Wet weight crop yield for Leafy (kg/m**2)	1.500E+00	1.500E+00	---	YV(2)
R19B	Wet weight crop yield for Fodder (kg/m**2)	1.100E+00	1.100E+00	---	YV(3)
R19B	Growing Season for Non-Leafy (years)	1.700E-01	1.700E-01	---	TE(1)
R19B	Growing Season for Leafy (years)	2.500E-01	2.500E-01	---	TE(2)
R19B	Growing Season for Fodder (years)	8.000E-02	8.000E-02	---	TE(3)

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	1.000E-01	1.000E-01	---	TIV(1)
R19B	Translocation Factor for Leafy	1.000E+00	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	1.000E+00	1.000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RDRY(1)
R19B	Dry Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	2.000E+01	2.000E+01	---	WLAM
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
C14	DCF correction factor for gaseous forms of C14	not used	8.894E+01	---	CO2F
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)

Site-Specific Parameter Summary (continued)

0 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	1	---	---	LYMAX
TITL	Maximum number of integration points for risk	5	---	---	KYMAX

Summary of Pathway Selections

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

```
1RESRAD, Version 6.22     T« Limit = 0.5 year        04/05/2005  14:22  Page   8
 Summary : 100-K-55 Overburden Cleanup Verification
 File    : 100-K-55_Overburden.RAD

      Contaminated Zone Dimensions           Initial Soil Concentrations, pCi/g
      ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ           ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
        Area:  46397.00 square meters               Eu-152     3.040E-01
   Thickness:     22.20 meters                      Eu-154     5.260E-02
 Cover Depth:      0.00 meters
0
                                    Total Dose TDOSE(t), mrem/yr
                                Basic Radiation Dose Limit = 1.500E+01 mrem/yr
                Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)
                ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
    t (years):  0.000E+00  1.000E+00  3.000E+00  1.300E+01  4.200E+01  1.000E+02  3.000E+02  1.000E+03
     TDOSE(t):  1.658E+00  1.567E+00  1.401E+00  8.036E-01  1.665E-01  7.779E-03  2.332E-07  5.385E-16
         M(t):  1.105E-01  1.045E-01  9.338E-02  5.357E-02  1.110E-02  5.186E-04  1.555E-08  3.590E-17
0Maximum TDOSE(t):  1.658E+00 mrem/yr   at t = 0.000E+00 years
```

RESRAD INPUT PARAMETERS FOR THE 100-K-56:1 SHALLOW ZONE

Summary : 100-K-56 Pipeline Cleanup Verification RESRAD Calculation
File : 100-K-56_Shallow_Zone.RAD

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

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

Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Cs-137+D	3.190E-05	3.190E-05	DCF2(1)
B-1	Eu-152	2.210E-04	2.210E-04	DCF2(2)
B-1	Eu-154	2.860E-04	2.860E-04	DCF2(4)
B-1	Gd-152	2.430E-01	2.430E-01	DCF2(5)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Cs-137+D	5.000E-05	5.000E-05	DCF3(1)
D-1	Eu-152	6.480E-06	6.480E-06	DCF3(2)
D-1	Eu-154	9.550E-06	9.550E-06	DCF3(4)
D-1	Gd-152	1.610E-04	1.610E-04	DCF3(5)
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-34				
D-34	Eu-152 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(2,1)
D-34	Eu-152 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(2,2)
D-34	Eu-152 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(2,3)
D-34				
D-34	Eu-154 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(4,1)
D-34	Eu-154 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(4,2)
D-34	Eu-154 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(4,3)
D-34				
D-34	Gd-152 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(5,1)
D-34	Gd-152 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(5,2)
D-34	Gd-152 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(5,3)
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)
D-5				
D-5	Eu-152 , fish	5.000E+01	5.000E+01	BIOFAC(2,1)
D-5	Eu-152 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(2,2)
D-5				
D-5	Eu-154 , fish	5.000E+01	5.000E+01	BIOFAC(4,1)
D-5	Eu-154 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(4,2)
D-5				
D-5	Gd-152 , fish	2.500E+01	2.500E+01	BIOFAC(5,1)
D-5	Gd-152 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(5,2)

1RESRAD, Version 6.22 T« Limit = 0.5 year 07/19/2005 07:23 Page 3
Summary : 100-K-56 Pipeline Cleanup Verification RESRAD Calculation
File : 100-K-56_Shallow_Zone.RAD

Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	1.984E+04	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	4.600E+00	2.000E+00	---	THICKO
R011	Length parallel to aquifer flow (m)	2.160E+02	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	1.500E+01	2.500E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	3.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.300E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	4.300E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	3.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Cs-137	6.100E-01	0.000E+00	---	S1(1)
R012	Initial principal radionuclide (pCi/g): Eu-152	1.700E+00	0.000E+00	---	S1(2)
R012	Initial principal radionuclide (pCi/g): Eu-154	1.400E-01	0.000E+00	---	S1(4)
R012	Concentration in groundwater (pCi/L): Cs-137	not used	0.000E+00	---	W1(1)
R012	Concentration in groundwater (pCi/L): Eu-152	not used	0.000E+00	---	W1(2)
R012	Concentration in groundwater (pCi/L): Eu-154	not used	0.000E+00	---	W1(4)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.600E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone field capacity	2.000E-01	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	2.500E+02	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	4.050E+00	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	3.400E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	9.100E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1.600E-01	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	7.600E-01	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1.000E+06	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	1.000E-03	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	1.600E+00	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	4.000E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	2.500E-01	2.000E-01	---	EPSZ
R014	Saturated zone field capacity	1.500E-01	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	5.530E+03	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	1.250E-03	2.000E-02	---	HGWT
R014	Saturated zone b parameter	4.050E+00	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	1.000E-03	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	4.600E+00	1.000E+01	---	DWIBWT

1RESRAD, Version 6.22 T« Limit = 0.5 year 07/19/2005 07:23 Page 4
Summary : 100-K-56 Pipeline Cleanup Verification RESRAD Calculation
File : 100-K-56_Shallow_Zone.RAD

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	2.500E+02	2.500E+02	---	UW
R015	Number of unsaturated zone strata	1	1	---	NS
R015	Unsat. zone 1, thickness (m)	1.110E+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	1.000E+03	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	1.000E+03	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	5.000E+01	1.000E+03	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.166E-04	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for Eu-152				
R016	Contaminated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.426E-05	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for Eu-154				
R016	Contaminated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCC(4)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCU(4,1)
R016	Saturated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.426E-05	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)
R016	Distribution coefficients for daughter Gd-152				
R016	Contaminated zone (cm**3/g)	-1.000E+00	-1.000E+00	8.249E+02	DCNUCC(5)
R016	Unsaturated zone 1 (cm**3/g)	-1.000E+00	-1.000E+00	8.249E+02	DCNUCU(5,1)
R016	Saturated zone (cm**3/g)	-1.000E+00	-1.000E+00	8.249E+02	DCNUCS(5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.316E-05	ALEACH(5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)
R017	Inhalation rate (m**3/yr)	7.300E+03	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	1.000E-04	1.000E-04	---	MLINH
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	8.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	6.000E-01	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	2.000E-01	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	1.100E+02	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	2.700E+00	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	1.000E+02	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	3.600E+01	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	1.970E+01	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	9.000E-01	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	7.300E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	7.300E+02	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	1.000E+00	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	1.000E+00	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	1.000E+00	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	5.000E-01	5.000E-01	---	FR9
R018	Contamination fraction of plant food	-1	-1	0.500E+00	FPLANT
R018	Contamination fraction of meat	-1	-1	0.992E+00	FMEAT
R018	Contamination fraction of milk	-1	-1	0.992E+00	FMILK
R019	Livestock fodder intake for meat (kg/day)	6.800E+01	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	5.500E+01	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	5.000E+01	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	1.600E+02	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	5.000E-01	5.000E-01	---	LSI

Site-Specific Parameter Summary (continued)

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

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Summary : 100-K-56 Pipeline Cleanup Verification RESRAD Calculation
File : 100-K-56_Shallow_Zone.RAD

Site-Specific Parameter Summary (continued)

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

Summary of Pathway Selections

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

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File : 100-K-56_Shallow_Zone.RAD

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	19844.00 square meters	Cs-137	6.100E-01
Thickness:	4.60 meters	Eu-152	1.700E+00
Cover Depth:	0.00 meters	Eu-154	1.400E-01

0

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

t (years):	0.000E+00	1.000E+00	3.000E+00	1.300E+01	4.300E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	9.948E+00	9.470E+00	8.585E+00	5.316E+00	1.421E+00	1.955E-01	1.444E-03	1.173E-10
M(t):	6.632E-01	6.313E-01	5.724E-01	3.544E-01	9.470E-02	1.303E-02	9.627E-05	7.820E-12

OMaximum TDOSE(t): 9.948E+00 mrem/yr at t = 0.000E+00 years

RESRAD INPUT PARAMETERS FOR THE 100-K-56:1 DEEP ZONE

Summary : 100-K-56 Pipeline Cleanup Verification RESRAD Calculation
File : 100-K-56_Deep_Zone.RAD

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

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

Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Cs-137+D	3.190E-05	3.190E-05	DCF2(1)
B-1	Eu-152	2.210E-04	2.210E-04	DCF2(2)
B-1	Eu-154	2.860E-04	2.860E-04	DCF2(4)
B-1	Gd-152	2.430E-01	2.430E-01	DCF2(5)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Cs-137+D	5.000E-05	5.000E-05	DCF3(1)
D-1	Eu-152	6.480E-06	6.480E-06	DCF3(2)
D-1	Eu-154	9.550E-06	9.550E-06	DCF3(4)
D-1	Gd-152	1.610E-04	1.610E-04	DCF3(5)
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-34				
D-34	Eu-152 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(2,1)
D-34	Eu-152 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(2,2)
D-34	Eu-152 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(2,3)
D-34				
D-34	Eu-154 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(4,1)
D-34	Eu-154 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(4,2)
D-34	Eu-154 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(4,3)
D-34				
D-34	Gd-152 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(5,1)
D-34	Gd-152 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(5,2)
D-34	Gd-152 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(5,3)
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)
D-5				
D-5	Eu-152 , fish	5.000E+01	5.000E+01	BIOFAC(2,1)
D-5	Eu-152 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(2,2)
D-5				
D-5	Eu-154 , fish	5.000E+01	5.000E+01	BIOFAC(4,1)
D-5	Eu-154 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(4,2)
D-5				
D-5	Gd-152 , fish	2.500E+01	2.500E+01	BIOFAC(5,1)
D-5	Gd-152 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(5,2)

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Summary : 100-K-56 Pipeline Cleanup Verification RESRAD Calculation
File : 100-K-56_Deep_Zone.RAD

Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	1.113E+04	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	1.110E+01	2.000E+00	---	THICKO
R011	Length parallel to aquifer flow (m)	2.160E+02	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	1.500E+01	2.500E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	3.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.300E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	4.300E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	3.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Cs-137	1.320E+01	0.000E+00	---	S1(1)
R012	Initial principal radionuclide (pCi/g): Eu-152	1.370E+01	0.000E+00	---	S1(2)
R012	Initial principal radionuclide (pCi/g): Eu-154	1.870E+00	0.000E+00	---	S1(4)
R012	Concentration in groundwater (pCi/L): Cs-137	not used	0.000E+00	---	W1(1)
R012	Concentration in groundwater (pCi/L): Eu-152	not used	0.000E+00	---	W1(2)
R012	Concentration in groundwater (pCi/L): Eu-154	not used	0.000E+00	---	W1(4)
R013	Cover depth (m)	4.600E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	1.600E+00	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.600E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone field capacity	2.000E-01	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	2.500E+02	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	4.050E+00	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	3.400E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	9.100E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1.600E-01	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	7.600E-01	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1.000E+06	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	1.000E-03	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	1.600E+00	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	4.000E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	2.500E-01	2.000E-01	---	EPSZ
R014	Saturated zone field capacity	1.500E-01	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	5.530E+03	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	1.250E-03	2.000E-02	---	HGWT
R014	Saturated zone b parameter	4.050E+00	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	1.000E-03	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	4.600E+00	1.000E+01	---	DWIBWT

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File : 100-K-56_Deep_Zone.RAD

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	2.500E+02	2.500E+02	---	UW
R015	Number of unsaturated zone strata	0	1	---	NS
R016	Distribution coefficients for Cs-137				
R016	Contaminated zone (cm**3/g)	5.000E+01	1.000E+03	---	DCNUCC(1)
R016	Saturated zone (cm**3/g)	5.000E+01	1.000E+03	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	8.978E-05	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for Eu-152				
R016	Contaminated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCC(2)
R016	Saturated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.249E-05	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for Eu-154				
R016	Contaminated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCC(4)
R016	Saturated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.249E-05	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)
R016	Distribution coefficients for daughter Gd-152				
R016	Contaminated zone (cm**3/g)	-1.000E+00	-1.000E+00	8.249E+02	DCNUCC(5)
R016	Saturated zone (cm**3/g)	-1.000E+00	-1.000E+00	8.249E+02	DCNUCS(5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.455E-06	ALEACH(5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)
R017	Inhalation rate (m**3/yr)	7.300E+03	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	1.000E-04	1.000E-04	---	MLINH
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	8.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	6.000E-01	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	2.000E-01	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	1.100E+02	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	2.700E+00	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	1.000E+02	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	3.600E+01	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	1.970E+01	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	9.000E-01	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	7.300E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	7.300E+02	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	1.000E+00	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	1.000E+00	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	1.000E+00	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	5.000E-01	5.000E-01	---	FR9
R018	Contamination fraction of plant food	-1	-1	0.500E+00	FPLANT
R018	Contamination fraction of meat	-1	-1	0.557E+00	FMEAT
R018	Contamination fraction of milk	-1	-1	0.557E+00	FMILK
R019	Livestock fodder intake for meat (kg/day)	6.800E+01	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	5.500E+01	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	5.000E+01	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	1.600E+02	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	5.000E-01	5.000E-01	---	LSI

Site-Specific Parameter Summary (continued)

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

Site-Specific Parameter Summary (continued)

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

Summary of Pathway Selections

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

1RESRAD, Version 6.22 T« Limit = 0.5 year 07/18/2005 15:52 Page 8
Summary : 100-K-56 Pipeline Cleanup Verification RESRAD Calculation
File : 100-K-56_Deep_Zone.RAD

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	11131.00 square meters	Cs-137	1.320E+01
Thickness:	11.10 meters	Eu-152	1.370E+01
Cover Depth:	4.60 meters	Eu-154	1.870E+00

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

t (years):	0.000E+00	1.000E+00	3.000E+00	1.300E+01	4.300E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	1.377E-25	2.547E-03	8.039E-03	2.863E-02	4.767E-02	2.973E-02	8.756E-04	2.730E-10
M(t):	9.183E-27	1.698E-04	5.359E-04	1.909E-03	3.178E-03	1.982E-03	5.838E-05	1.820E-11

Maximum TDOSE(t): 4.767E-02 mrem/yr at t = 43.38 ñ 0.09 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 4.338E+01 years
Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	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
Eu-152	1.575E-26	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-154	3.114E-27	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	1.887E-26	0.0000	0.000E+00	0.0000	0.000E+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 = 4.338E+01 years
Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	1.973E-02	0.4139	1.093E-02	0.2293	0.000E+00	0.0000	2.201E-03	0.0462	8.349E-03	0.1752	6.457E-03	0.1355	4.767E-02	1.0000
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.575E-26	0.0000
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.114E-27	0.0000
Total	1.973E-02	0.4139	1.093E-02	0.2293	0.000E+00	0.0000	2.201E-03	0.0462	8.349E-03	0.1752	6.457E-03	0.1355	4.767E-02	1.0000

*Sum of all water independent and dependent pathways.

CALCULATION BRIEF EXCERPTS

DISCLAIMER FOR CALCULATIONS

The attached calculations have been generated for a specific purpose and task. Use of these calculations by persons who do not have access to all pertinent facts may lead to incorrect conclusions and/or results. Before applying these calculations to your work, the underlying basis, rationale, and other pertinent information relevant to these calculations must be thoroughly reviewed with appropriate Washington Closure Hanford officials or other authorized personnel. Washington Closure Hanford is not responsible for the use of a calculation not under its direct control.

CALCULATION BRIEFS

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

100-K-55 Pipeline and Overburden Variance Calculation, Calculation No. 0100K-CA-V0041, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

100-KW-55 Pipelines Shallow, Deep, and Overburden Zone Sampling Plan, Calculation No. 0100K-CA-V0039, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

100-K-55:1 Pipeline Cleanup Verification 95% UCL Calculation, Calculation No. 0100K-CA-V0045, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

100-K-55:1 Pipeline RESRAD Calculation, Calculation No. 0100K-CA-V0046, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

100-K-55:1 Comparison to Drinking Water Standards (MCL) Calculation Brief, Calculation No. 0100K-CA-V0047, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

100-K-56:1 Pipeline Variance Calculation, Calculation No. 0100K-CA-V0052, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

100-K-56:1 Pipelines Shallow and Deep Zone Sampling Plan, Calculation No. 0100K-CA-V0053, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

100-K-56:1 Pipeline Cleanup Verification 95% UCL Calculation, Calculation No. 0100K-CA-V0049, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

100-K-56:1 Pipeline RESRAD Calculation, Calculation No. 0100K-CA-V0050, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

100-K-56:1 Comparison to Drinking Water Standards (MCL) Calculation, Calculation No. 0100K-CA-V0051, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

116-KW-4 and 116-KE-5 Heat Recovery Stations Hazard Quotient and Carcinogenic Risk Calculations, Calculation No. 0100K-CA-V0054, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

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

CALCULATION COVER SHEET

Project Title:	100-K Remedial Action	**Job No.**	**22192**
Area	100-K		
Discipline	Environmental	***Calc. No.**	0100K-CA-V0041
Subject	100-K-55 Pipeline and Overburden Variance Calculation		
Computer Program	Excel	**Program No.**	Excel 97

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

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover - 1 Summary - 1 Calculations - 9 Total - 11	S. W. Callison 3-3-05	M. T. Stankovich 3-7-05	M. A. Buckmaster	M. A. Buckmaster	3/10/05

SUMMARY OF REVISIONS

Scanned	Rev.	Date	Bar Code No.

* Obtain Calc. No. from DIS.

CALCULATION SHEET

Bechtel Hanford Inc.

Originator	S. W. Callison SWC	Date	3/3/2005	Calc. No.	0100K-CA-V0041	Rev. No.	0
Project	100-K Remedial Action	Job No.	22192	Checked	M. T. Stankovich MTS	Date	3-7-05
Subject	100-K-55 Pipeline and Overburden Variance Calculation					Sheet No.	1 of 10

Conclusion:
The required number of samples calculated (1 or 3 sample) for each decision sub-unit is less than the default number (4 samples) specified in the DOE/RL-96-22, Rev 3. Therefore, the default number of samples will be collected from each shallow zone decision sub-unit.

Problem:
Calculate the number of close out samples required for 100-K-55 Pipeline Shallow and Overburden Decision Units verification sampling as required in "100 Area Remedial Action Sampling and Analysis Plan" (DOE/RL-96-22, Rev 3) and "Instruction Guide for the Remediation of 100 Areas Waste Sites" (0100X-IG-G0001, Rev 5).

Given:
1) Sample locations for the 100-K-55 Pipeline Retention Basin Decision Unit are identified on the 100-K-55 Pipelines Shallow, Deep, and Overburden Sample Design, Calculation number 0100K-CA-V0039, Rev. 0.
2) Lookup values from DOE/RL-96-22, Rev 3.
3) Sample Design requirements from DOE/RL-96-22, Rev 3 and 0100X-IG-G0001, Rev 5.
4) Field sampling information from sampling logbook EL-1572-2.

Solution:
Calculation methodology is described in Appendix A of DOE/RL-96-22, Rev 3. Data from attached worksheets are used to calculate the required number of closeout samples. Variance calculation is based on the same three isotopes used to develop the statistical approach in DOE/RL-96-22, Rev 3. The statistical design is based on the premise that these isotopes are the predominant components of the contamination and are representative of the contamination distribution.

Sheet No.	Contents	Topic
1	Calc. Summary	Summary of Calc Brief
2-4	Shallow Zone	Required Number of Samples Calculation
5-10	Overburden	Required Number of Samples Calculation

CALCULATION SHEET

Bechtel Hanford Inc.

Originator	S. W. Callison SWC	Date 3/3/2005	Calc. No.	0100K-CA-V0041	Rev. No.	0	
Project	100-K Remedial Action	Job No. 22192	Checked	M. T. Stankovich MTS	Date	3/7/05	
Subject	100-K-55 Pipeline and Overburden Variance Calculation				Sheet No.	2 of 10	

Statistical Evaluation of Analytical Data

The required number of samples resulting from the calculation is highlighted at the bottom of the page.
Each value is reflective of the specific analyte evaluated.
The highest value of the three evaluations is used to determine the required number of samples as compared against the default of four.
Sample locations are from Calculation 0100K-CA-V0039.
Mean, Standard Deviation, *t*, and Number of Samples formulas are from DOE/RL-96-22, Appendix A.

Decision Unit: Pipeline Shallow Zone
Samples values from GEA analysis
Sample Areas . **A, B, C, D, E & F**

Sample #	Sample Date	Location	Constituent Cesium-137 pCi/g	Q	Europium-152 pCi/g	Q	Europium-154 pCi/g	Q
Look-up Value (HT) ==========>			**6.2**		**3.3**		**3.0**	
J02DX1	February 3, 2005	S-A1-2	0.056	U	0.14	U	0.18	U
J02DX2	February 2, 2005	S-A1-3	0.065	U	0.21	U	0.24	U
J02DX3	February 2, 2005	S-A1-4	0.066	U	0.21	U	0.25	U
J02DX4	February 3, 2005	S-A1-10	0.25		0.25	U	0.26	U
J02DX5	February 3, 2005	S-A1-13	0.054	U	0.14	U	0.18	U
J02DX6	February 2, 2005	S-A1-16	0.054	U	0.13	U	0.16	U
J02DX7	February 2, 2005	S-A2-3	0.068	U	0.15	U	0.21	U
J02DX8	February 2, 2005	S-A2-6	0.058	U	0.14	U	0.22	U
J02DX9	February 2, 2005	S-A2-7	0.064	U	0.14	U	0.21	U
J02DY0	February 2, 2005	S-A2-10	0.068	U	0.64		0.24	U
J02DY1	February 2, 2005	S-A2-14	0.06	U	0.14	U	0.16	U
J02DY2	February 3, 2005	S-A2-15	0.083	U	0.24	U	0.27	U
J02DY3	February 3, 2005	S-A3-1	0.097	U	0.176		0.22	U
J02DY4	February 2, 2005	S-A3-2	0.065	U	0.261		0.24	U
J02DY5	February 2, 2005	S-A3-4	0.051	U	0.13	U	0.17	U
J02DY6	February 2, 2005	S-A3-5	0.06	U	0.21	U	0.25	U
J02DY7	February 2, 2005	S-A3-9	0.044	U	0.097	U	0.18	U
J02DY8	February 2, 2005	S-A3-11	0.37		1.23		0.26	U
J02DY9	February 2, 2005	S-A4-3	0.128		0.823		0.25	U
J02F00	February 3, 2005	S-A4-4	0.958		4.64		0.36	U
J02F01	February 2, 2005	S-A4-7	0.095		0.877		0.29	U
J02F02	February 2, 2005	S-A4-9	0.048	U	0.12	U	0.19	U
J02F03	February 3, 2005	S-A4-12	0.092	U	0.299		0.27	U
J02F04	February 2, 2005	S-A4-13	0.069	U	0.21	U	0.24	U
J02F05	February 2, 2005	S-B5-1	0.063	U	0.2	U	0.23	U
J02F06	February 2, 2005	S-B5-2	0.101		0.282		0.2	U
J02F07	February 2, 2005	S-B5-5	0.056	U	0.19	U	0.23	U
J02F08	February 2, 2005	S-B5-7	0.054	U	0.15	U	0.2	U
J02F09	February 3, 2005	S-B5-13	0.071	U	0.22	U	0.24	U
J02F10	February 3, 2005	S-B5-15	0.164		0.412		0.22	U
J02F11	February 3, 2005	S-B6-1	0.06	U	0.21	U	0.25	U
J02F12	February 3, 2005	S-B6-10	0.054	U	0.14	U	0.2	U
J02F13	February 3, 2005	S-B6-12	0.099		0.394		0.26	U
J02F14	February 2, 2005	S-B6-13	0.056	U	0.15	U	0.2	U
J02F15	February 2, 2005	S-B6-15	0.07	U	0.611		0.26	U
J02F16	February 2, 2005	S-B6-16	0.06	U	0.17	U	0.21	U
J02F17	February 2, 2005	S-B7-1	0.059	U	0.2	U	0.19	U
J02F18	February 4, 2005	S-B7-3	0.068	U	0.24	U	0.27	U
J02F19	February 3, 2005	S-B7-4	0.057	U	0.15	U	0.23	U
J02F20	February 2, 2005	S-B7-5	0.065	U	0.23	U	0.23	U
J02F21	February 3, 2005	S-B7-8	0.053	U	0.13	U	0.23	U
J02F22	February 4, 2005	S-B7-11	0.075	U	0.23	U	0.23	U
J02F23	February 3, 2005	S-B8-2	0.052	U	0.12	U	0.16	U
J02F24	February 3, 2005	S-B8-3	0.057	U	0.096	U	0.2	U
J02F25	February 3, 2005	S-B8-4	0.059	U	0.14	U	0.16	U
J02F26	February 2, 2005	S-B8-8	0.379		0.29	U	0.26	U
J02F27	February 2, 2005	S-B8-12	0.43		0.345		0.23	U
J02F28	February 2, 2005	S-B8-13	0.141		0.242		0.23	U
J02F29	February 3, 2005	S-C9-3	0.07	U	0.177		0.22	U
J02F30	February 3, 2005	S-C9-4	0.062	U	0.2	U	0.25	U
J02F31	February 3, 2005	S-C9-5	0.084		0.13	U	0.21	U
J02F32	February 3, 2005	S-C9-10	0.069	U	0.22	U	0.26	U
J02F33	February 3, 2005	S-C9-14	0.785		1.6		0.26	U
J02F34	February 3, 2005	S-C9-16	0.06	U	2.04		0.22	U
J02F35	February 3, 2005	S-C10-3	0.092	U	0.23	U	0.27	U
J02F36	February 3, 2005	S-C10-4	0.365		0.6		0.23	U
J02F37	February 3, 2005	S-C10-8	0.076	U	0.23	U	0.28	U
J02F38	February 4, 2005	S-C10-10	0.081	U	0.26	U	0.31	U

Shallow Zone

CALCULATION SHEET

Bechtel Hanford Inc.

Originator	S. W. Callison SWC	Date	3/3/2005	Calc. No.	0100K-CA-V0041	Rev. No.	0
Project	100-K Remedial Action	Job No.	22192	Checked	M. T. Stankovich MTS	Date	3-7-05
Subject	100-K-55 Pipeline and Overburden Variance Calculation					Sheet No.	3 of 10

Statistical Evaluation of Analytical Data

The required number of samples resulting from the calculation is highlighted at the bottom of the page.
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The highest value of the three evaluations is used to determine the required number of samples as compared against the default of four.
Sample locations are from Calculation 0100K-CA-V0039.
Mean, Standard Deviation, *t*, and Number of Samples formulas are from DOE/RL-96-22, Appendix A.

Decision Unit: Pipeline Shallow Zone
Samples values from GEA analysis
Sample Areas. **A, B, C, D, E & F**

Sample #	Sample Date	Location	Constituent: Cesium-137 pCi/g	Q	Europium-152 pCi/g	Q	Europium-154 pCi/g	Q
Look-up Value (HT) ==========>			**6.2**		**3.3**		**3.0**	
J02F39	February 4, 2005	S-C10-14	0.11	U	0.34	U	0.37	U
J02F40	February 3, 2005	S-C10-16	0.175		0.26	U	0.31	U
J02F41	February 4, 2005	S-C1-2	0.074	U	0.24	U	0.23	U
J02F42	February 3, 2005	S-C1-3	0.212		0.12	U	0.23	U
J02F43	February 3, 2005	S-C1-4	0.059	U	0.663		0.062	U
J02F44	February 3, 2005	S-C1-10	3.5		3.87		0.32	U
J02F45	February 3, 2005	S-C1-13	0.066	U	0.17	U	0.22	U
J02F46	February 3, 2005	S-C1-16	0.071	U	0.25	U	0.26	U
J02F47	February 3, 2005	S-C2-3	2.24		0.23	U	0.29	U
J02F48	February 3, 2005	S-C2-6	0.13	U	6.1		0.44	U
J02F49	February 3, 2005	S-C2-7	0.076	U	0.19	U	0.27	U
J02F50	February 3, 2005	S-C2-10	0.054	U	0.13	U	0.2	U
J02F51	February 3, 2005	S-C2-14	0.644		9.05		0.853	
J02F52	February 3, 2005	S-C2-15	0.425		1.12		0.29	U
J02F53	February 8, 2005	S-D3-1	0.069	U	0.18	U	0.22	U
J02F54	February 8, 2005	S-D3-2	0.073	U	0.25	U	0.27	U
J02F55	February 8, 2005	S-D3-4	0.099	U	0.306		0.31	U
J02F56	February 8, 2005	S-D3-5	1.4		6.3		0.753	
J02F57	February 8, 2005	S-D3-9	0.077		0.268		0.15	U
J02F58	February 8, 2005	S-D3-11	0.045	U	0.12	U	0.18	U
J02F59	February 8, 2005	S-D4-3	0.07	U	0.985		0.24	U
J02F60	February 8, 2005	S-D4-4	0.074	U	0.23	U	0.25	U
J02F61	February 8, 2005	S-D4-7	0.072	U	0.18		0.26	U
J02F62	February 8, 2005	S-D4-9	0.847		0.22	U	0.22	U
J02F63	February 8, 2005	S-D4-12	0.043	U	0.12	U	0.17	U
J02F64	February 8, 2005	S-D4-13	0.68		0.391		0.13	U
J02F65	February 8, 2005	S-D5-1	0.556		0.775		0.16	U
J02F66	February 4, 2005	S-D5-2	0.085	U	0.21	U	0.28	U
J02F67	February 8, 2005	S-D5-5	0.175		0.306		0.21	U
J02F68	February 8, 2005	S-D5-7	1.85		0.29	U	0.31	U
J02F69	February 8, 2005	S-D5-13	0.16		0.175		0.2	U
J02F70	February 8, 2005	S-D5-15	0.048	U	0.12	U	0.16	U
J02F71	February 8, 2005	S-D6-1	0.045		0.17	U	0.19	U
J02F72	February 8, 2005	S-D6-10	0.337		0.475		0.33	U
J02F73	February 8, 2005	S-D6-12	0.078	U	0.449		0.29	U
J02F74	February 8, 2005	S-D6-13	0.072	U	0.23	U	0.26	U
J02F75	February 8, 2005	S-D6-15	0.692		11.2		1.41	
J02F76	February 8, 2005	S-D6-16	0.078	U	0.207		0.26	U
J02F77	February 8, 2005	S-E7-1	0.823		0.543		0.23	U
J02F78	February 8, 2005	S-E7-3	0.569		0.17	U	0.18	U
J02F79	February 8, 2005	S-E7-4	0.616		0.25	U	0.27	U
J02F80	February 8, 2005	S-E7-5	0.444		0.286		0.21	U
J02F81	February 8, 2005	S-E7-8	0.052	U	0.12	U	0.15	U
J02F82	February 8, 2005	S-E7-11	0.06	U	0.15	U	0.17	U
J02F83	February 8, 2005	S-E8-2	0.063		0.2	U	0.19	U
J02F84	February 8, 2005	S-E8-3	0.11	U	0.193		0.28	U
J02F85	February 8, 2005	S-E8-4	0.23		0.126		0.17	U
J02F86	February 8, 2005	S-E8-8	0.211		0.24	U	0.25	U
J02F87	February 8, 2005	S-E8-12	2.57		9.21		0.934	
J02F88	February 8, 2005	S-E8-13	0.211		0.2	U	0.16	U
J02F89	February 8, 2005	S-E9-3	0.291		0.25	U	0.22	U
J02F90	February 8, 2005	S-E9-4	0.728		0.27	U	0.3	U
J02F91	February 8, 2005	S-E9-5	0.248		1.54		0.27	U
J02F92	February 8, 2005	S-E9-10	0.212		0.28	U	0.27	U
J02F93	February 8, 2005	S-E9-14	0.175		0.283		0.33	U
J02F94	February 8, 2005	S-E9-16	0.06	U	0.16	U	0.16	U
J02F95	January 31, 2005	S-E10-3	0.05	U	0.14	U	0.19	U
J02F96	January 31, 2005	S-E10-4	0.112		0.131	U	0.22	U
J02F97	January 31, 2005	S-E10-8	0.057	U	0.15	U	0.2	U

Shallow Zone

CALCULATION SHEET

Bechtel Hanford Inc.

Originator	S. W. Callison SWC	Date 3/3/2005	Calc. No.	0100K-CA-V0041	Rev. No.	0	
Project	100-K Remedial Action	Job No. 22192	Checked	M. T. Stankovich MTS	Date	3-7-05	
Subject	100-K-55 Pipeline and Overburden Variance Calculation				Sheet No.	4 of 10	

1 Statistical Evaluation of Analytical Data
2
3 The required number of samples resulting from the calculation is highlighted at the bottom of the page.
4 Each value is reflective of the specific analyte evaluated.
5 The highest value of the three evaluations is used to determine the required number of samples as compared
6 against the default of four.
7 Sample locations are from Calculation 0100K-CA-V0039.
8 Mean, Standard Deviation, *t*, and Number of Samples formulas are from DOE/RL-96-22, Appendix A.
9
10
11 Decision Unit: Pipeline Shallow Zone
12 Samples values from GEA analysis
13 Sample Areas . **A, B, C, D, E & F**

14 Sample #	Sample Date	Location	Constituent Cesium-137 pCi/g	Q	Europium-152 pCi/g	Q	Europium-154 pCi/g	Q
15								
16 **Look-up Value (HT) ==========>**			**6.2**		**3.3**		**3.0**	
17 J02F98	January 31, 2005	S-E10-10	0.047	U	0.11	U	0.16	U
18 J02F99	January 31, 2005	S-E10-14	0.049	U	0.12	U	0.18	U
19 J02FB0	January 31, 2005	S-E10-16	0.052	U	0.13	U	0.19	U
20 J02FB1	January 27, 2005	S-F1-2	0.059	U	0.13	U	0.17	U
21 J02FB2	January 27, 2005	S-F1-3	0.061	U	0.15	U	0.2	U
22 J02FB3	January 27, 2005	S-F1-4	0.041	U	0.11	U	0.15	U
23 J02FB4	January 27, 2005	S-F1-10	0.043	U	0.12	U	0.18	U
24 J02FB5	January 27, 2005	S-F1-13	0.062	U	0.14	U	0.24	U
25 J02FB6	January 27, 2005	S-F1-16	0.054	U	0.18	U	0.2	U
26 J02FB7	January 27, 2005	S-F2-3	0.052	U	0.15	U	0.18	U
27 J02FB8	January 27, 2005	S-F2-6	0.046	U	0.11	U	0.16	U
28 J02FB9	January 27, 2005	S-F2-7	0.052	U	0.17	U	0.2	U
29 J02FC0	January 27, 2005	S-F2-10	0.049	U	0.15	U	0.19	U
30 J02FC1	January 27, 2005	S-F2-14	0.039	U	0.11	U	0.18	U
31 J02FC2	January 27, 2005	S-F2-15	0.049	U	0.16	U	0.18	U
32 J02FC3	January 27, 2005	S-F3-1	0.07	U	0.16	U	0.23	U
33 J02FC4	January 27, 2005	S-F3-2	0.049	U	0.14	U	0.2	U
34 J02FC5	January 27, 2005	S-F3-4	0.057	U	0.18	U	0.19	U
35 J02FC6	January 27, 2005	S-F3-5	0.053	U	0.15	U	0.25	U
36 J02FC7	January 27, 2005	S-F3-9	0.049	U	0.12	U	0.17	U
37 J02FC8	January 27, 2005	S-F3-11	0.049	U	0.16	U	0.18	U
38 J02FC9	January 27, 2005	S-F4-3	0.057	U	0.15	U	0.16	U
39 J02FD0	January 27, 2005	S-F4-4	0.049	U	0.12	U	0.17	U
40 J02FD1	January 27, 2005	S-F4-7	0.05	U	0.16	U	0.21	U
41 J02FD2	January 27, 2005	S-F4-9	0.051	U	0.13	U	0.16	U
42 J02FD3	January 27, 2005	S-F4-12	0.037	U	0.11	U	0.13	U
43 J02FD4	January 27, 2005	S-F4-13	0.046	U	0.15	U	0.18	U
44 Mean (LV) ==========>			0.22		0.61		0.26	
45 Standard Deviation (S) ==========>			0.46		1.62		0.15	
46 α (5%) ==========>			1.645		1.645		1.645	
47 β (20%) ==========>			0.842		0.842		0.842	
48 **Number of Samples ==========>**			**1**		**3**		**1**	
49								

CALCULATION SHEET

Bechtel Hanford Inc.

Originator	S. W. Callison SWC	Date 3/3/2005	Calc. No.	0100K-CA-V0041	Rev. No.	0	
Project	100-K Remedial Action	Job No. 22192	Checked	M. T. Stankovich MTS	Date	3.7.05	
Subject	100-K-55 Pipeline and Overburden Variance Calculation				Sheet No.	5 of 10	

Statistical Evaluation of Analytical Data

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Sample locations are from Calculation 0100K-CA-V0039.
Mean, Standard Deviation, *t*, and Number of Samples formulas are from DOE/RL-96-22, Appendix A.

Decision Unit: Pipeline Overburden
Samples values from GEA analysis
Sample Areas: **A, B, C, D, E, F, G, H, I, J, K, & L**

Sample #	Sample Date	Location	Constituent: Cesium-137 pCi/g	Q	Europium-152 pCi/g	Q	Europium-154 pCi/g	Q
Look-up Value (HT) ==========>			**6.2**		**3.3**		**3.0**	
J023H9	December 21, 2004	O-A1-2	0.153		0.12	U	0.18	U
J023J0	December 21, 2004	O-A1-3	0.128		0.13	U	0.19	U
J023J1	December 21, 2004	O-A1-4	0.199		0.23	U	0.38	U
J023J2	December 21, 2004	O-A1-10	1.32		0.726		0.2	U
J023J3	December 21, 2004	O-A1-13	0.245		0.393		0.27	U
J023J4	December 21, 2004	O-A1-16	0.074	U	0.15	U	0.25	U
J023J5	December 21, 2004	O-A2-3	1.28		0.15	U	0.15	U
J023J6	December 21, 2004	O-A2-6	0.085		0.17	U	0.19	U
J023J7	December 21, 2004	O-A2-7	0.136		0.11	U	0.14	U
J023J8	December 21, 2004	O-A2-10	0.726		1.32		0.183	
J023J9	December 21, 2004	O-A2-14	0.639		2.13		0.291	
J023K0	December 21, 2004	O-A2-15	0.099	U	0.285		0.37	U
J023K1	December 21, 2004	O-A3-1	0.068		0.1	U	0.14	U
J023K2	December 21, 2004	O-A3-2	10.1		1.95		0.292	
J023K3	December 21, 2004	O-A3-4	1.13		0.27	U	0.3	U
J023K4	December 21, 2004	O-A3-5	1.02		0.18	U	0.16	U
J023K5	December 21, 2004	O-A3-9	0.148		0.16	U	0.21	U
J023K6	December 21, 2004	O-A3-11	0.406		0.23	U	0.28	U
J023K7	December 21, 2004	O-A4-3	1.6		0.17	U	0.2	U
J023K8	December 21, 2004	O-A4-4	0.217		0.17	U	0.26	U
J023K9	December 21, 2004	O-A4-7	4.36		1.05		0.35	U
J023L0	December 21, 2004	O-A4-9	3.19		0.261		0.18	U
J023L1	December 21, 2004	O-A4-12	1.57		0.283		0.26	U
J023L2	December 21, 2004	O-A4-13	0.958		0.28	U	0.35	U
J023L3	December 21, 2004	O-B5-1	0.695		0.302		0.29	U
J023L4	December 21, 2004	O-B5-2	0.497		0.15	U	0.2	U
J023L5	December 21, 2004	O-B5-5	0.075		0.16	U	0.26	U
J023L6	December 21, 2004	O-B5-7	0.496		0.23	U	0.31	U
J023L7	December 21, 2004	O-B5-13	0.058	U	0.16	U	0.2	U
J023L8	December 21, 2004	O-B5-15	0.084	U	0.2	U	0.34	U
J023L9	December 21, 2004	O-B6-1	0.074	U	0.163		0.26	U
J023M0	December 21, 2004	O-B6-10	0.042	U	0.11	U	0.14	U
J023M1	December 21, 2004	O-B6-12	0.085	U	0.305		0.19	U
J023M2	December 21, 2004	O-B6-13	0.085	U	0.462		0.27	U
J023M3	December 21, 2004	O-B6-15	0.141		0.323		0.16	U
J023M4	December 21, 2004	O-B6-16	0.077	U	0.46		0.23	U
J023M5	December 21, 2004	O-B7-1	0.166		0.323		0.27	U
J023M6	December 21, 2004	O-B7-3	0.467		0.729		0.18	U
J023M7	December 21, 2004	O-B7-4	0.123		0.32		0.19	U
J023M8	December 21, 2004	O-B7-5	1		0.944		0.35	U
J023M9	December 21, 2004	O-B7-8	0.041	U	0.1	U	0.16	U
J023N0	December 21, 2004	O-B7-11	0.063		0.16	U	0.24	U
J023N1	December 21, 2004	O-B8-2	0.17		0.19	U	0.27	U
J023N2	December 21, 2004	O-B8-3	0.036	U	0.096	U	0.13	U
J023N3	December 21, 2004	O-B8-4	0.13	U	0.19	U	0.27	U
J023N4	December 21, 2004	O-B8-8	0.237		0.139		0.24	U
J023N5	December 21, 2004	O-B8-12	0.108		0.2		0.13	U
J023N6	December 21, 2004	O-B8-13	0.061	U	0.16	U	0.23	U
J023N7	December 22, 2004	O-C9-3	0.061	U	0.108	U	0.18	U
J023N8	December 22, 2004	O-C9-4	0.091		0.304		0.28	U
J023N9	December 22, 2004	O-C9-5	0.474		1.66		0.369	

CALCULATION SHEET

Bechtel Hanford Inc.

Originator	S. W. Callison SWC	Date	3/3/2005	Calc. No.	0100K-CA-V0041	Rev. No.	0
Project	100-K Remedial Action	Job No.	22192	Checked	M. T. Stankovich MTS	Date	3-7-05
Subject	100-K-55 Pipeline and Overburden Variance Calculation					Sheet No.	6 of 10

Statistical Evaluation of Analytical Data

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Decision Unit: Pipeline Overburden
Samples values from GEA analysis
Sample Areas: **A, B, C, D, E, F, G, H, I, J, K, & L**

Sample #	Sample Date	Location	Constituent: Cesium-137 pCi/g	Q	Europium-152 pCi/g	Q	Europium-154 pCi/g	Q
Look-up Value (HT) ==========>			**6.2**		**3.3**		**3.0**	
J023P0	December 22, 2004	O-C9-10	0.045	U	0.12	U	0.17	U
J023P1	December 22, 2004	O-C9-14	0.048	U	0.12	U	0.18	U
J023P2	December 22, 2004	O-C9-16	0.068	U	0.16	U	0.22	U
J023P3	December 22, 2004	O-C10-3	0.046	U	0.11	U	0.15	U
J023P4	December 22, 2004	O-C10-4	0.166		0.361		0.23	U
J023P5	December 22, 2004	O-C10-8	0.063	U	0.19	U	0.27	U
J023P6	December 22, 2004	O-C10-10	0.098	U	0.652		0.34	U
J023P7	December 22, 2004	O-C10-14	0.037	U	0.11	U	0.14	U
J023P8	December 22, 2004	O-C10-16	0.06	U	0.16	U	0.17	U
J023P9	December 22, 2004	O-C1-2	1.21		1.34		0.28	U
J023R0	December 22, 2004	O-C1-3	0.451		0.508		0.27	U
J023R1	December 22, 2004	O-C1-4	0.105		0.285		0.34	U
J023R2	December 22, 2004	O-C1-10	0.206		0.26		0.16	U
J023R3	December 22, 2004	O-C1-13	0.063	U	0.17	U	0.23	U
J023R4	December 22, 2004	O-C1-16	0.082	U	0.17	U	0.26	U
J023R5	December 22, 2004	O-C2-3	0.383		0.272		0.11	U
J023R6	December 22, 2004	O-C2-6	0.197		0.232		0.16	U
J023R7	December 22, 2004	O-C2-7	0.224		0.177		0.26	U
J023R8	December 22, 2004	O-C2-10	0.521		0.15	U	0.18	U
J023R9	December 22, 2004	O-C2-14	0.092		0.156		0.19	U
J023T0	December 22, 2004	O-C2-15	0.072	U	0.17	U	0.21	U
J023T1	December 22, 2004	O-D3-1	0.2	U	0.16	U	0.27	U
J023T2	December 22, 2004	O-D3-2	0.378		0.952		0.18	U
J023T3	December 22, 2004	O-D3-4	0.718		1.13		0.207	U
J023T4	December 22, 2004	O-D3-5	0.953		0.561		0.35	U
J023T5	December 22, 2004	O-D3-9	1.54		0.2		0.16	U
J023T6	December 22, 2004	O-D3-11	0.1	U	0.22	U	0.31	U
J023T7	December 22, 2004	O-D4-3	0.335		0.913		0.29	U
J023T8	December 22, 2004	O-D4-4	0.227		0.45		0.16	U
J023T9	December 22, 2004	O-D4-7	0.07	U	0.16	U	0.19	U
J023V0	December 22, 2004	O-D4-9	0.092	U	0.21	U	0.3	U
J023V1	December 22, 2004	O-D4-12	0.043	U	0.11	U	0.15	U
J023V2	December 22, 2004	O-D4-13	0.065	U	0.15	U	0.22	U
J023V3	December 22, 2004	O-D5-1	0.086	U	0.22	U	0.36	U
J023V4	December 22, 2004	O-D5-2	0.059		0.192		0.18	U
J023V5	December 22, 2004	O-D5-5	1.09		0.5		0.24	U
J023V6	December 22, 2004	O-D5-7	0.212		0.221	U	0.31	U
J023V7	December 22, 2004	O-D5-13	0.93		0.827		0.21	U
J023V8	December 22, 2004	O-D5-15	0.06	U	0.14	U	0.24	U
J023V9	December 22, 2004	O-D6-1	0.088	U	0.18	U	0.33	U
J023W0	December 22, 2004	O-D6-10	0.041	U	0.081	U	0.15	U
J023W1	December 22, 2004	O-D6-12	0.304		0.265		0.25	U
J023W2	December 22, 2004	O-D6-13	0.541		0.503		0.074	U
J023W3	December 22, 2004	O-D6-15	0.009	U	0.024	U	0.032	U
J023W4	December 22, 2004	O-D6-16	0.013	U	0.03	U	0.044	U
J023W5	December 22, 2004	O-E7-1	0.1	U	0.22	U	0.29	U
J023W6	December 22, 2004	O-E7-3	0.045	U	0.13	U	0.18	U
J023W7	December 22, 2004	O-E7-4	0.309		0.586		0.23	U
J023W8	December 22, 2004	O-E7-5	0.172		0.969		0.28	U
J023W9	December 22, 2004	O-E7-8	0.047	U	0.099	U	0.13	U
J023X0	December 22, 2004	O-E7-11	0.054	U	0.14	U	0.18	U

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Bechtel Hanford Inc.

Originator	S. W. Callison SWC	Date	3/3/2005	Calc. No.	0100K-CA-V0041	Rev. No.	0
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Statistical Evaluation of Analytical Data

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Decision Unit: Pipeline Overburden
Samples values from GEA analysis
Sample Areas. **A, B, C, D, E, F, G, H, I, J, K, & L**

Sample #	Sample Date	Location	Constituent: Cesium-137 pCi/g	Q	Europium-152 pCi/g	Q	Europium-154 pCi/g	Q
Look-up Value (HT) ==========>			**6.2**		**3.3**		**3.0**	
J023X1	December 22, 2004	O-E8-2	0.12	U	0.254		0.32	U
J023X2	December 22, 2004	O-E8-3	0.049	U	0.13	U	0.18	U
J023X3	December 22, 2004	O-E8-4	0.954		0.227		0.25	U
J023X4	December 22, 2004	O-E8-8	4.92		4.35		0.687	
J023X5	December 22, 2004	O-E8-12	0.57		0.606		0.18	U
J023X6	December 22, 2004	O-E8-13	0.067	U	0.306		0.21	U
J023X7	December 22, 2004	O-E9-3	0.098	U	0.276		0.31	U
J023X8	December 22, 2004	O-E9-4	0.04	U	0.11	U	0.17	U
J023X9	December 22, 2004	O-E9-5	0.082	U	0.17	U	0.2	U
J023Y0	December 22, 2004	O-E9-10	0.378		0.472		0.22	U
J023Y1	December 22, 2004	O-E9-14	0.035	U	0.09	U	0.12	U
J023Y2	December 22, 2004	O-E9-16	0.159		0.469		0.2	U
J023Y3	December 22, 2004	O-E10-3	0.089	U	0.2	U	0.33	U
J023Y4	December 22, 2004	O-E10-4	0.261		0.12	U	0.13	U
J023Y5	December 22, 2004	O-E10-5	1.19		0.17	U	0.23	U
J023Y6	December 22, 2004	O-E10-10	0.443		0.452		0.31	U
J023Y7	December 22, 2004	O-E10-14	0.13		0.16	U	0.15	U
J023Y8	December 22, 2004	O-E10-16	0.07		1.18		0.25	U
J023Y9	December 22, 2004	O-F1-2	0.358		0.13	U	0.18	U
J02400	December 22, 2004	O-F1-3	0.074	U	0.16	U	0.19	U
J02401	December 22, 2004	O-F1-4	0.085	U	0.18	U	0.26	U
J02402	December 22, 2004	O-F1-10	0.164		0.1	U	0.13	U
J02403	December 22, 2004	O-F1-13	0.081		0.354		0.21	U
J02404	December 22, 2004	O-F1-16	0.134		0.694		0.308	
J02405	December 22, 2004	O-F2-3	0.038	U	0.096	U	0.15	U
J02406	December 22, 2004	O-F2-6	0.062	U	0.16	U	0.2	U
J02407	December 22, 2004	O-F2-7	0.14		0.2	U	0.31	U
J02408	December 22, 2004	O-F2-10	0.108		0.097	U	0.18	U
J02409	December 22, 2004	O-F2-14	0.55		1.03		0.25	U
J02410	December 22, 2004	O-F2-15	0.066	U	0.14	U	0.2	U
J02411	December 22, 2004	O-F3-1	0.034	U	0.1	U	0.17	U
J02412	December 22, 2004	O-F3-2	0.077	U	0.17	U	0.26	U
J02413	December 22, 2004	O-F3-4	0.084	U	0.2	U	0.31	U
J02414	December 22, 2004	O-F3-5	0.276		0.13	U	0.15	U
J02415	December 22, 2004	O-F3-9	0.064	U	0.16	U	0.26	U
J02416	December 22, 2004	O-F3-11	0.11	U	0.25	U	0.31	U
J02417	December 22, 2004	O-F4-3	0.051	U	0.128	U	0.2	U
J02418	December 22, 2004	O-F4-4	0.979		0.209		0.21	U
J02419	December 22, 2004	O-F4-7	0.036	U	0.129		0.16	U
J02420	December 22, 2004	O-F4-9	0.082	U	0.15	U	0.25	U
J02421	December 22, 2004	O-F4-12	0.19		0.11	U	0.13	U
J02422	December 22, 2004	O-F4-13	0.146		0.304		0.36	U
J02423	February 8, 2005	O-G5-1	0.116		0.24	U	0.24	U
J02424	February 8, 2005	O-G5-2	0.11	U	0.21		0.22	U
J02425	February 8, 2005	O-G5-5	0.098		0.415		0.18	U
J02426	February 8, 2005	O-G5-7	0.073	U	0.23	U	0.24	U
J02427	February 8, 2005	O-G5-13	0.187		0.985		0.37	U
J02428	February 8, 2005	O-G5-15	0.085	U	0.2	U	0.28	U
J02429	February 8, 2005	O-G6-1	0.07	U	0.25	U	0.28	U
J02430	February 8, 2005	O-G6-10	0.059	U	0.13	U	0.17	U
J02431	February 8, 2005	O-G6-12	0.057	U	0.14	U	0.21	U

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Bechtel Hanford Inc.

Originator	S. W. Callison SWC	Date	3/3/2005	Calc. No.	0100K-CA-V0041	Rev. No.	0
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Statistical Evaluation of Analytical Data

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Decision Unit: Pipeline Overburden
Samples values from GEA analysis
Sample Areas. **A, B, C, D, E, F, G, H, I, J, K, & L**

Sample #	Sample Date	Location	Constituent: Cesium-137 pCi/g	Q	Europium-152 pCi/g	Q	Europium-154 pCi/g	Q
Look-up Value (HT) ==========>			**6.2**		**3.3**		**3.0**	
J02432	February 8, 2005	O-G6-13	0.06	U	0.15	U	0.21	U
J02433	February 8, 2005	O-G6-15	0.056	U	0.14	U	0.17	U
J02434	February 8, 2005	O-G6-16	0.064	U	0.16	U	0.24	U
J02435	February 8, 2005	O-G7-1	0.053	U	0.14	U	0.21	U
J02436	February 8, 2005	O-G7-3	0.052	U	0.14	U	0.22	U
J02437	February 8, 2005	O-G7-4	0.054	U	0.15	U	0.21	U
J02438	February 8, 2005	O-G7-5	0.06	U	0.17	U	0.2	U
J02439	February 8, 2005	O-G7-8	0.048	U	0.15	U	0.17	U
J02440	February 8, 2005	O-G7-11	0.06	U	0.14	U	0.21	U
J02441	February 16, 2005	O-G8-2	0.054	U	0.18	U	0.2	U
J02442	February 16, 2005	O-G8-3	0.288		1.28		0.34	U
J02443	February 16, 2005	O-G8-4	0.211		0.716		0.31	U
J02444	February 16, 2005	O-G8-8	0.089	U	0.17	U	0.29	U
J02445	February 16, 2005	O-G8-12	0.11	U	0.39		0.3	U
J02446	February 16, 2005	O-G8-13	0.601		0.454		0.35	U
J02447	February 16, 2005	O-H9-3	0.092		0.229		0.23	U
J02448	February 16, 2005	O-H9-4	0.088		0.2	U	0.23	U
J02449	February 16, 2005	O-H9-5	0.274		0.315		0.22	U
J02450	February 16, 2005	O-H9-10	0.062	U	0.2	U	0.22	U
J02451	February 16, 2005	O-H9-14	0.24		0.99		0.33	U
J02452	February 16, 2005	O-H9-16	0.116		0.27	U	0.27	U
J02453	February 16, 2005	O-H10-3	0.082	U	0.18	U	0.27	U
J02454	February 16, 2005	O-H10-4	0.363		0.24	U	0.23	U
J02455	February 16, 2005	O-H10-8	0.214		0.331		0.21	U
J02456	February 16, 2005	O-H10-10	0.209		0.25	U	0.33	U
J02457	February 16, 2005	O-H10-14	0.122		0.25	U	0.29	U
J02458	February 16, 2005	O-H10-16	0.05	U	0.11	U	0.15	U
J02459	February 16, 2005	O-H1-2	0.155		0.189		0.26	U
J02460	February 16, 2005	O-H1-3	0.098		0.37		0.25	U
J02461	February 16, 2005	O-H1-4	0.123		0.565		0.31	U
J02462	February 16, 2005	O-H1-10	0.1	U	1.46		0.32	U
J02463	February 16, 2005	O-H1-13	0.075	U	0.17	U	0.27	U
J02464	February 16, 2005	O-H1-16	0.06	U	0.2	U	0.23	U
J02465	February 16, 2005	O-H2-3	0.074	U	0.17	U	0.3	U
J02466	February 16, 2005	O-H2-6	0.067	U	0.23	U	0.27	U
J02467	February 16, 2005	O-H2-7	0.059	U	0.13	U	0.18	U
J02468	February 16, 2005	O-H2-10	0.061	U	0.21	U	0.26	U
J02469	February 16, 2005	O-H2-14	0.037	U	0.099	U	0.14	U
J02470	February 16, 2005	O-H2-15	0.682		0.18	U	0.2	U
J02471	January 5, 2005	O-I3-1	0.071		0.19	U	0.31	U
J02472	January 5, 2005	O-I3-2	0.112		0.17	U	0.17	U
J02473	January 5, 2005	O-I3-4	0.076	U	0.19	U	0.28	U
J02474	January 5, 2005	O-I3-5	0.068	U	0.15	U	0.21	U
J02475	January 5, 2005	O-I3-9	0.582		0.22	U	0.28	U
J02476	January 5, 2005	O-I3-11	0.258		0.17	U	0.22	U
J02477	January 5, 2005	O-I4-3	0.185		0.271		0.3	U
J02478	January 5, 2005	O-I4-4	0.449		0.243		0.21	U
J02479	January 5, 2005	O-I4-7	0.085		0.14	U	0.23	U
J02480	January 5, 2005	O-I4-9	0.083	U	0.14	U	0.2	U
J02481	January 5, 2005	O-I4-12	1.09		0.21	U	0.23	U
J02482	January 5, 2005	O-I4-13	0.082	U	0.2	U	0.28	U

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Bechtel Hanford Inc.

Originator	S. W. Callison SWC	Date	3/3/2005	Calc. No.	0100K-CA-V0041	Rev. No.	0
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Statistical Evaluation of Analytical Data

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Decision Unit: Pipeline Overburden
Samples values from GEA analysis
Sample Areas: **A, B, C, D, E, F, G, H, I, J, K, & L**

Sample #	Sample Date	Location	Constituent: Cesium-137 pCi/g	Q	Europium-152 pCi/g	Q	Europium-154 pCi/g	Q
Look-up Value (HT) ==========>			**6.2**		**3.3**		**3.0**	
J02483	January 5, 2005	O-I5-1	0.066	U	0.17	U	0.21	U
J02484	January 5, 2005	O-I5-2	0.085		0.16	U	0.21	U
J02485	January 5, 2005	O-I5-5	0.056	U	0.13	U	0.19	U
J02486	January 5, 2005	O-I5-7	0.056	U	0.15	U	0.19	U
J02487	January 5, 2005	O-I5-13	0.064	U	0.15	U	0.21	U
J02488	January 5, 2005	O-I5-15	0.079	U	0.19	U	0.25	U
J02489	January 5, 2005	O-I6-1	0.07	U	0.18	U	0.26	U
J02490	January 5, 2005	O-I6-10	0.152		0.16	U	0.21	U
J02491	January 5, 2005	O-I6-12	0.059	U	0.11	U	0.15	U
J02492	January 5, 2005	O-I6-13	0.215		0.13	U	0.23	U
J02493	January 5, 2005	O-I6-15	0.053	U	0.11	U	0.16	U
J02494	January 5, 2005	O-I6-16	0.068	U	0.2	U	0.29	U
J02495	January 20, 2005	O-J7-1	0.053	U	0.14	U	0.2	U
J02496	January 20, 2005	O-J7-3	0.187		0.18	U	0.23	U
J02497	January 20, 2005	O-J7-4	0.115		0.13	U	0.19	U
J02498	January 20, 2005	O-J7-5	0.258		0.2	U	0.24	U
J02499	January 20, 2005	O-J7-8	0.041	U	0.097	U	0.15	U
J024B0	January 20, 2005	O-J7-11	0.045	U	0.14	U	0.17	U
J024B1	January 20, 2005	O-J8-2	0.057	U	0.15	U	0.22	U
J024B2	January 20, 2005	O-J8-3	0.053	U	0.17	U	0.18	U
J024B3	January 20, 2005	O-J8-4	0.061	U	0.13	U	0.18	U
J024B4	January 20, 2005	O-J8-8	0.057	U	0.19	U	0.2	U
J024B5	January 20, 2005	O-J8-12	1.49		0.787		0.22	U
J024B6	January 20, 2005	O-J8-13	0.052	U	0.17	U	0.2	U
J024B7	January 20, 2005	O-J9-3	0.256		0.166		0.17	U
J024B8	January 20, 2005	O-J9-4	0.165		0.12	U	0.14	U
J024B9	January 20, 2005	O-J9-5	0.088		0.15	U	0.19	U
J024C0	January 20, 2005	O-J9-10	0.099		0.108	U	0.18	U
J024C1	January 20, 2005	O-J9-14	0.599		1.09		0.17	U
J024C2	January 20, 2005	O-J9-16	0.054	U	0.14	U	0.17	U
J024C3	January 20, 2005	O-J10-3	0.091		0.11	U	0.18	U
J024C4	January 20, 2005	O-J10-4	0.931		0.511		0.16	U
J024C5	January 20, 2005	O-J10-8	0.03	U	0.08	U	0.11	U
J024C6	January 20, 2005	O-J10-10	0.394		0.14	U	0.15	U
J024C7	January 20, 2005	O-J10-14	0.046	U	0.12	U	0.13	U
J024C8	January 20, 2005	O-J10-16	0.027	U	0.082	U	0.1	U
J024C9	January 20, 2005	O-K1-2	0.036	U	0.097	U	0.13	U
J024D0	January 20, 2005	O-K1-3	0.082		0.086	U	0.12	U
J024D1	January 20, 2005	O-K1-4	0.116		0.11	U	0.14	U
J024D2	January 20, 2005	O-K1-10	0.083	U	0.2	U	0.28	U
J024D3	January 20, 2005	O-K1-13	0.047	U	0.12	U	0.19	U
J024D4	January 20, 2005	O-K1-16	0.058	U	0.18	U	0.23	U
J024D5	January 20, 2005	O-K2-3	0.069	U	0.17	U	0.25	U
J024D6	January 20, 2005	O-K2-6	0.468		0.468		0.22	U
J024D7	January 20, 2005	O-K2-7	0.063	U	0.27	U	0.22	U
J024D8	January 20, 2005	O-K2-10	0.067	U	0.16	U	0.26	U
J024D9	January 20, 2005	O-K2-14	0.062	U	0.179		0.24	U
J024F0	January 20, 2005	O-K2-15	0.066	U	0.19	U	0.22	U
J024F1	January 20, 2005	O-K3-1	0.049	U	0.13	U	0.2	U
J024F2	January 20, 2005	O-K3-2	0.034	U	0.098	U	0.12	U
J024F3	January 20, 2005	O-K3-4	0.049	U	0.15	U	0.17	U

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Bechtel Hanford Inc.

Originator	S. W. Callison SWC	Date	3/3/2005	Calc. No.	0100K-CA-V0041	Rev. No.	0
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Statistical Evaluation of Analytical Data

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Decision Unit: Pipeline Overburden
Samples values from GEA analysis
Sample Areas: **A, B, C, D, E, F, G, H, I, J, K, & L**

Sample #	Sample Date	Location	Constituent: Cesium-137 pCi/g	Q	Europium-152 pCi/g	Q	Europium-154 pCi/g	Q
Look-up Value (HT) ==========>			**6.2**		**3.3**		**3.0**	
J024F4	January 20, 2005	O-K3-5	0.046	U	0.12	U	0.2	U
J024F5	January 20, 2005	O-K3-9	0.046	U	0.11	U	0.16	U
J024F6	January 20, 2005	O-K3-11	0.057	U	0.17	U	0.22	U
J024F7	January 20, 2005	O-K4-3	0.063	U	0.19	U	0.26	U
J024F8	January 20, 2005	O-K4-4	0.071	U	0.17	U	0.24	U
J024F9	January 20, 2005	O-K4-7	0.054	U	0.17	U	0.22	U
J024H0	January 20, 2005	O-K4-9	0.053	U	0.14	U	0.19	U
J024H1	January 20, 2005	O-K4-12	0.047	U	0.13	U	0.17	U
J024H2	January 20, 2005	O-K4-13	0.053	U	0.19	U	0.22	U
J024H3	January 19, 2005	O-L5-1	0.079	U	0.14	U	0.22	U
J024H4	January 19, 2005	O-L5-2	0.045	U	0.13	U	0.2	U
J024H5	January 19, 2005	O-L5-5	0.054	U	0.18	U	0.2	U
J024H6	January 19, 2005	O-L5-7	0.053	U	0.13	U	0.22	U
J024H7	January 19, 2005	O-L5-13	0.047	U	0.12	U	0.17	U
J024H8	January 19, 2005	O-L5-15	0.056	U	0.18	U	0.21	U
J024H9	January 19, 2005	O-L6-1	0.052	U	0.14	U	0.19	U
J024J0	January 19, 2005	O-L6-10	0.041	U	0.11	U	0.15	U
J024J1	January 19, 2005	O-L6-12	0.048	U	0.15	U	0.18	U
J024J2	January 19, 2005	O-L6-13	0.04	U	0.094	U	0.13	U
J024J3	January 19, 2005	O-L6-15	0.031	U	0.082	U	0.12	U
J024J4	January 19, 2005	O-L6-16	0.031	U	0.11	U	0.13	U
J024J5	January 19, 2005	O-L7-1	0.051	U	0.11	U	0.16	U
J024J6	January 19, 2005	O-L7-3	0.052	U	0.14	U	0.19	U
J024J7	January 19, 2005	O-L7-4	0.061	U	0.21	U	0.27	U
J024J8	January 19, 2005	O-L7-5	0.047	U	0.12	U	0.19	U
J024J9	January 19, 2005	O-L7-8	0.045	U	0.12	U	0.17	U
J024K0	January 19, 2005	O-L7-11	0.068	U	0.22	U	0.27	U
J024K1	January 19, 2005	O-L8-2	0.049	U	0.18	U	0.22	U
J024K2	January 19, 2005	O-L8-3	0.042	U	0.12	U	0.14	U
J024K3	January 19, 2005	O-L8-4	0.066	U	0.19	U	0.24	U
J024K4	January 19, 2005	O-L8-8	0.064	U	0.14	U	0.22	U
J024K5	January 19, 2005	O-L8-12	0.046	U	0.14	U	0.24	U
J024K6	January 19, 2005	O-L8-13	0.054	U	0.18	U	0.2	U
Mean (LV) ==========>			0.28		0.29		0.22	
Standard Deviation (S) ==========>			0.77		0.38		0.07	
α (5%) ==========>			1.645		1.645		1.645	
β (20%) ==========>			0.842		0.842		0.842	
Number of Samples ==========>			**1**		**1**		**1**	

CALCULATION COVER SHEET

(Sample Design, Verification, or Waste Characterization Calculation)

Project Title:	**100-KW-55 Pipelines Sample Design**	**Job No.**	**22192**
Area	**100-K**		
Discipline	**Environmental Engineering**	**Calc. No.**	**0100K-CA-V0039**
Subject	**100-KW-55 Pipelines Shallow, Deep, and Overburden Zone Sampling Plan**		
Computer Program	**Excel**	**Program No.**	**Excel 97**

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

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

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover = 1 Sht Calc = 2 Shts Attach1 = 1 Sht Attach2 = 1 Sht Attach3 = 6 Shts Total = 11 Shts	G. Cruz 1/28/05	C.A. Bentz 1/31/05	M.T. Stankovich 2/1/05	S.W. Callison 2-2-05	2-2-05
SUMMARY OF REVISIONS						

*Obtain Calc. No. from DIS

January 2003

DE01-437.03

Bechtel Hanford, Inc. **CALCULATION SHEET**

Originator G. Cruz Date 1/18/2005 Calc. No. 0100K-CA-V0039 Rev. No. 0

Project 100-KW-55 Pipelines Sample Design Job No. 22192 Checked CAB Date 1/31/05

Subject 100-KW-55 Pipelines Shallow, Deep, and Overburden Zone Sampling Plan Sheet No. 1 of 2

1	**Problem:**	Calculate and display required sampling nodes in concurrence with 100 Area		
2		SAP DOE/RL-96-22 Rev. 3 for verification and closure.		
3				
4	**Given:**	-SAP (DOE/RL-96-22 Rev. 3) and IG (0100X-IG-G0001 Rev. 5) requirements		
5		-Shallow Sampling Area (Surface area of each zone determined from CAD program,		
6		Attachment 3, Sht 1of6, CAD file 1K:011805A, 100-KW-55 Pipelines Shallow Zone Sampling Plan		
7		Attachment 3, Sht 2of6, CAD file 1K:011805B, 100-KW-55 Pipelines Sample Location Table		
8		Attachment 3, Sht 3of6, CAD file 1K:011805C, 100-KW-55 Pipelines Deep Zone Sampling Plan		
9		Attachment 3, Sht 4of6, CAD file 1K:011805D, 100-KW-55 Pipelines Overburden (West) Sampling Plan		
10		Attachment 3, Sht 5of6, CAD file 1K:011805E, 100-KW-55 Pipelines Overburden (East) Sampling Plan		
11		Attachment 3, Sht 6of6, CAD file 1K:011805F, 100-KW-55 Pipelines Overburden Sample Location Table)		
12				
13	**SAP and IG Requirements:**			
14		-Develop a 16 node sampling grid for the sampling area		
15	Shallow Zone	-Use appendix A of the IG to determine which six of the sixteen will be sampled		
16		to collect variance and verification samples		
17				
18		-Develop a 16 node sampling grid for the sampling area		
19	Overburden:	-Use appendix A of the IG to determine which six of the sixteen will be sampled		
20		to collect variance and verification samples		
21				
22		-Develop a 16 node sampling grid for the sampling area		
23	Deep Zone:	-Use appendix A of the IG to determine which four of the sixteen will be sampled		
24		to collect verification samples		
25				
26	**Determination of Shallow Zone Sampling Grid:**			
27				
28	Shallow Zone Sampling Grid Area determined from Table 5-1, IG			
29	Attachment 2, Number of Decision Subunits Based on Area (Converted to Sq Meters)			
30				
31	Total Area:		21364.20	m^2
32	Area of Decision Subunits (total area 6 subunits)		3560.70	m^2
33				
34	Decision Subunit divided into 4 Sampling Areas:		890.17	m^2
35				
36	Sampling Areas divided into a 16 node grid (node numbers 1-16):		55.63	m^2
37				
38	Nodes to be Sampled (as determined from Attachment 1, Sample Grid Point Lookup Table)			
39		See Attachment 3, Sht 1of6, 100-KW-55 Pipelines Shallow Zone Sampling Plan,		
40		for Sample Location Table		
41				
42				
43				
44				

Bechtel Hanford, Inc. **CALCULATION SHEET**

Originator G. Cruz Date 1/18/2005 Calc. No. 0100K-CA-V0039 Rev. No. 0

Project 100-KW-55 Pipelines Sample Design Job No. 22192 Checked AB Date 1/31/05

Subject 100-KW-55 Pipelines Shallow, Deep, and Overburden Zone Sampling Plan Sheet No. 2 of 2

Determination of Deep Zone Sampling Grid:

Deep Zone Sampling Grid Area determined from Table 5-1, IG
Attachment 2, Number of Decision Subunits Based on Area (Converted to Sq Meters)

Total Area:	3618.16	m^2
Area of Decision Subunits (total area 4 subunits)	904.54	m^2
Decision Subunits divided into 3 Sampling Areas:	301.51	m^2
Sampling Areas divided into a 16 node grid (node numbers 1-16):	18.84	m^2

Nodes to be Sampled (as determined from Attachment 1, Table A-1, Sample Grid Point Lookup Table)
See Attachment 3, Sht 3of6, 100-KW-55 Pipelines Deep Zone Sampling Plan,
for Sample Location Table

Determination of Overburden Sampling Grid:

Overburden Sampling Grid Area determined from Table 5-1, IG
Attachment 2, Number of Decision Subunits Based on Area (Converted to Sq Meters)

Total Area:	46397.05	m^2
Area of Decision Subunits (total area 12 subunits)	3866.42	m^2
Decision Subunits divided into 4 Sampling Areas:	966.60	m^2
Sampling Areas divided into a 16 node grid (node numbers 1-16):	60.41	m^2

Nodes to be Sampled (as determined from Attachment 1, Table A-1, Sample Grid Point Lookup Table)
See Attachment 3, Shts 4 and 5of6, 100-KW-55 Pipelines Overburden (West and East) Sampling Plan,
for Sample Location Table

Bechtel Hanford, Inc.

Originator G. Cruz Date 1/18/2005 Calc. No. 0100K-CA-V0039 Rev. No. 0

Project 100-KW-55 Pipelines Sample Design Job No. 22192 Checked CAB Date 1/31/05

Subject 100-KW-55 Pipelines Shallow, Deep, and Overburden Zone Sampling Plan Sheet No 1 of 1

ATTACHMENT 1

Sample Grid Point Lookup Table.

Default Plan	Sampling Area 1	Sampling Area 2	Sampling Area 3	Sampling Area 4	Sampling Area 5	Sampling Area 6	Sampling Area 7	Sampling Area 8	Sampling Area 9	Sampling Area 10
Variance/Verification	3	6	1	4	5	1	3	3	4	16
Variance/Verification	4	7	11	3	15	15	5	13	10	10
Variance/Verification	16	3	2	7	7	10	11	4	3	14
Variance/Verification	10	15	4	12	1	13	4	8	16	4
Variance	2	14	5	9	13	12	8	2	14	8
Variance	13	10	9	13	2	16	1	12	5	3
Not Sampling	6	1	10	8	14	4	16	5	8	6
Not Sampling	1	9	13	1	10	5	12	1	1	15
Not Sampling	9	12	7	5	6	2	6	7	15	9
Not Sampling	15	16	15	14	16	6	2	15	11	1
Not Sampling	8	13	8	10	12	11	13	14	2	12
Not Sampling	5	2	3	11	4	3	9	10	7	11
Not Sampling	7	11	14	15	11	14	14	6	13	2
Not Sampling	11	4	6	2	9	7	7	11	9	7
Not Sampling	12	8	16	16	3	8	15	9	6	13
Not Sampling	14	5	12	6	8	9	10	16	12	5

** **Note:** Grid nodes for each sampling area in each waste site should be numbered consistently, e.g., begin numbering the nodes in the northwestern-most node, then number consecutively left to right.

Bechtel Hanford, Inc.

Originator G. Cruz Date 1/18/2005 Calc. No. 0100K-CA-V0039 Rev. No. 0

Project 100-KW-55 Pipelines Sample Design Job No. 22192 Checked CAB Date 1/31/05

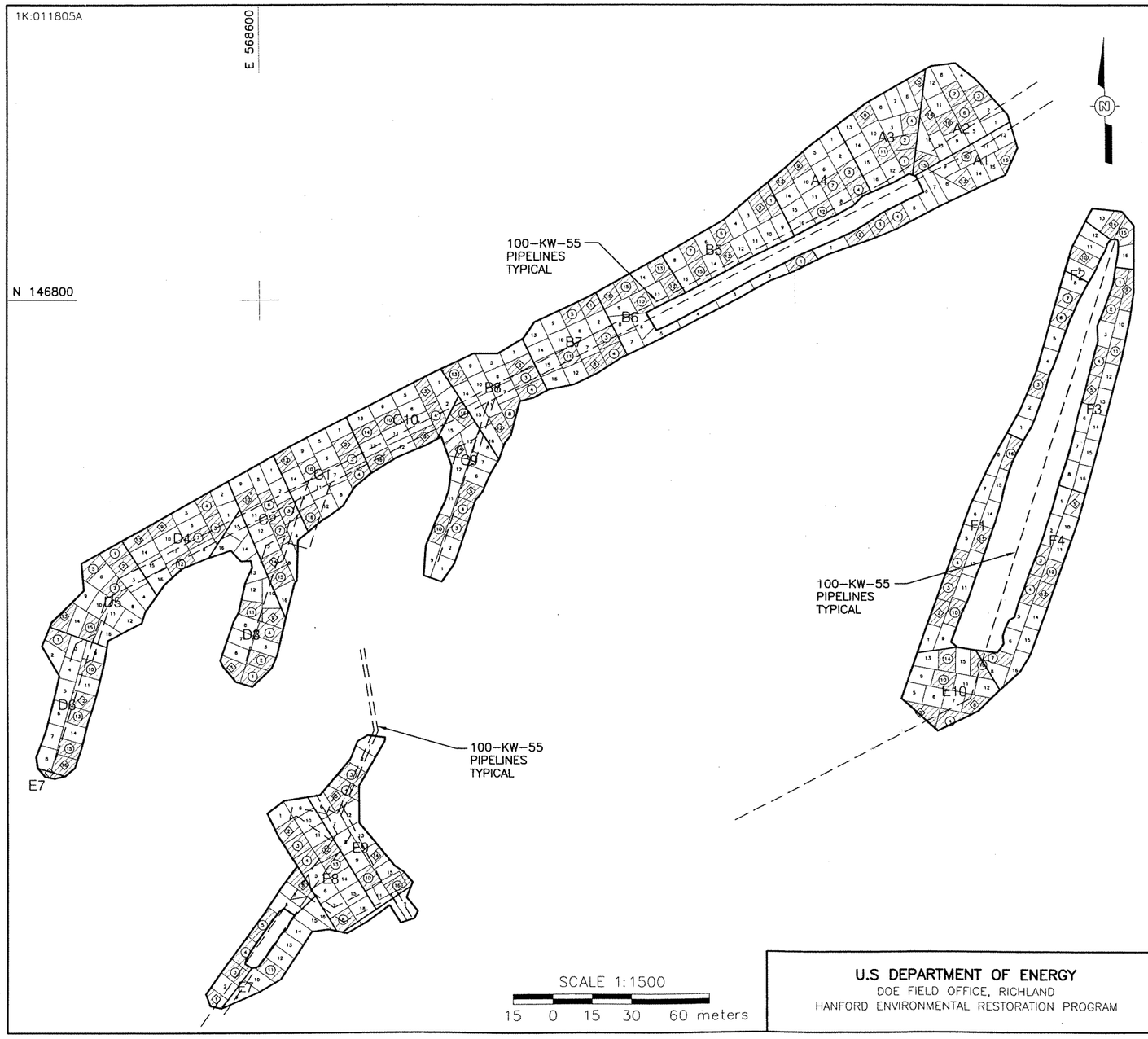
Subject 100-KW-55 Pipelines Shallow, Deep, and Overburden Zone Sampling Plan Sheet No. 1 of 1

ATTACHMENT 2

Number of Decision Subunits Based on Area.

Area of Primary Decision Unit (m2)	Number of Subunits
<1,394	1
>1,394 to <2,326	2
>2,326 to <3,256	3
>3,256 to <4,186	4
>4,186 to <9,303	2
>9,303 to <13,024	3
>13,024 to <16,745	4
>16,745 to <20,466	5
>20,466	ROUNDa (Area/3,720)

a ROUND is an integer rounding function.



NOTES

1. SHALLOW ZONE NODE AREAS ARE APPROXIMATELY 55.63 SQUARE METERS.
2. SAMPLES ARE TAKEN FROM THE APPROXIMATE CENTER OF EACH NODE.
3. THE SHALLOW ZONE CONSISTS OF SAMPLING AREAS A1, A2, A3 AND A4 WITHIN DECISION SUBUNIT 1. AREAS B5, B6, B7, AND B8 WITHIN DECISION SUBUNIT 2. AREAS C9, C10, C1, AND C2 WITHIN DECISION SUBUNIT 3. AREAS D3, D4, D5, AND D6 WITHIN DECISION SUBUNIT 4. AREAS E7, E8, E9, AND E10 WITHIN DECISION SUBUNIT 5. AREAS F1, F2, F3, AND F4 WITHIN DECISION SUBUNIT 6.
4. SEE ATTACHMENT 3 SHEET 2 OF 6 FOR SAMPLE LOCATION TABLE.

LEGEND

(E) VARIANCE AND VERIFICATION SAMPLING NODE

(V) VERIFICATION SAMPLING NODE

Attachment 3 Sheet No. 1 of 6
Originator G. CRAIG Date 1/28/05
Checked By CABG Date 1/31/05
Calc. No. 0100K-CA-V0039 Rev. No. 10

ATTACHMENT 3

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

100 K AREA
100-KW-55 PIPELINES
SHALLOW ZONE SAMPLING PLAN

1K:011805B

SAMPLE LOCATION TABLE

DECISION SUBUNIT	SAMPLING AREA	SAMPLE NODE	NORTHING	EASTING
1	A1	S-A1-2	146824.69	568829.69
		S-A1-3	146828.60	568837.30
		S-A1-4	146831.64	568844.04
		S-A1-10	146854.43	568869.89
		S-A1-13	146845.00	568868.78
		S-A1-16	146853.08	568884.90
	A2	S-A2-3	146877.39	568874.62
		S-A2-6	146871.06	568869.28
		S-A2-7	146878.17	568865.61
		S-A2-10	146867.16	568863.12
		S-A2-14	146870.21	568856.38
		S-A2-15	146850.97	568853.86
	A3	S-A3-1	146852.53	568846.54
		S-A3-2	146860.49	568846.82
		S-A3-4	146867.90	568849.46
		S-A3-5	146882.54	568852.52
		S-A3-9	146869.98	568831.78
		S-A3-11	146856.16	568838.52
	A4	S-A4-3	146848.37	568825.60
		S-A4-4	146841.82	568829.11
		S-A4-7	146843.39	568819.30
		S-A4-9	146850.78	568806.09
		S-A4-12	146833.47	568815.31
		S-A4-13	146844.87	568799.01
2	B5	S-B5-1	146837.66	568795.32
		S-B5-2	146834.97	568791.39
		S-B5-5	146825.27	568776.52
		S-B5-7	146818.66	568764.62
		S-B5-13	146816.65	568778.99
		S-B5-15	146810.85	568768.24
	B6	S-B6-1	146814.59	568807.10
		S-B6-10	146799.35	568745.66
		S-B6-12	146805.19	568757.48
		S-B6-13	146811.98	568752.61
		S-B6-15	146804.98	568739.71
		S-B6-16	146801.40	568733.09
	B7	S-B7-1	146797.89	568726.24
		S-B7-3	146785.48	568732.15
		S-B7-4	146779.32	568735.09
		S-B7-5	146794.51	568719.02
		S-B7-8	146775.31	568727.70
		S-B7-11	146778.31	568717.59
	B8	S-B8-2	146775.00	568699.30
		S-B8-3	146770.13	568701.51
		S-B8-4	146765.63	568703.76
		S-B8-8	146756.28	568695.36
		S-B8-12	146750.80	568691.47
		S-B8-13	146771.41	568673.89
3	C9	S-C9-3	146712.15	568674.48
		S-C9-4	146719.56	568676.95
		S-C9-5	146726.54	568680.16
		S-C9-10	146711.75	568667.87
		S-C9-14	146742.63	568675.71
		S-C9-16	146756.48	568677.30
	C10	S-C10-3	146764.88	568662.91
		S-C10-4	146755.57	568666.77
		S-C10-8	146747.45	568662.65
		S-C10-10	146753.79	568649.16
		S-C10-14	146749.13	568640.70
		S-C10-16	146738.58	568645.47
	C1	S-C1-2	146744.44	568632.57
		S-C1-3	146738.83	568635.04
		S-C1-4	146732.94	568637.63
		S-C1-10	146734.97	568619.21
		S-C1-13	146738.47	568609.85
		S-C1-16	146716.40	568619.23
	C2	S-C2-3	146718.94	568610.98
		S-C2-6	146721.30	568603.42
		S-C2-7	146711.39	568607.56
		S-C2-10	146723.31	568595.16
		S-C2-14	146699.36	568605.20
		S-C2-15	146693.45	568607.67

DECISION SUBUNIT	SAMPLING AREA	SAMPLE NODE	NORTHING	EASTING
4	D3	S-D3-1	146655.36	568596.79
		S-D3-2	146661.62	568600.07
		S-D3-4	146672.06	568603.36
		S-D3-5	146658.80	568588.66
		S-D3-9	146677.85	568604.68
		S-D3-11	146679.98	568596.50
	D4	S-D4-3	146712.35	568582.75
		S-D4-4	146720.91	568579.41
		S-D4-7	146708.67	568576.03
		S-D4-9	146712.99	568562.10
		S-D4-12	146698.62	568569.27
		S-D4-13	146707.90	568553.17
	D5	S-D5-1	146702.72	568544.16
		S-D5-2	146697.84	568547.44
		S-D5-5	146696.78	568535.88
		S-D5-7	146689.35	568544.08
		S-D5-13	146678.53	568524.86
		S-D5-15	146674.25	568534.61
	D6	S-D6-1	146669.63	568522.28
		S-D6-10	146658.19	568534.95
		S-D6-12	146646.15	568531.67
		S-D6-13	146640.20	568529.83
		S-D6-15	146627.92	568526.46
		S-D6-16	146621.72	568524.60
5	E7	S-E7-1A	146618.79	568518.91
		S-E7-1B	146532.89	568582.06
		S-E7-3	146543.01	568589.42
		S-E7-4	146550.75	568593.47
		S-E7-5	146560.95	568600.06
		S-E7-8	146575.93	568615.42
		S-E7-11	146543.94	568602.98
	E8	S-E8-2	146596.44	568610.13
		S-E8-3	146590.90	568613.43
		S-E8-4	146585.26	568616.96
		S-E8-8	146562.90	568630.54
		S-E8-12	146589.35	568624.40
		S-E8-13	146583.81	568627.77
	E9	S-E9-3	146617.78	568634.01
		S-E9-4	146611.88	568632.00
		S-E9-5	146609.67	568628.21
		S-E9-10	146578.67	568640.10
		S-E9-14	146587.11	568643.08
		S-E9-16	146575.75	568651.23
	E10	S-E10-3	146641.13	568851.49
		S-E10-4	146637.91	568862.63
		S-E10-8	146644.17	568871.77
		S-E10-10	146653.75	568860.29
		S-E10-14	146661.83	568861.96
		S-E10-16	146659.50	568874.78
6	F1	S-F1-2	146679.47	568858.81
		S-F1-3	146689.16	568862.30
		S-F1-4	146698.78	568865.77
		S-F1-10	146679.63	568864.70
		S-F1-13	146707.98	568874.91
		S-F1-16	146740.94	568886.40
	F2	S-F2-3	146767.60	568896.79
		S-F2-6	146793.31	568905.70
		S-F2-7	146800.76	568908.09
		S-F2-10	146816.30	568914.44
		S-F2-14	146828.95	568925.87
		S-F2-15	146825.71	568929.71
	F3	S-F3-1	146806.88	568928.14
		S-F3-2	146796.56	568924.72
		S-F3-4	146776.63	568920.03
		S-F3-5	146765.64	568917.05
		S-F3-9	146804.09	568930.78
		S-F3-11	146780.45	568926.33
	F4	S-F4-3	146699.81	568897.23
		S-F4-4	146688.55	568893.19
		S-F4-7	146662.15	568878.88
		S-F4-9	146721.78	568910.30
		S-F4-12	146695.39	568901.36
		S-F4-13	146686.71	568898.32

NOTES

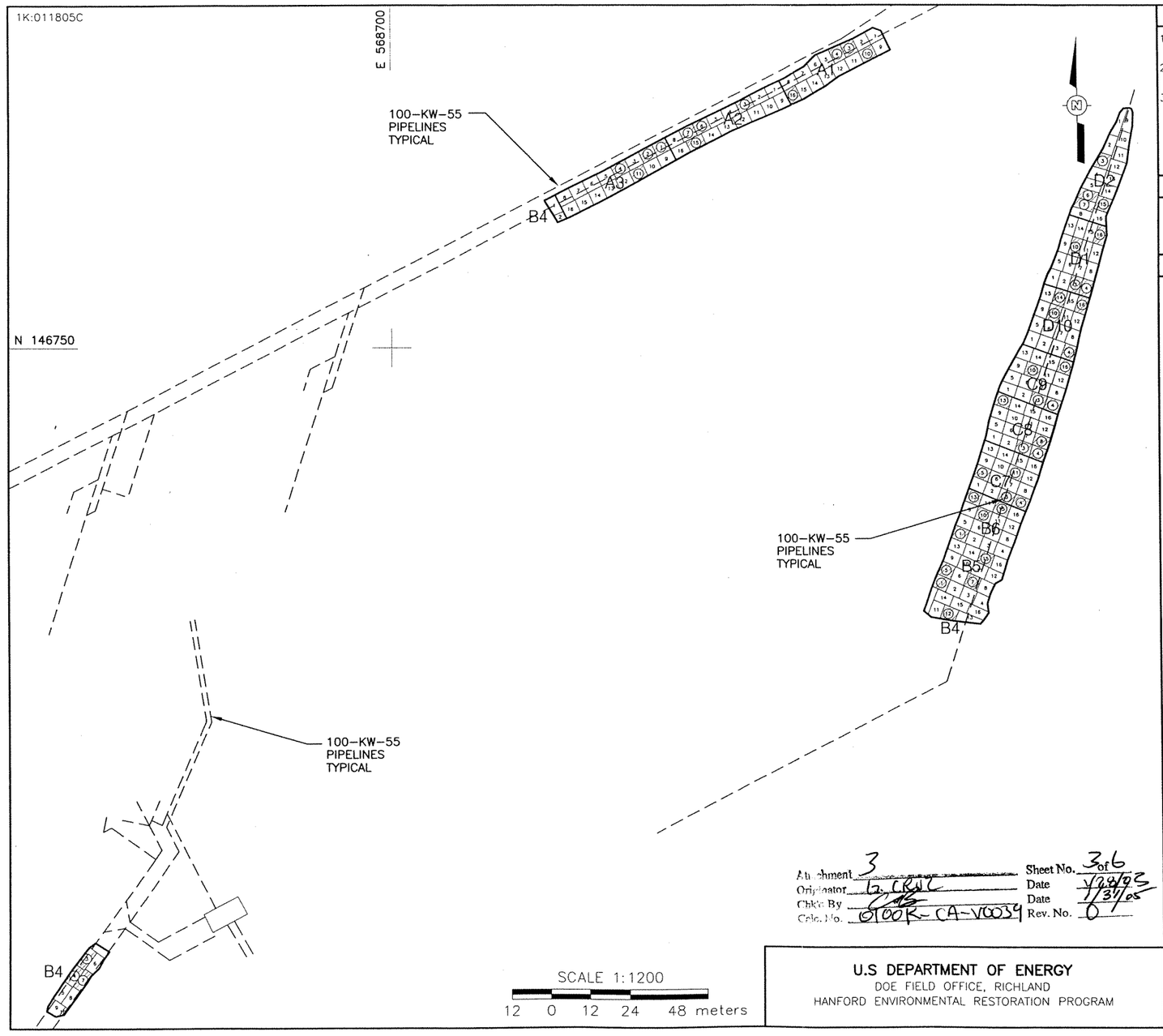
1. SEE ATTACHMENT 3 SHEET 1 OF 6 FOR SAMPLING PLAN.

Attachment 3 Sheet No. 2 of 6
Originator G. CRUZ Date 1/28/05
Chk'd By [illegible] Date 1/31/05
Calc. No. 0100K-CA-V0039 Rev. No. 0

ATTACHMENT 3

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

100 K AREA
100-KW-55 PIPELINES
SHALLOW ZONE SAMPLE LOCATION TABLE



NOTES

1. DEEP ZONE NODE AREAS ARE APPROXIMATELY 18.84 SQUARE METERS.
2. SAMPLES ARE TAKEN FROM THE APPROXIMATE CENTER OF EACH NODE.
3. THE DEEP ZONE CONSISTS OF SAMPLING AREAS A1, A2, AND A3 WITHIN DECISION SUBUNIT 1. AREAS B4, B5, AND B6 WITHIN DECISION SUBUNIT 2. AREAS C7, C8, AND C9 WITHIN DECISION SUBUNIT 3. AREAS D10, D1, AND D2 WITHIN DECISION SUBUNIT 4.

LEGEND

(8) VERIFICATION SAMPLING NODE

SAMPLE LOCATION TABLE

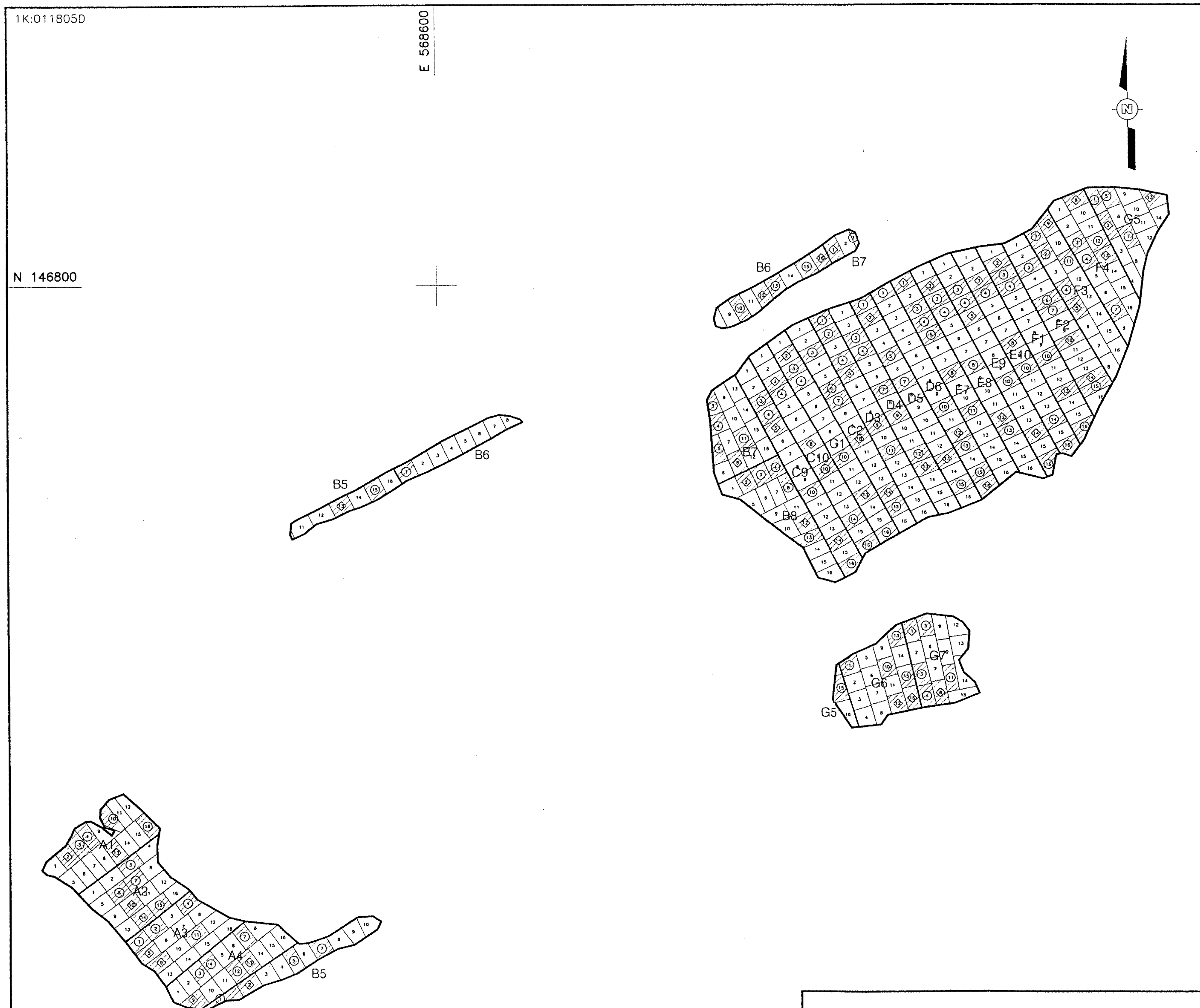
DECISION SUBUNIT	SAMPLING AREA	SAMPLE NODE	NORTHING	EASTING
1	A1	D-A1-3	146841.47	568841.04
		D-A1-4	146839.69	568837.39
		D-A1-10	146839.75	568846.72
		D-A1-16	146827.11	568823.77
	A2	D-A2-3	146824.34	568808.86
		D-A2-6	146817.73	568795.64
		D-A2-7	146815.64	568791.40
		D-A2-15	146812.65	568793.83
	A3	D-A3-1	146811.28	568783.04
		D-A3-2	146809.12	568778.85
		D-A3-4	146804.66	568770.37
		D-A3-11	146803.11	568775.93
2	B4	D-B4-3	146562.50	568605.50
		D-B4-4	146557.27	568601.75
		D-B4-7	146555.88	568604.38
		D-B4-12	146667.39	568870.73
	B5	D-B5-1	146676.92	568868.69
		D-B5-5	146680.88	568870.24
		D-B5-7	146677.21	568878.20
		D-B5-15	146684.45	568882.31
	B6	D-B6-1	146692.13	568874.57
		D-B6-10	146697.89	568881.72
		D-B6-13	146703.53	568878.76
		D-B6-15	146699.91	568887.38
3	C7	D-C7-3	146703.67	568888.78
		D-C7-4	146701.83	568893.14
		D-C7-5	146711.08	568881.47
		D-C7-11	146711.16	568891.51
	C8	D-C8-3	146718.76	568894.03
		D-C8-4	146717.13	568898.42
		D-C8-8	146720.90	568899.55
		D-C8-13	146733.56	568887.94
	C9	D-C9-3	146733.66	568898.58
		D-C9-4	146732.08	568902.90
		D-C9-10	146742.89	568896.97
		D-C9-16	146743.97	568906.72
4	D10	D-D10-4	146748.47	568907.93
		D-D10-10	146760.53	568903.50
		D-D10-14	146765.37	568905.23
		D-D10-16	146763.07	568912.03
	D1	D-D1-3	146769.28	568910.00
		D-D1-4	146768.19	568913.40
		D-D1-10	146780.83	568910.05
		D-D1-16	146784.56	568917.50
	D2	D-D2-3	146807.04	568918.38
		D-D2-6	146796.64	568913.94
		D-D2-7	146793.75	568912.79
		D-D2-15	146793.88	568918.57

Attachment 3 Sheet No. 3 of 6
Originator [illegible] Date 1/28/05
Chkr. By [illegible] Date 1/31/05
Calc. No. 0100K-CA-V00059 Rev. No. 0

ATTACHMENT 3

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

100 K AREA
100-KW-55 PIPELINES
DEEP ZONE SAMPLING PLAN



SCALE 1:1750

17.5 0 17.5 35 70 meters

NOTES

1. OVERBURDEN NODE AREAS ARE APPROXIMATELY 60.41 SQUARE METERS.
2. SAMPLES ARE TAKEN FROM THE APPROXIMATE CENTER OF EACH NODE.
3. THE OVERBURDEN CONSISTS OF SAMPLING AREAS A1, A2, A3 AND A4 WITHIN DECISION SUBUNIT 1. AREAS B5, B6, B7, AND B8 WITHIN DECISION SUBUNIT 2. AREAS C9, C10, C1, AND C2 WITHIN DECISION SUBUNIT 3. AREAS D3, D4, D5, AND D6 WITHIN DECISION SUBUNIT 4. AREAS E7, E8, E9, AND E10 WITHIN DECISION SUBUNIT 5. AREAS F1, F2, F3, AND F4 WITHIN DECISION SUBUNIT 6. AREAS G5, G6, G7, AND G8 WITHIN DECISION SUBUNIT 7. AREAS H9, H10, H1, AND H2 WITHIN DECISION SUBUNIT 8. AREAS I3, I4, I5, AND I6 WITHIN DECISION SUBUNIT 9. AREAS J7, J8, J9, AND J10 WITHIN DECISION SUBUNIT 10. AREAS K1, K2, K3, AND K4 WITHIN DECISION SUBUNIT 11. AREAS L5, L6, L7, AND L8 WITHIN DECISION SUBUNIT 12.
4. SEE ATTACHMENT 3 SHEET 6 OF 6 FOR SAMPLE LOCATION TABLE.

LEGEND

VARIANCE AND VERIFICATION SAMPLING NODE

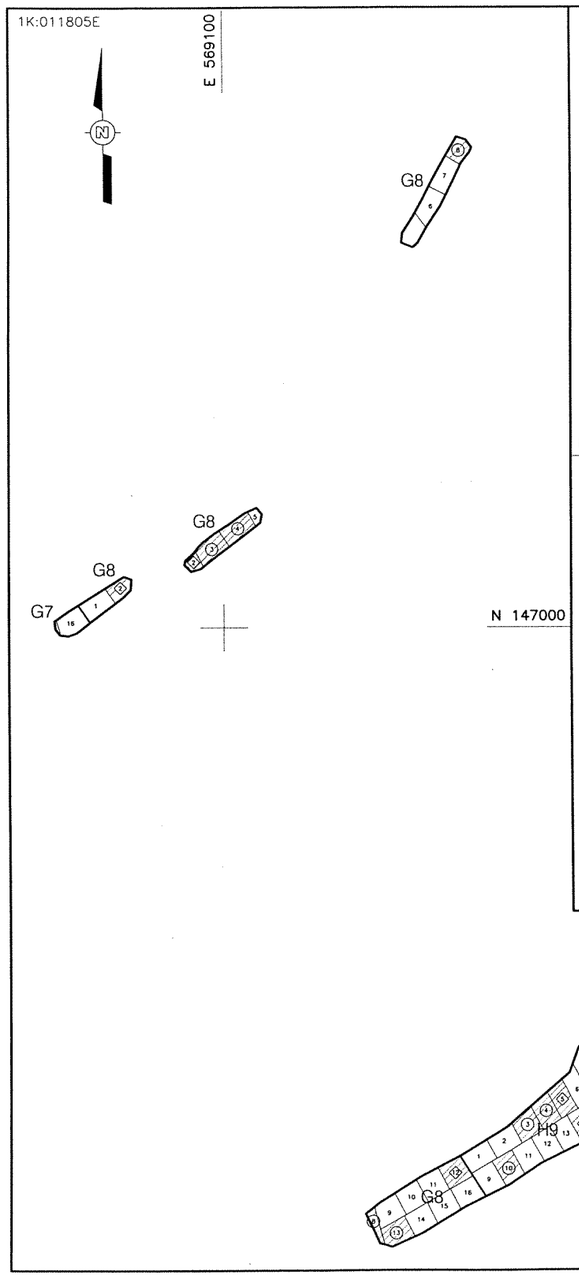
VERIFICATION SAMPLING NODE

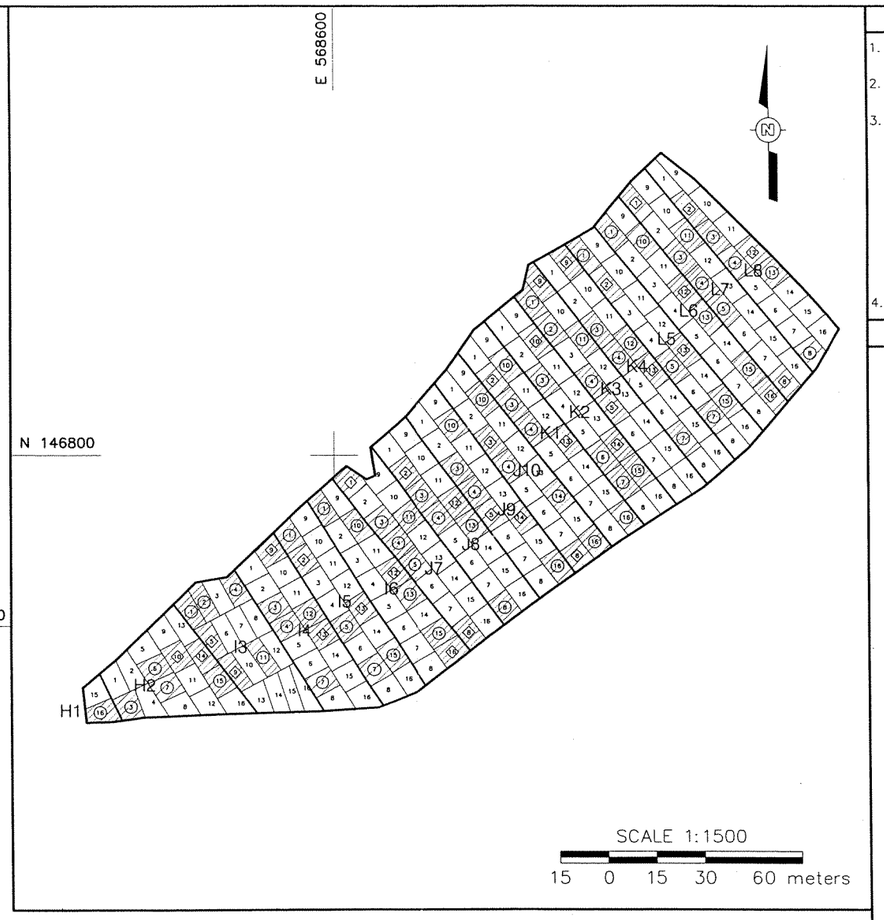
Attachment 3 Sheet No. 4 of 6
Originator G. Kutz Date 1/28/05
Chk'd By Date 1/31/05
Calc. No. 0100K-CA-V0039 Rev. No. 0

ATTACHMENT 3

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

100 K AREA
100-KW-55 PIPELINES
OVERBURDEN (WEST) SAMPLING PLAN





NOTES

1. OVERBURDEN NODE AREAS ARE APPROXIMATELY 60.41 SQUARE METERS.
2. SAMPLES ARE TAKEN FROM THE APPROXIMATE CENTER OF EACH NODE.
3. THE OVERBURDEN CONSISTS OF SAMPLING AREAS A1, A2, A3 AND A4 WITHIN DECISION SUBUNIT 1. AREAS B5, B6, B7, AND B8 WITHIN DECISION SUBUNIT 2. AREAS C9, C10, C1, AND C2 WITHIN DECISION SUBUNIT 3. AREAS D3, D4, D5, AND D6 WITHIN DECISION SUBUNIT 4. AREAS E7, E8, E9, AND E10 WITHIN DECISION SUBUNIT 5. AREAS F1, F2, F3, AND F4 WITHIN DECISION SUBUNIT 6. AREAS G5, G6, G7, AND G8 WITHIN DECISION SUBUNIT 7. AREAS H9, H10, H1, AND H2 WITHIN DECISION SUBUNIT 8. AREAS I3, I4, I5, AND I6 WITHIN DECISION SUBUNIT 9. AREAS J7, J8, J9, AND J10 WITHIN DECISION SUBUNIT 10. AREAS K1, K2, K3, AND K4 WITHIN DECISION SUBUNIT 11. AREAS L5, L6, L7, AND L8 WITHIN DECISION SUBUNIT 12.
4. SEE ATTACHMENT 3 SHEET 6 OF 6 FOR SAMPLE LOCATION TABLE.

VARIANCE AND VERIFICATION SAMPLING NODE

VERIFICATION SAMPLING NODE

Attachment 3 Sheet No. 5 of 6
Originator G. CRUZ Date 1/26/05
Chk'd By C.A. Bath Date 1/31/05
Calc. No. 0100K-CA-V0039 Rev. No. 0

ATTACHMENT 3

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

100 K AREA
100-KW-55 PIPELINES
OVERBURDEN (EAST) SAMPLING PLAN

1K:011805F

SAMPLE LOCATION TABLE

DECISION SUBUNIT	SAMPLING AREA	SAMPLE NODE	NORTHING	EASTING
1	A1	O-A1-2	146555.61	568440.64
		O-A1-3	146560.78	568445.60
		O-A1-4	146564.27	568448.99
		O-A1-10	146571.81	568459.82
		O-A1-13	146557.30	568461.05
		O-A1-16	146568.42	568474.34
	A2	O-A2-3	146552.18	568466.93
		O-A2-6	146540.39	568462.10
		O-A2-7	146545.47	568468.98
		O-A2-10	146535.24	568467.31
		O-A2-14	146529.86	568472.28
		O-A2-15	146535.03	568479.15
	A3	O-A3-1	146519.64	568470.23
		O-A3-2	146525.07	568477.31
		O-A3-4	146535.62	568491.53
		O-A3-5	146514.73	568474.53
		O-A3-9	146510.72	568479.67
		O-A3-11	146522.28	568495.04
	A4	O-A4-3	146506.03	568496.41
		O-A4-4	146509.92	568501.32
		O-A4-7	146521.48	568515.93
		O-A4-9	146494.75	568493.47
		O-A4-12	146506.82	568512.64
		O-A4-13	146510.50	568517.84
2	B5	O-B5-1	146495.14	568505.11
		O-B5-2	146501.08	568517.70
		O-B5-5	146511.11	568536.82
		O-B5-7	146516.18	568548.86
		O-B5-13	146705.37	568558.87
		O-B5-15	146712.26	568573.24
	B6	O-B6-1	146719.95	568586.51
		O-B6-10	146789.99	568729.83
		O-B6-12	146795.59	568739.44
		O-B6-13	146799.42	568745.15
		O-B6-15	146807.64	568758.37
		O-B6-16	146811.22	568764.37
	B7	O-B7-1	146814.77	568769.91
		O-B7-3A	146819.81	568778.41
		O-B7-3B	146748.08	568718.04
		O-B7-4	146739.39	568720.35
		O-B7-5	146729.74	568720.65
		O-B7-8	146723.60	568728.52
		O-B7-11	146734.01	568731.19
	B8	O-B8-2	146715.27	568732.14
		O-B8-3	146718.37	568738.39
		O-B8-4	146721.54	568744.76
		O-B8-8	146712.77	568750.29
		O-B8-12	146697.50	568757.04
		O-B8-13	146691.09	568758.55
3	C9	O-C9-3	146750.07	568738.70
		O-C9-4	146744.24	568741.87
		O-C9-5	146738.48	568744.99
		O-C9-10	146710.80	568760.02
		O-C9-14	146689.83	568771.36
		O-C9-16	146679.88	568776.75
	C10	O-C10-3	146758.52	568744.74
		O-C10-4	146753.12	568747.74
		O-C10-8	146731.52	568759.74
		O-C10-10	146720.71	568765.74
		O-C10-14	146699.10	568777.74
		O-C10-16	146687.79	568783.62
	C1	O-C1-2	146769.52	568749.78
		O-C1-3	146764.08	568752.80
		O-C1-4	146758.63	568755.83
		O-C1-10	146725.93	568773.99
		O-C1-13	146709.59	568783.06
		O-C1-16	146693.31	568792.10
	C2	O-C2-3	146770.91	568760.55
		O-C2-6	146755.45	568768.88
		O-C2-7	146750.15	568771.74
		O-C2-10	146733.73	568780.59
		O-C2-14	146710.48	568793.13
		O-C2-15	146704.39	568796.41

DECISION SUBUNIT	SAMPLING AREA	SAMPLE NODE	NORTHING	EASTING
4	D3	O-D3-1	146784.60	568764.64
		O-D3-2	146778.94	568767.63
		O-D3-4	146767.55	568773.65
		O-D3-5	146761.91	568776.63
		O-D3-9	146739.66	568788.39
		O-D3-11	146728.72	568794.17
	D4	O-D4-3	146777.03	568779.38
		O-D4-4	146771.48	568782.35
		O-D4-7	146754.83	568791.24
		O-D4-9	146743.73	568797.16
		O-D4-12	146727.08	568806.06
		O-D4-13	146721.52	568809.03
	D5	O-D5-1	146791.37	568782.63
		O-D5-2	146785.83	568785.59
		O-D5-5	146769.23	568794.46
		O-D5-7	146758.17	568800.37
		O-D5-13	146724.96	568818.10
		O-D5-15	146713.89	568824.02
	D6	O-D6-1	146796.24	568791.21
		O-D6-10	146747.35	568817.05
		O-D6-12	146736.17	568822.96
		O-D6-13	146730.53	568825.94
		O-D6-15	146719.14	568831.95
		O-D6-16	146713.26	568835.08
5	E7	O-E7-1	146800.59	568800.02
		O-E7-3	146789.36	568805.95
		O-E7-4	146783.80	568808.89
		O-E7-5	146778.27	568811.81
		O-E7-8	146761.87	568820.47
		O-E7-11	146745.73	568828.99
	E8	O-E8-2	146799.19	568811.50
		O-E8-3	146793.56	568814.50
		O-E8-4	146787.93	568817.51
		O-E8-8	146765.40	568829.53
		O-E8-12	146742.88	568841.54
		O-E8-13	146737.25	568844.55
	E9	O-E9-3	146797.51	568823.15
		O-E9-4	146791.91	568826.13
		O-E9-5	146786.32	568829.12
		O-E9-10	146758.33	568844.05
		O-E9-14	146735.93	568856.00
		O-E9-16	146722.62	568861.14
	E10	O-E10-3	146801.37	568832.23
		O-E10-4	146796.11	568835.01
		O-E10-8	146774.79	568846.27
		O-E10-10	146763.95	568851.99
		O-E10-14	146741.93	568863.62
		O-E10-16	146730.90	568869.32
6	F1	O-F1-2	146808.96	568840.08
		O-F1-3	146803.97	568842.68
		O-F1-4	146798.99	568845.29
		O-F1-10	146769.06	568860.93
		O-F1-13	146754.11	568868.75
		O-F1-16	146738.92	568876.69
	F2	O-F2-3	146806.93	568853.39
		O-F2-6	146793.07	568861.12
		O-F2-7	146788.66	568863.56
		O-F2-10	146775.92	568870.62
		O-F2-14	146759.94	568879.46
		O-F2-15	146756.16	568881.56
	F3	O-F3-1	146820.31	568856.48
		O-F3-2	146812.59	568860.64
		O-F3-4	146797.50	568869.31
		O-F3-5	146789.71	568873.79
		O-F3-9	146825.68	568861.87
		O-F3-11	146809.68	568870.35
	F4	O-F4-3	146817.57	568874.07
		O-F4-4	146810.57	568878.06
		O-F4-7	146789.10	568890.31
		O-F4-9	146835.64	568873.67
		O-F4-12	146818.30	568882.90
		O-F4-13	146812.02	568886.25

DECISION SUBUNIT	SAMPLING AREA	SAMPLE NODE	NORTHING	EASTING
7	G5	O-G5-1	146835.67	568881.39
		O-G5-2	146824.92	568887.27
		O-G5-5	146837.32	568886.60
		O-G5-7	146820.25	568895.73
		O-G5-13	146836.84	568904.82
		O-G5-15	146626.38	568771.82
	G6	O-G6-1	146636.06	568775.42
		O-G6-10	146635.19	568791.75
		O-G6-12	146619.60	568796.28
		O-G6-13	146648.69	568795.97
		O-G6-15	146631.27	568800.01
		O-G6-16	146621.86	568802.47
	G7	O-G7-1	146650.59	568802.54
		O-G7-3	146632.09	568806.49
		O-G7-4	146622.77	568808.72
		O-G7-5	146652.90	568808.50
		O-G7-8	146624.18	568814.49
		O-G7-11	146630.60	568818.73
	G8	O-G8-2A	147012.54	569067.54
		O-G8-2B	147020.55	569090.46
		O-G8-3	147024.62	569096.20
		O-G8-4	147031.08	569104.42
		O-G8-8A	147148.24	569173.43
		O-G8-8B	146815.49	569145.46
		O-G8-12	146830.52	569170.84
		O-G8-13	146811.87	569152.41
8	H9	O-H9-3	146845.27	569192.99
		O-H9-4	146849.56	569198.91
		O-H9-5	146853.02	569204.11
		O-H9-10	146831.82	569187.03
		O-H9-14	146845.37	569210.71
		O-H9-16	146850.33	569220.70
	H10	O-H10-3	146858.15	569223.97
		O-H10-4	146851.61	569227.46
		O-H10-8	146855.09	569234.14
		O-H10-10	146872.79	569233.17
		O-H10-14	146877.15	569240.05
		O-H10-16	146863.39	569246.56
	H1	O-H1-2	146880.25	569248.09
		O-H1-3	146873.69	569250.96
		O-H1-4	146866.97	569253.89
		O-H1-10	146885.82	569264.93
		O-H1-13	146887.61	569272.58
		O-H1-16	147119.31	569426.64
	H2	O-H2-3	147121.04	569436.09
		O-H2-6	147133.15	569443.54
		O-H2-7	147127.19	569447.22
		O-H2-10	147136.83	569450.48
		O-H2-14	147137.06	569458.02
		O-H2-15	147129.21	569463.59
9	I3	O-I3-1	147151.00	569454.81
		O-I3-2	147153.98	569458.82
		O-I3-4	147157.84	569468.76
		O-I3-5	147141.60	569461.12
		O-I3-9	147131.90	569468.48
		O-I3-11	147136.49	569477.16
	I4	O-I4-3	147152.16	569481.00
		O-I4-4	147146.26	569484.75
		O-I4-7	147128.70	569495.93
		O-I4-9	147170.25	569479.94
		O-I4-12	147150.27	569491.97
		O-I4-13	147143.74	569496.12
	I5	O-I5-1	147174.88	569485.70
		O-I5-2	147167.13	569490.18
		O-I5-5	147146.09	569503.71
		O-I5-7	147132.65	569512.35
		O-I5-13	147151.83	569508.53
		O-I5-15	147137.12	569517.99
	I6	O-I6-1	147183.29	569496.63
		O-I6-10	147177.86	569507.21
		O-I6-12	147162.94	569518.35
		O-I6-13	147156.26	569523.28
		O-I6-15	147143.94	569532.34
		O-I6-16	147138.11	569536.36

DECISION SUBUNIT	SAMPLING AREA	SAMPLE NODE	NORTHING	EASTING
10	J7	O-J7-1	147191.40	569505.19
		O-J7-3	147178.95	569514.72
		O-J7-4	147172.37	569519.77
		O-J7-5	147165.60	569524.96
		O-J7-8	147144.22	569541.47
		O-J7-11	147180.49	569523.03
	J8	O-J8-2	147194.29	569522.09
		O-J8-3	147187.22	569527.24
		O-J8-4	147180.17	569532.37
		O-J8-8	147152.11	569552.72
		O-J8-12	147184.92	569537.46
		O-J8-13	147177.84	569542.61
	J9	O-J9-3	147195.60	569538.12
		O-J9-4	147188.34	569543.46
		O-J9-5	147181.21	569548.70
		O-J9-10	147209.13	569536.44
		O-J9-14	147180.33	569557.71
		O-J9-16	147165.13	569568.90
	J10	O-J10-3	147203.82	569548.44
		O-J10-4	147196.19	569554.12
		O-J10-8	147168.38	569574.97
		O-J10-10	147217.20	569545.99
		O-J10-14	147187.03	569569.39
		O-J10-16	147172.76	569580.55
11	K1	O-K1-2	147223.15	569549.22
		O-K1-3	147215.54	569555.18
		O-K1-4	147207.90	569561.16
		O-K1-10	147227.80	569553.42
		O-K1-13	147204.18	569571.81
		O-K1-16	147180.35	569590.43
	K2	O-K2-3	147223.16	569564.64
		O-K2-6	147199.26	569583.27
		O-K2-7	147191.37	569589.42
		O-K2-10	147235.28	569562.73
		O-K2-14	147203.21	569587.73
		O-K2-15	147195.08	569594.06
	K3	O-K3-1	147247.41	569561.65
		O-K3-2	147239.12	569567.29
		O-K3-4	147222.88	569579.88
		O-K3-5	147214.73	569586.20
		O-K3-9	147253.90	569563.96
		O-K3-11	147235.94	569577.00
	K4	O-K4-3	147238.94	569581.65
		O-K4-4	147230.28	569588.42
		O-K4-7	147205.04	569608.18
		O-K4-9	147259.67	569572.15
		O-K4-12	147234.72	569592.04
		O-K4-13	147226.31	569598.66
12	L5	O-L5-1	147261.93	569577.38
		O-L5-2	147252.91	569584.74
		O-L5-5	147227.52	569605.02
		O-L5-7	147211.81	569617.56
		O-L5-13	147232.57	569608.45
		O-L5-15	147216.76	569621.36
	L6	O-L6-1	147269.12	569586.21
		O-L6-10	147266.19	569595.95
		O-L6-12	147250.62	569608.80
		O-L6-13	147242.72	569615.33
		O-L6-15	147226.66	569628.59
		O-L6-16	147218.36	569635.18
	L7	O-L7-1	147278.07	569593.87
		O-L7-3	147261.31	569607.56
		O-L7-4	147253.27	569614.25
		O-L7-5	147245.40	569620.79
		O-L7-8	147222.84	569639.51
		O-L7-11	147267.99	569609.66
	L8	O-L8-2	147276.12	569610.33
		O-L8-3	147267.58	569617.61
		O-L8-4	147259.65	569624.38
		O-L8-8	147231.79	569647.39
		O-L8-12	147262.90	569629.78
		O-L8-13	147256.59	569635.74

NOTES

1. SEE ATTACHMENT 3 SHEETS 4 AND 5 OF 6 FOR SAMPLING PLANS.

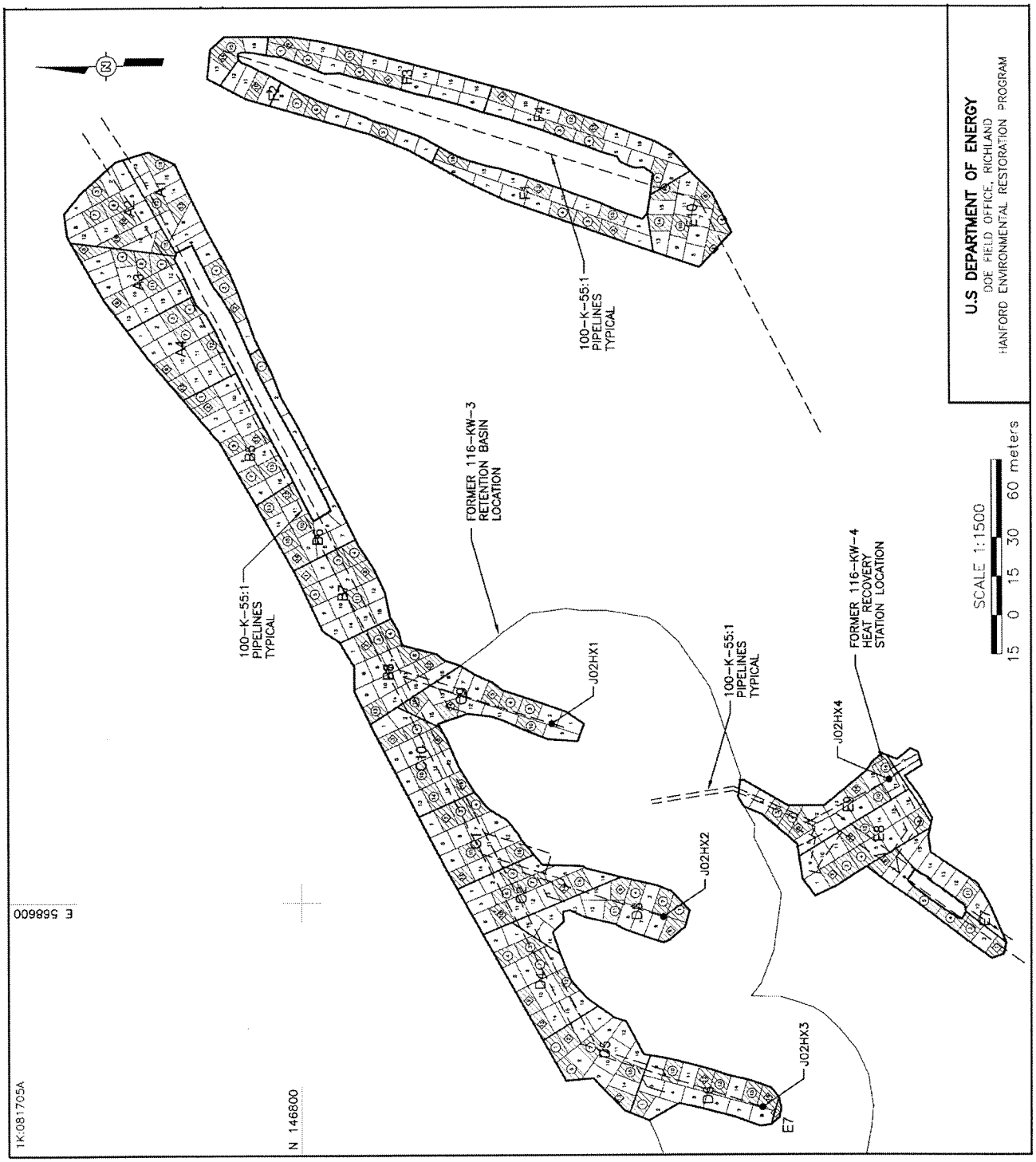
ATTACHMENT 3

Attachment 3 Sheet No. 6 of 6
Originator G. CRUZ Date 1/28/05
Chk'd By [illegible] Date 1/31/05
Calc. No. 01DOR-CA-V0039 Rev. No. 0

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

100 K AREA
100-KW-55 PIPELINES
OVERBURDEN SAMPLE LOCATION TABLE

116-KW-3 and 116-KW-4 Discrete Sample Location Map



CALCULATION COVER SHEET

Project Title:	100-K Remedial Action	**Job No.**	22192
Area	100-K		
Discipline	Environmental	***Calc. No.**	0100K-CA-V0045
Subject	100-K-55:1 Pipeline Cleanup Verification 95% UCL Calculation		
Computer Program	Excel	**Program No.**	Excel 2003

The attached calculations have been generated to document compliance with established clean-up 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 Sheets = 8 Total = 9	B Hudson 4/12/05 W. K. Hudson	J B Miley 4-13-05 T. B. Miley K A Anselm 4-12-05 K. A. Anselm	SW Callison 4-14-05 S. W. Callison	4/14/05 M. A. Buckmaster	4/15/05

SUMMARY OF REVISIONS

* Obtain calc no. from DIS

DE01437.03 (12/09/2004)

Bechtel Hanford, Inc.

CALCULATION SHEET

Originator	W. K. Hudson BH	**Date**	04/12/05	**Calc. No.**	0100K-CA-V0045
Project	100-K Remedial Action	**Job No.**	22192	**Checked**	T. B. Miley TBM
Subject	100-K-55:1 Pipeline Cleanup Verification 95% UCL Calculation			**Checked**	K. A. Anselm KAA

Rev. No. 0
Date 4-13-05
Date 4-12-05
Sheet No. 1 of 8

Summary

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

Table of Contents:

Given/References:

1) Sample Results
2) All lookup values, background values, and remedial action goals (RAGs) are taken from the Remedial Design Report/Remedial Action Work Plan (RDR/RAWP) (DOE-RL 2002) and Ecology (1996) unless otherwise specified.
3) DOE-RL, 2001, *100 Area Remedial Action Sampling and Analysis Plan* (SAP), DOE/RL-96-22, Rev. 3, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
4) DOE-RL, 2002, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, DOE/RL-96-17, Rev. 4, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
5) Ecology, 1992, *Statistical Guidance for Ecology Site Managers*, Publication #92-54, Washington Department of Ecology, Olympia, Washington.
6) Ecology, 1993, *Statistical Guidance for Ecology Site Managers, Supplement S-6, Analyzing Site or Background Data with Below-Detection Limit or Below-PQL Values (Censored Data Sets)*, Publication #92-54, Washington Department of Ecology, Olympia, Washington.
7) Ecology, 1996, *Model Toxics Control Act Cleanup Levels and Risk Calculations (CLARC II)*, Publication #94-145, Washington State Department of Ecology, Olympia, Washington.
8) EPA, 1994, *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*, EPA 540/R-94/013, U.S. Environmental Protection Agency, Washington, D.C.
9) WAC 173-340, 1996, "Model Toxics Control Act--Cleanup," *Washington Administrative Code*.

Solution:
Calculation methodology is described in Ecology (1992, 1993) and below. Use data from attached worksheets to calculate the 95% UCL for each analyte, the carcinogenic risk, perform the WAC 173-340 3-part test for nonradionuclides, and the RPD for each COC. There are no nonradiunuclide COCs for this site; therefore, the WAC 173-340 3-part test and carcinogenic risk calculations are not required.

Calculation Description:
The subject calculations were performed on data from soil verification samples from the subject waste site. The data were entered into an EXCEL 2003 spreadsheet and calculations performed by utilizing the built-in spreadsheet functions and/or creating formulae within the cells. The statistical evaluation of data for use in accordance with the RDR/RAWP is documented by this calculation. Split and duplicate RPD results are used in evaluation of data quality and are presented in the Cleanup Verfication Package (CVP) for this site.

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

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

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

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

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

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

Bechtel Hanford, Inc. CALCULATION SHEET

Originator W. K. Hudson Date 04/12/05 Calc. No. 0100K-CA-V0045 Rev. No. 0
Project 100-K Remedial Action Job No. 22192 Checked T. B. Miley TBM Date 4-13-05
Subject 100-K-55:1 Pipeline Cleanup Verification 95% UCL Calculation Checked K. A. Anselm KAA Date 4-12-05
Sheet No. 2 of 8

Summary (continued)

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

Result Summary - Shallow Zone			
Analyte	**Result**	**Qualifier**	**Units**
Cs-137	2.7E-01		pCi/g
Eu-152	7.3E-01		pCi/g
Eu-154	1.2E-01		pCi/g

Relative Percent Difference (RPD) Results - QA/QC Analysis Shallow Zone*				
Analyte	**A4 Duplicate Analysis****	**A4 Split Analysis****	**F4 Duplicate Analysis****	**F4 Split Analysis****
Cs-137				
Eu-152	47%	63%		
Eu-154				

* A blank box indicates the RPD did not need to be calculated.
** Addition discussion on RPDs >30% is provided in the data quality assessment section of the CVP.

Result Summary - Deep Zone			
Analyte	**Result**	**Qualifier**	**Units**
Cs-137	8.2E-01		pCi/g
Eu-152	7.4E-01		pCi/g
Eu-154	1.2E-01		pCi/g

RPD Results - QA/QC Analysis Deep Zone*				
Analyte	**D2 Duplicate Analysis**	**D2 Split Analysis**	**A1 Duplicate Analysis**	**A1 Split Analysis**
Cs-137			29%	29%
Eu-152				
Eu-154				

* A blank box indicates the RPD did not need to be calculated.

Result Summary - Overburden			
Analyte	**Result**	**Qualifier**	**Units**
Cs-137	0 (< BG)		pCi/g
Eu-152	3.0E-01		pCi/g
Eu-154	5.3E-02		pCi/g

RPD Results - QA/QC Analysis Overburden*						
Analyte	**A4 Duplicate Analysis**	**A4 Split Analysis**	**F4 Duplicate Analysis**	**F4 Split Analysis**	**K4 Duplicate Analysis**	**K4 Split Analysis**
Cs-137	11%	29%				
Eu-152						
Eu-154						

* A blank box indicates the RPD did not need to be calculated.

Acronyms/abbreviations used on the following pages are listed below.

CVP = cleanup verification package
HEIS = Hanford Environmental Information System
J = estimate
MDA = minimal detectable activity
MTCA = *Model Toxics Control Act*
NA = not applicable
PQL = practical quantitation limit
Q = qualifier
QA/QC = quality assurance/quality control
RESRAD = RESidual RADioactivity (dose model)
RPD = relative percent difference
TDL = target detection limit
U = undetected
WAC = *Washington Administrative Code*

CALCULATION SHEET

Bechtel Hanford, Inc.

Originator W. K. Hudson Date 04/12/05 Calc. No. 0100K-CA-V0045 Rev. No. 0
Project 100-K Remedial Action Job No. 22192 Checked T. B. Miley Date 4-13-05
Subject 100-K-55:1 Pipeline Cleanup Verification 95% UCL Calculation Checked K. A. Anselm Date 4-12-05
Sheet No. 3 of 8

Shallow Zone Sample Data

Sampling Area	HEIS Number	Sample Date	Cs-137			Eu-152			Eu-154		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
A4	J02HK9	02/23/05	3.51E-01		5.5E-02	1.26E+00		1.0E-01	2.48E-01		1.6E-01
Duplicate of J02HK9	J02HL0	02/23/05	5.39E-01		5.3E-02	2.04E+00		1.1E-01	1.7E-01	U	1.7E-01
F4	J02HN0	02/28/05	3.0E-02	U	3.0E-02	7.0E-02	U	7.0E-02	1.1E-01	U	1.1E-01
Duplicate of J02HN0	J02HN1	02/28/05	3.4E-02	U	3.4E-02	1.2E-01	U	1.2E-01	1.3E-01	U	1.3E-01
A1	J02HK6	02/23/05	2.9E-02	U	3.4E-02	8.1E-02		7.3E-02	9.5E-02	U	9.5E-02
A2	J02HK7	02/23/05	4.1E-02	U	4.1E-02	1.4E-01		1.4E-01	1.5E-01	U	1.5E-01
A3	J02HK8	02/23/05	1.42E-01		3.6E-02	4.62E-01		7.8E-02	1.1E-01	U	1.1E-01
B5	J02HL1	02/23/05	6.3E-02		3.6E-02	1.82E-01		7.4E-02	1.3E-01	U	1.3E-01
B6	J02HL2	02/23/05	3.2E-02	U	3.2E-02	1.16E-01		7.5E-02	1.0E-01	U	1.0E-01
B7	J02HL3	02/23/05	4.0E-02	U	4.0E-02	1.3E-01		1.3E-01	1.6E-01	U	1.6E-01
B8	J02HL4	02/23/05	2.26E-01		4.7E-02	6.4E-01		7.8E-02	1.3E-01	U	1.3E-01
C9	J02HL5	02/23/05	3.4E-02	U	3.4E-02	6.6E-02		7.5E-02	1.0E-01	U	1.0E-01
C10	J02HL6	02/23/05	2.90E-01		5.5E-02	3.09E-01		1.0E-01	1.6E-01	U	1.6E-01
C1	J02HL7	02/23/05	3.20E-01		4.3E-02	7.07E-01		8.5E-02	1.3E-01	U	1.3E-01
C2	J02HL8	02/23/05	2.34E-01		4.0E-02	2.79E-01		8.4E-02	1.1E-01	U	1.1E-01
D3	J02HL9	02/24/05	4.4E-02		3.5E-02	1.4E-01		9.2E-02	1.4E-01	U	1.4E-01
D4	J02HM0	02/24/05	3.7E-02		2.8E-02	1.61E-01		8.2E-02	1.3E-01	U	1.3E-01
D5	J02HM1	02/24/05	6.1E-01		4.5E-02	2.28E-01		9.3E-02	1.6E-01	U	1.6E-01
D6	J02HM2	02/24/05	3.98E-01		7.7E-02	3.87E+00		1.3E-01	5.21E-01		1.7E-01
E7	J02HM3	02/24/05	5.7E-01		4.3E-02	3.15E-01		7.9E-02	1.1E-01	U	1.1E-01
E8	J02HM4	02/24/05	2.05E-01		3.8E-02	1.4E-01	U	1.4E-01	1.6E-01	U	1.6E-01
E9	J02HM5	02/24/05	8.44E-01		6.3E-02	1.07E+00		1.2E-01	1.9E-01	U	1.9E-01
E10	J02HM6	02/24/05	6.3E-02	U	6.3E-02	8.2E-02	U	8.2E-02	1.2E-01	U	1.2E-01
F1	J02HM7	02/24/05	3.6E-02	U	3.6E-02	1.2E-01	U	1.2E-01	1.4E-01	U	1.4E-01
F2	J02HM8	02/24/05	3.1E-02	U	3.1E-02	7.5E-02	U	7.5E-02	1.1E-01	U	1.1E-01
F3	J02HM9	02/24/05	3.3E-02	U	3.3E-02	7.8E-02	U	7.8E-02	1.3E-01	U	1.3E-01

Statistical Computation Input Data

Sampling Area	HEIS Number	Sample Date	Cs-137 pCi/g			Eu-152 pCi/g			Eu-154 pCi/g		
A4	J02HK9/ J02HL0	02/23/05	4.5E-01			1.7E+00			1.7E-01		
F4	J02HN0/ J02HN1	02/28/05	1.6E-02			4.8E-02			6.0E-02		
A1	J02HK6	02/23/05	2.9E-02			8.1E-02			4.8E-02		
A2	J02HK7	02/23/05	2.1E-02			1.4E-01			7.5E-02		
A3	J02HK8	02/23/05	1.4E-01			4.6E-01			5.5E-02		
B5	J02HL1	02/23/05	6.3E-02			1.8E-01			6.5E-02		
B6	J02HL2	02/23/05	1.6E-02			1.2E-01			5.0E-02		
B7	J02HL3	02/23/05	2.0E-02			1.3E-01			8.0E-02		
B8	J02HL4	02/23/05	2.3E-01			6.4E-01			6.5E-02		
C9	J02HL5	02/23/05	1.7E-02			6.6E-02			5.0E-02		
C10	J02HL6	02/23/05	2.9E-01			3.1E-01			8.0E-02		
C1	J02HL7	02/23/05	3.2E-01			7.1E-01			6.5E-02		
C2	J02HL8	02/23/05	2.3E-01			2.8E-01			5.5E-02		
D3	J02HL9	02/24/05	4.4E-02			1.4E-01			7.0E-02		
D4	J02HM0	02/24/05	3.7E-02			1.6E-01			6.5E-02		
D5	J02HM1	02/24/05	6.1E-01			2.3E-01			8.0E-02		
D6	J02HM2	02/24/05	4.0E-01			3.9E+00			5.2E-01		
E7	J02HM3	02/24/05	5.7E-01			3.2E-01			5.5E-02		
E8	J02HM4	02/24/05	2.1E-01			7.0E-02			8.0E-02		
E9	J02HM5	02/24/05	8.4E-01			1.1E+00			9.5E-02		
E10	J02HM6	02/24/05	3.2E-02			4.1E-02			6.0E-02		
F1	J02HM7	02/24/05	1.8E-02			6.0E-02			7.0E-02		
F2	J02HM8	02/24/05	1.6E-02			3.8E-02			5.5E-02		
F3	J02HM9	02/24/05	1.7E-02			3.9E-02			6.5E-02		

Statistical Computations

	Cs-137			Eu-152			Eu-154		
Statistical value based on	Radionuclide data set. Use nonparametric z-stat.			Radionuclide data set. Use nonparametric z-stat.			Radionuclide data set. Use nonparametric z-stat.		
N	24			24			24		
% < Detection limit	42%			25%			92%		
mean	1.9E-01			4.5E-01			8.9E-02		
st. dev.	2.3E-01			8.2E-01			9.5E-02		
Z-statistic	1.6E+00			1.6E+00			1.6E+00		
95%UCL on mean	2.7E-01			7.3E-01			1.2E-01		
max value	8.4E-01			3.9E+00			5.2E-01		
Statistical value	2.7E-01			7.3E-01			1.2E-01		
Background	NA			NA			NA		
Statistical value above background	2.7E-01			7.3E-01			1.2E-01		
Lookup Value - 15 mrem/yr for rad	6.2			3.3			3.0		

Bechtel Hanford, Inc. **CALCULATION SHEET**

Originator W. K. Hudson Date 04/12/05 Calc. No. 0100K-CA-V0045 Rev. No. 0
Project 100-K Remedial Action Job No. 22192 Checked T. B. Miley Date 4-13-05
Subject 100-K-55:1 Pipeline Cleanup Verification 95% UCL Calculation Checked K. A. Anselm Date 4-12-05
Sheet No. 4 of 8

Deep Zone Sample Data

Sampling Area	HEIS Number	Sample Date	Cs-137 pCi/g	Q	Cs-137 MDA	Eu-152 pCi/g	Q	Eu-152 MDA	Eu-154 pCi/g	Q	Eu-154 MDA
A1	J02H20	02/15/05	2.88E+00		5.7E-02	1.9E-01	U	1.9E-01	1.7E-01	U	1.7E-01
Duplicate of J02H20	J02HW9	02/15/05	3.85E+00		4.4E-02	2.05E-01		1.1E-01	1.1E-01	U	1.1E-01
D2	J02H14	01/26/05	4.1E-02	U	4.1E-02	1.4E-01	U	1.4E-01	1.5E-01	U	1.5E-01
Duplicate of J02H14	J02H15	01/26/05	3.5E-02	U	3.5E-02	9.7E-02	U	9.7E-02	1.3E-01	U	1.3E-01
A2	J02H19	02/15/05	4.5E-02	U	4.5E-02	6.39E-01		1.0E-01	1.7E-01	U	1.7E-01
A3	J02H18	02/15/05	8.2E-02		5.4E-02	1.16E+00		9.7E-02	2.3E-01	U	2.3E-01
B4	J02H17	02/15/05	1.49E-01		5.5E-02	1.00E+00		9.9E-02	2.9E-01	U	2.9E-01
B5	J02H07	01/26/05	3.0E-02	U	3.0E-02	7.4E-02	U	7.4E-02	8.5E-02	U	8.5E-02
B6	J02H08	01/26/05	3.6E-02	U	3.6E-02	8.8E-02	U	8.8E-02	1.1E-01	U	1.1E-01
C7	J02H09	01/26/05	6.5E-02		3.4E-02	3.03E-01		7.9E-02	1.2E-01	U	1.2E-01
C8	J02H10	01/26/05	3.1E-02	U	3.1E-02	7.8E-02	U	7.8E-02	9.9E-02	U	9.9E-02
C9	J02H11	01/26/05	5.90E-01		2.4E-02	1.85E+00		4.2E-02	2.88E-01		5.8E-02
D10	J02H12	01/26/05	3.8E-02	U	3.8E-02	1.0E-01	U	1.0E-01	1.4E-01	U	1.4E-01
D1	J02H13	01/26/05	8.9E-02		1.0E-01	1.24E-01		3.5E-02	1.1E-01	U	1.1E-01

Statistical Computation Input Data

Sampling Area	HEIS Number	Sample Date	Cs-137 pCi/g			Eu-152 pCi/g			Eu-154 pCi/g		
A1	J02H20/ J02HW9	02/15/05	3.4E+00			1.5E-01			7.0E-02		
D2	J02H14/ J02H15	01/26/05	1.9E-02			5.9E-02			7.0E-02		
A2	J02H19	02/15/05	2.3E-02			6.4E-01			8.5E-02		
A3	J02H18	02/15/05	8.2E-02			1.2E+00			1.2E-01		
B4	J02H17	02/15/05	1.5E-01			1.0E+00			1.5E-01		
B5	J02H07	01/26/05	1.5E-02			3.7E-02			4.3E-02		
B6	J02H08	01/26/05	1.8E-02			4.4E-02			5.5E-02		
C7	J02H09	01/26/05	6.5E-02			3.0E-01			6.0E-02		
C8	J02H10	01/26/05	1.6E-02			3.9E-02			5.0E-02		
C9	J02H11	01/26/05	5.9E-01			1.9E+00			2.9E-01		
D10	J02H12	01/26/05	1.9E-02			5.0E-02			7.0E-02		
D1	J02H13	01/26/05	8.9E-02			1.2E-01			5.5E-02		

Statistical Computations

	Cs-137			Eu-152			Eu-154		
Statistical value based on	Radionuclide data set. Use nonparametric z-stat.			Radionuclide data set. Use nonparametric z-stat.			Radionuclide data set. Use nonparametric z-stat.		
N	12			12			12		
% < Detection limit	50%			42%			92%		
mean	3.7E-01			4.5E-01			9.2E-02		
st. dev.	9.6E-01			5.9E-01			6.8E-02		
Z-statistic	1.6E+00			1.6E+00			1.6E+00		
95%UCL on mean	8.2E-01			7.4E-01			1.2E-01		
max value	3.9E+00			1.9E+00			2.9E-01		
Statistical value	8.2E-01			7.4E-01			1.2E-01		
Background	NA			NA			NA		
Statistical value above background	8.2E-01			7.4E-01			1.2E-01		
Lookup Value - 15 mrem/yr for rad	6.2			3.3			3.0		

Bechtel Hanford, Inc. CALCULATION SHEET

Originator W. K. Hudson Date 04/12/05 Calc. No. 0100K-CA-V0045 Rev. No. 0
Project 100-K Remedial Action Job No. 22192 Checked T. B. Miley TBM Date 4-13-05
Subject 100-K-55:1 Pipeline Cleanup Verification 95% UCL Calculation Checked K. A. Anselm KAA Date 4-12-05
Sheet No. 5 of 8

Overburden Sample Data

Sampling Area	HEIS Number	Sample Date	Cs-137			Eu-152			Eu-154		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
A4	J02HN7	02/18/05	1.61E+00		5.4E-02	2.65E-01		8.5E-02	1.2E-01	U	1.2E-01
Duplicate of J02HN7	J02HN8	02/18/05	1.80E+00		3.9E-02	2.03E-01		8.2E-02	1.2E-01	U	1.2E-01
F4	J02HR8	03/01/05	1.48E-01		4.0E-02	1.14E-01		8.3E-02	1.3E-01	U	1.3E-01
Duplicate of J02HR8	J02HR9	03/01/05	2.00E-01		4.0E-02	1.2E-01	U	1.2E-01	1.2E-01	U	1.2E-01
K4	J02HV9	02/17/05	3.9E-02	U	3.9E-02	9.5E-02	U	9.5E-02	1.4E-01	U	1.4E-01
Duplicate of J02HV9	J02HW0	02/17/05	4.5E-02	U	4.5E-02	1.4E-01	U	1.4E-01	1.7E-01	U	1.7E-01
A1	J02HN4	02/18/05	2.94E-01		4.1E-02	1.59E-01		7.5E-02	1.3E-01	U	1.3E-01
A2	J02HN5	02/18/05	1.94E-01		4.4E-02	1.44E+00		8.4E-02	3.27E-01		1.4E-01
A3	J02HN6	02/18/05	3.95E-01		4.3E-02	1.5E-01	U	1.5E-01	1.5E-01	U	1.5E-01
B5	J02HN9	03/03/05	3.44E-01		4.4E-02	2.03E-01		8.4E-02	1.2E-01	U	1.2E-01
B6	J02HP0	03/03/05	8.1E-02		3.7E-02	1.61E-01		8.9E-02	1.5E-01	U	1.5E-01
B7	J02HP1	03/03/05	5.60E-01		5.3E-02	1.12E+00		8.9E-02	1.6E-01	U	1.6E-01
B8	J02HP2	03/03/05	2.19E-01		3.9E-02	1.2E-01	U	1.2E-01	1.4E-01	U	1.4E-01
C9	J02HP3	02/22/05	4.4E-02		3.0E-02	1.2E-01	U	1.2E-01	1.2E-01	U	1.2E-01
C10	J02HP4	02/22/05	5.3E-02		3.5E-02	2.17E-01		7.2E-02	1.1E-01	U	1.1E-01
C1	J02HP5	02/22/05	8.2E-02		3.6E-02	1.21E-01		7.7E-02	1.3E-01	U	1.3E-01
C2	J02HP6	02/22/05	3.38E-01		4.1E-02	1.5E-01	U	1.5E-01	1.4E-01	U	1.4E-01
D3	J02HP7	02/22/05	2.86E-01		3.0E-02	4.82E-01		7.1E-02	1.3E-01	U	1.3E-01
D4	J02HP8	02/22/05	6.1E-02		3.6E-02	1.26E-01		8.1E-02	1.2E-01	U	1.2E-01
D5	J02HP9	02/22/05	1.05E-01		3.7E-02	1.5E-01	U	1.5E-01	1.4E-01	U	1.4E-01
D6	J02HR0	02/22/05	1.52E-01		3.5E-02	1.4E-01	U	1.4E-01	1.4E-01	U	1.4E-01
E7	J02HR1	03/01/05	1.08E-01		3.6E-02	2.65E-01		1.0E-01	1.6E-01	U	1.6E-01
E8	J02HR2	03/01/05	1.62E+00		5.0E-02	1.24E+00		1.0E-01	2.3E-01	U	2.3E-01
E9	J02HR3	03/01/05	1.36E-01		4.5E-02	4.65E-01		1.0E-01	1.8E-01	U	1.8E-01
E10	J02HR4	03/01/05	1.69E-01		4.5E-02	5.96E-01		1.0E-01	1.7E-01	U	1.7E-01
F1	J02HR5	03/01/05	1.92E-01		3.8E-02	4.08E-01		7.8E-02	1.4E-01	U	1.4E-01
F2	J02HR6	03/01/05	3.6E-02		3.6E-02	1.0E-01	U	1.0E-01	1.3E-01	U	1.3E-01
F3	J02HR7	03/01/05	7.6E-02		3.4E-02	1.2E-01	U	1.2E-01	1.5E-01	U	1.5E-01
G5	J02HT0	03/02/05	5.3E-02	U	5.3E-02	1.3E-01	U	1.3E-01	1.4E-01	U	1.4E-01
G6	J02HT1	03/02/05	3.6E-02	U	3.6E-02	8.6E-02	U	8.6E-02	1.2E-01	U	1.2E-01
G7	J02HT2	03/02/05	5.1E-02	U	5.1E-02	1.1E-01	U	1.1E-01	1.6E-01	U	1.6E-01
G8	J02HT3	03/02/05	2.58E-01		3.1E-02	5.63E-01		7.2E-02	1.1E-01	U	1.1E-01
H9	J02HT4	03/02/05	2.06E-01		3.1E-02	3.33E-01		6.0E-02	9.7E-02	U	9.7E-02
H10	J02HT5	03/02/05	2.56E-01		4.4E-02	1.91E-01		8.2E-02	1.2E-01	U	1.2E-01
H1	J02HT6	03/02/05	1.40E-01		4.1E-02	7.60E-01		7.3E-02	1.83E-01		1.1E-01
H2	J02HT7	03/02/05	3.58E-01		3.9E-02	1.3E-01	U	1.3E-01	1.5E-01	U	1.5E-01
I3	J02HT8	02/18/05	1.26E-01		3.0E-02	1.1E-01	U	1.1E-01	1.4E-01	U	1.4E-01
I4	J02HT9	02/18/05	3.34E-01		3.3E-02	1.2E-01	U	1.2E-01	1.5E-01	U	1.5E-01
I5	J02HV0	02/18/05	3.3E-02	U	3.3E-02	8.1E-02	U	8.1E-02	1.2E-01	U	1.2E-01
I6	J02HV1	02/18/05	8.3E-02		3.0E-02	1.1E-01	U	1.1E-01	1.3E-01	U	1.3E-01
J7	J02HV2	02/17/05	3.62E-01		3.4E-02	7.4E-02	U	7.4E-02	1.1E-01	U	1.1E-01
J8	J02HV3	02/17/05	5.1E-02		2.0E-02	4.3E-02		5.0E-02	7.8E-02	U	7.8E-02
J9	J02HV4	02/17/05	1.51E-01		2.6E-02	9.4E-02	U	9.4E-02	1.0E-01	U	1.0E-01
J10	J02HV5	02/17/05	4.59E-01		4.7E-02	2.55E-01		9.4E-02	1.7E-01	U	1.7E-01
K1	J02HV6	02/17/05	1.44E-01		3.3E-02	8.3E-02	U	8.3E-02	1.2E-01	U	1.2E-01
K2	J02HV7	02/17/05	3.1E-02		2.9E-02	1.4E-01	U	1.4E-01	1.5E-01	U	1.5E-01
K3	J02HV8	02/17/05	4.2E-02	U	4.2E-02	1.0E-01	U	1.0E-01	1.6E-01	U	1.6E-01
L5	J02HW1	02/17/05	3.7E-02	U	3.7E-02	9.3E-02	U	9.3E-02	1.3E-01	U	1.3E-01
L6	J02HW2	02/17/05	3.2E-02	U	3.2E-02	7.4E-02	U	7.4E-02	1.0E-01	U	1.0E-01
L7	J02HW3	02/17/05	3.7E-02	U	3.7E-02	1.3E-01	U	1.3E-01	1.4E-01	U	1.4E-01
L8	J02HW4	02/17/05	3.6E-02	U	3.6E-02	9.3E-02	U	9.3E-02	1.3E-01	U	1.3E-01

Continued on next page

Bechtel Hanford, Inc. **CALCULATION SHEET**

Originator	W. K. Hudson	**Date**	04/12/05	**Calc. No.**	0100K-CA-V0045	**Rev. No.**	0
Project	100-K Remedial Action	**Job No.**	22192	**Checked**	T. B. Miley TBM	**Date**	4-13-05
Subject	100-K-55:1 Pipeline Cleanup Verification 95% UCL Calculation			**Checked**	K. A. Anselm KAA	**Date**	4-12-05
						Sheet No.	6 of 8

Statistical Computation Input Data (Overburden continued)

Sampling Area	HEIS Number	Sample Date	Cs-137 pCi/g			Eu-152 pCi/g			Eu-154 pCi/g		
A4	J02HN7/ J02HN8	02/18/05	1.7E+00			2.3E-01			6.0E-02		
F4	J02HR8/ J02HR9	03/01/05	1.7E-01			8.7E-02			6.3E-02		
K4	J02HV9/ J02HW0	02/17/05	2.1E-02			5.9E-02			7.8E-02		
A1	J02HN4	02/18/05	2.9E-01			1.6E-01			6.5E-02		
A2	J02HN5	02/18/05	1.9E-01			1.4E+00			3.3E-01		
A3	J02HN6	02/18/05	4.0E-01			7.5E-02			7.5E-02		
B5	J02HN9	03/03/05	3.4E-01			2.0E-01			6.0E-02		
B6	J02HP0	03/03/05	8.1E-02			1.6E-01			7.5E-02		
B7	J02HP1	03/03/05	5.6E-01			1.1E+00			8.0E-02		
B8	J02HP2	03/03/05	2.2E-01			6.0E-02			7.0E-02		
C9	J02HP3	02/22/05	4.4E-02			6.0E-02			6.0E-02		
C10	J02HP4	02/22/05	5.3E-02			2.2E-01			5.5E-02		
C1	J02HP5	02/22/05	8.2E-02			1.2E-01			6.5E-02		
C2	J02HP6	02/22/05	3.4E-01			7.5E-02			7.0E-02		
D3	J02HP7	02/22/05	2.9E-01			4.8E-01			6.5E-02		
D4	J02HP8	02/22/05	6.1E-02			1.3E-01			6.0E-02		
D5	J02HP9	02/22/05	1.1E-01			7.5E-02			7.0E-02		
D6	J02HR0	02/22/05	1.5E-01			7.0E-02			7.0E-02		
E7	J02HR1	03/01/05	1.1E-01			2.7E-01			8.0E-02		
E8	J02HR2	03/01/05	1.6E+00			1.2E+00			1.2E-01		
E9	J02HR3	03/01/05	1.4E-01			4.7E-01			9.0E-02		
E10	J02HR4	03/01/05	1.7E-01			6.0E-01			8.5E-02		
F1	J02HR5	03/01/05	1.9E-01			4.1E-01			7.0E-02		
F2	J02HR6	03/01/05	3.6E-02			5.0E-02			6.5E-02		
F3	J02HR7	03/01/05	7.6E-02			6.0E-02			7.5E-02		
G5	J02HT0	03/02/05	2.7E-02			6.5E-02			7.0E-02		
G6	J02HT1	03/02/05	1.8E-02			4.3E-02			6.0E-02		
G7	J02HT2	03/02/05	2.6E-02			5.5E-02			8.0E-02		
G8	J02HT3	03/02/05	2.6E-01			5.6E-01			5.5E-02		
H9	J02HT4	03/02/05	2.1E-01			3.3E-01			4.9E-02		
H10	J02HT5	03/02/05	2.6E-01			1.9E-01			6.0E-02		
H1	J02HT6	03/02/05	1.4E-01			7.6E-01			1.8E-01		
H2	J02HT7	03/02/05	3.6E-01			6.5E-02			7.5E-02		
I3	J02HT8	02/18/05	1.3E-01			5.5E-02			7.0E-02		
I4	J02HT9	02/18/05	3.3E-01			6.0E-02			7.5E-02		
I5	J02HV0	02/18/05	1.7E-02			4.1E-02			6.0E-02		
I6	J02HV1	02/18/05	8.3E-02			5.5E-02			6.5E-02		
J7	J02HV2	02/17/05	3.6E-01			3.7E-02			5.5E-02		
J8	J02HV3	02/17/05	5.1E-02			4.3E-02			3.9E-02		
J9	J02HV4	02/17/05	1.5E-01			4.7E-02			5.0E-02		
J10	J02HV5	02/17/05	4.6E-01			2.6E-01			8.5E-02		
K1	J02HV6	02/17/05	1.4E-01			4.2E-02			6.0E-02		
K2	J02HV7	02/17/05	3.1E-02			7.0E-02			7.5E-02		
K3	J02HV8	02/17/05	2.1E-02			5.0E-02			8.0E-02		
L5	J02HW1	02/17/05	1.9E-02			4.7E-02			6.5E-02		
L6	J02HW2	02/17/05	1.6E-02			3.7E-02			5.0E-02		
L7	J02HW3	02/17/05	1.9E-02			6.5E-02			7.0E-02		
L8	J02HW4	02/17/05	1.8E-02			4.7E-02			6.5E-02		

Statistical Computations

	Cs-137			Eu-152			Eu-154		
Statistical value based on	Radionuclide data set. Use nonparametric z-stat.			Radionuclide data set. Use nonparametric z-stat.			Radionuclide data set. Use nonparametric z-stat.		
N	48			48			48		
% < Detection limit	21%			54%			96%		
mean	2.2E-01			2.3E-01			7.6E-02		
st. dev.	3.3E-01			3.2E-01			4.2E-02		
Z-statistic	1.6E+00			1.6E+00			1.6E+00		
95%UCL on mean	3.0E-01			3.0E-01			8.6E-02		
max value	1.8E+00			1.4E+00			3.3E-01		
Statistical value	3.0E-01			3.0E-01			8.6E-02		
Background	1.1E+00			NA			3.3E-02		
Statistical value above background	0 (< BG)			3.0E-01			5.3E-02		
Lookup Value - 15 mrem/yr for rad	6.2			3.3			3.0		

Bechtel Hanford, Inc. CALCULATION SHEET

Originator W. K. Hudson Date 04/12/05
Project 100-K Remedial Action Job No. 22192
Subject 100-K-55:1 Pipeline Cleanup Verification 95% UCL Calculation

Calc. No. 0100K-CA-V0045 Rev. No. 0
Checked T. B. Miley Date 4-13-05
Checked K. A. Anselm Date 4-12-05
Sheet 7 of 8

Split-Duplicate Analysis

Shallow Zone Sample Results:

Composite Area	HEIS Number	Cs-137			Eu-152			Eu-154		
		pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
A4	J02HK9	3.5E-01		5.5E-02	1.3E+00		1.0E-01	2.5E-01		1.6E-01
Duplicate of J02HK9	J02HL0	5.4E-01		5.3E-02	2.0E+00		1.1E-01	1.7E-01	U	1.7E-01
Split of J02HK9	J02HN2	6.74E-01		2.25E-02	2.42E+00		5.8E-02	2.66E-01	U	8.6E-02
F4	J025N0	3.00E-02	U	3.00E-02	7.0E-02	U	7.0E-02	1.1E-01	U	1.1E-01
Duplicate of J025N0	J025N1	3.4E-02	U	3.4E-02	1.2E-01	U	1.2E-01	1.3E-01	U	1.3E-01
Split of J025N0	J025N3	8.13E-04	U	1.59E-02	-1.51E-02	U	4.03E-02	-1.82E-02	U	4.82E-02

Shallow Zone Sample Analysis:

(TDL)		0.1	0.1	0.1
Duplicate Analysis 1	Both > MDA?	**Yes (continue)**	**Yes (continue)**	No-Stop (acceptable)
	Both >5xTDL?	No-Stop (acceptable)	**Yes (calc RPD)**	
	RPD		*47%*	
Split Analysis 1	Both > MDA?	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**
	Both >5xTDL?	No-Stop (acceptable)	**Yes (calc RPD)**	No-Stop (acceptable)
	RPD		*63%*	
Duplicate Analysis 2	Both > MDA?	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)
	Both >5xTDL?			
	RPD			
Split Analysis 2	Both > MDA?	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)
	Both >5xTDL?			
	RPD			

Split-Duplicate Analysis (continued)

Deep Zone Sample Results:

Composite Area	HEIS Number	Cs-137			Eu-152			Eu-154		
		pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
D2	J02H14	4.1E-02	U	4.1E-02	1.4E-01	U	1.4E-01	1.5E-01	U	1.5E-01
Duplicate of J02H14	J02H15	3.5E-02	U	3.5E-02	9.7E-02	U	9.7E-02	1.3E-01	U	1.3E-01
Split of J02H14	J02H21	2.12E-02	U	2.01E-02	-3.34E-02	U	4.9E-02	-9.17E-03	U	6.4E-02
A1	J02H20	2.88E+00		5.7E-02	1.9E-01	U	1.9E-01	1.7E-01	U	1.7E-01
Duplicate of J02H20	J02HW9	3.85E+00		4.4E-02	2.05E-01		1.1E-01	1.1E-01	U	1.1E-01
Split of J02H20	J02HX0	3.86E+00		1.61E-02	2.13E-01	U	5.75E-02	1.35E-02	U	4.77E-02

Deep Zone Sample Analysis:

(TDL)		0.1	0.1	0.1
D2 Duplicate Analysis	Both > MDA?	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)
	Both >5xTDL?			
	RPD			
A1 Duplicate Analysis	Both > MDA?	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**
	Both >5xTDL?	**Yes (calc RPD)**	No-Stop (acceptable)	No-Stop (acceptable)
	RPD	29%		
D2 Split Analysis	Both > MDA?	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)
	Both >5xTDL?			
	RPD			
A1 Split Analysis	Both > MDA?	**Yes (continue)**	No-Stop (acceptable)	No-Stop (acceptable)
	Both >5xTDL?	**Yes (calc RPD)**		
	RPD	29%		

Bechtel Hanford, Inc. **CALCULATION SHEET**

Originator W. K. Hudson **Date** 04/12/05
Project 100-K Remedial Action **Job No.** 22192
Subject 100-K-55:1 Pipeline Cleanup Verification 95% UCL Calculation

Calc. No. 0100K-CA-V0045 **Rev. No.** 0
Checked T. B. Miley **Date** 4-13-05
Checked K. A. Anselm **Date** 4-12-05
Sheet 8 of 8

Split-Duplicate Analysis (continued)

Overburden Sample Results:

Composite Area	HEIS Number	Cs-137			Eu-152			Eu-154		
		pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
A4	J02HN7	1.61E+00		5.4E-02	2.65E-01		8.5E-02	1.2E-01		1.2E-01
Duplicate of J02HN7	J02HN8	1.80E+00		3.9E-02	2.03E-01		8.2E-02	1.2E-01		1.2E-01
Split of J02HN7	J02HW5	2.15E+00		2.26E-02	2.90E-01	U	8.46E-02	3.26E-02	U	7.38E-02
F4	J02HR8	1.48E-01		4.0E-02	1.1E-01		8.3E-02	1.3E-01	U	1.3E-01
Duplicate of J02HR8	J02HR9	2.00E-01		4.0E-02	1.2E-01	U	1.2E-01	1.2E-01	U	1.2E-01
Split of J02HR8	J02HW6	1.98E-01		1.51E-02	1.57E-01	U	5.12E-02	2.48E-03	U	5.43E-02
K4	J02HV9	3.9E-02	U	3.9E-02	9.5E-02	U	9.5E-02	1.4E-01	U	1.4E-01
Duplicate of J02HV9	J02HW0	4.5E-02	U	4.5E-02	1.4E-01	U	1.4E-01	1.7E-01	U	1.7E-01
Split of J02HV9	J02HW7	1.18E-02	U	1.52E-02	2.13E-02	U	3.9E-02	-1.78E-02	U	4.15E-02

Overburden Sample Analysis:

(TDL)		0.1	0.1	0.1
A4 Duplicate Analysis	Both > MDA?	**Yes (continue)**	**Yes (continue)**	No-Stop (acceptable)
	Both >5xTDL?	**Yes (calc RPD)**	No-Stop (acceptable)	
	RPD	11%		
F4 Duplicate Analysis	Both > MDA?	**Yes (continue)**	No-Stop (acceptable)	No-Stop (acceptable)
	Both >5xTDL?	No-Stop (acceptable)		
	RPD			
K4 Duplicate Analysis	Both > MDA?	**Yes (continue)**	No-Stop (acceptable)	No-Stop (acceptable)
	Both >5xTDL?	No-Stop (acceptable)		
	RPD			
A4 Split Analysis	Both > MDA?	**Yes (continue)**	**Yes (continue)**	No-Stop (acceptable)
	Both >5xTDL?	**Yes (calc RPD)**	No-Stop (acceptable)	
	RPD	29%		
F4 Split Analysis	Both > MDA?	**Yes (continue)**	**Yes (continue)**	No-Stop (acceptable)
	Both >5xTDL?	No-Stop (acceptable)	No-Stop (acceptable)	
	RPD			
K4 Split Analysis	Both > MDA?	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)
	Both >5xTDL?			
	RPD			

CALCULATION COVER SHEET

Project Title 100-K Remedial Action **Job No.** 22192
Area 100-K Area
Discipline Environmental ***Calc. No.** 0100K-CA-V0046
Subject 100-K-55:1 Pipeline RESRAD Calculation
Computer Program RESRAD **Program No.** Version 6.22

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 pg Summary – 5 pg Attm. 1 - 1 pg Attm. 2 - 18 pg Attm. 3 - 18 pg Attm. 4 - 9 pg Attm. 5 - 18 pg Attm. 6 - 18 pg Attm. 7 - 9 pg Attm. 8 - 18 pg Attm. 9 - 18 pg Attm.10 - 9 pg Total – 142 pages	S. W. Clark S.W. Clark 4/11/05	S. W. Callison SW Callison 4-14-05	R. A. Carlson RA Carlson 4/14/05	M. A. Buckmaster 4/20/05	4/20/05

SUMMARY OF REVISION

*Obtain Calc. No. from DIS

Bechtel Hanford, Inc. CALCULATION SHEET

Originator:	S. W. Clark SWC	Date:	4/11/05	Calc. No.:	0100K-CA-V0046	Rev.:	0
Project:	100-K Remedial Action	Job No:	22192	Checked:	S. W. Callison SWC	Date:	4-14-05
Subject:	100-K-55:1 Pipeline RESRAD Calculation					Sheet No.	1 of 5

PURPOSE:

Calculate the soil and groundwater concentrations, dose, and risk contributions from remaining radionuclide contaminants in the vadose zone and in stockpiled overburden soil over a period of 1,000 years.

GIVEN/REFERENCES:

1) Cleanup verification data from *100-K-55:1 Pipeline Cleanup Verification 95% UCL Calculation*, Calculation No. 0100K-CA-V0045, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.
2) *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP), DOE/RL-96-17, Rev. 4, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
3) Radioactive and nonradioactive contaminants of concern from the *100 Area Remedial Action Sampling and Analysis Plan* (100 Area SAP), DOE/RL-96-22, Rev. 3, U.S. Department of Energy, Richland Operations Office, Richland, Washington. For the purpose of these RESRAD calculations, the radioactive contaminants of concern (COCs) are cesium-137, europium-152, and europium-154.
4) For the purpose of these RESRAD calculations, there are no nonradionuclide contaminants of concern.
5) RESidual RADioactivity (RESRAD) computer code, version 6.22, 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.
6) Sample design data from the *100-K-55 Pipelines Shallow, Deep, and Overburden Zone Sampling Plan,* Calculation No. 0100-CA-V0039, Rev. 0, Bechtel Hanford, Inc., Richland, Washington. For the purpose of these RESRAD calculations, the shallow and deep zone sampling areas identified in the sampling plan calculation brief were summed for a total site area of 24,982 m^2. Overburden area is 46,397 m^2.

SOLUTION:

1) Separate RESRAD runs were performed for the shallow and deep vadose zone soil horizons, and for overburden soil. Table 1 shows the waste site parameters used for RESRAD modeling. The model for the RESRAD runs uses the conservative assumption that the residual contamination levels from the data set extend uniformly from the ground surface to groundwater.

2) Table 2 shows the radionuclide activities for each COC. For overburden assays all background concentrations are subtracted from the 95% UCL values. Input factors for each RESRAD run are shown in the "Summary" section of the RESRAD

Bechtel Hanford, Inc. CALCULATION SHEET

Originator:	S. W. Clark	Date:	4/11/05	Calc. No.:	0100K-CA-V0046	Rev.:	0
Project:	100-K Remedial Action	Job No:	22192	Checked:	S. W. Callison	Date:	4-14-05
Subject:	100-K-55:1 Pipeline RESRAD Calculation					Sheet No.	2 of 5

"Mixture Sums and Single Radionuclide Guidelines" printouts in Attachments to this Calculation Summary.

3) The year where the peak dose (or concentration) occurs from each individual radionuclide COC was determined by a preliminary run. This year was then included in all final RESRAD runs. For the direct exposure pathway (i.e. soil ingestion and inhalation and external radiation), the peak year occurred at year zero (year 2005) for all COCs. For the water pathways (i.e., drinking water and food ingestion) the peak year was 42 for cesium-137. The 42-year time period was included in all of the RESRAD runs.

Table 1. Waste Site Dimensions for RESRAD Modeling

Parameter	Units	Shallow Zone	Deep Zone	Overburden	Comments
Cover Depth	m	0	4.6	0	
Area of Zone	m^2	24,982	24,982	46,397	Based on Sample Design [a]
Length Parallel to Aquifer Flow	m	204	204	189	Based on Sample Design [a]
Elevation: Zone Surface	m	142.0	137.4	142.0	NAVD88
Elevation: Groundwater	m	119.8	119.8	119.8	NAVD88
Thickness: Contaminated Zone	m	22.2	17.6	22.2	Conservative assumption for modeling

[a] Sample design data from the *100-K-55 Pipelines Shallow, Deep, and Overburden Zone Sampling Plan*, Calculation No. 0100K-CA-V0039

METHODOLOGY:

1) Runs of RESRAD version 6.22 were completed for the shallow zone using the radionuclide concentrations shown in Table 2. RESRAD numerical output reports for dose, risk, and concentration for the shallow zone are presented in the Attachments to this calculation summary.

Bechtel Hanford, Inc. CALCULATION SHEET

Originator:	S. W. Clark	Date:	4/11/05	Calc. No.:	0100K-CA-V0046	Rev.:	0
Project:	100-K Remedial Action	Job No:	22192	Checked:	S. W. Callison	Date:	4-14-05
Subject:	100-K-55:1 Pipeline RESRAD Calculation					Sheet No. 3 of 5	

Table 2. Cleanup Verification Data Set

COCs	Shallow Zone	Deep Zone	Overburden
Radionuclide Activity (pCi/g) [a]			
Cs-137	2.71E-01	8.25E-01	0 (< BG) [b]
Eu-152	7.27E-01	7.35E-01	3.04E-01
Eu-154	1.20E-01	1.25E-01	5.26E-02 [b]

[a] Soil concentration values are from *100-K-55 Pipeline Cleanup Verification 95% UCL Calculation*, Calculation No. 0100K-CA-V0045.
[b] Background concentrations are subtracted from the 95% UCL values for overburden assays.

RESULTS:

1) Radionuclide "All Pathways" Dose Rate

The "all pathways" (maximum) dose rates are shown in Table 3. The combined shallow and deep zone maximum all-pathways dose is 4.59 mrem/yr which occurs at year zero (2005). The maximum dose rate from the overburden (1.66 mrem/yr) also occurs at year zero (2005).

Table 3. All Pathways Dose Rate (mrem/yr)

RESRAD Run #	Vadose Zone Horizons	"All Pathways" Dose Contributions in mrem/yr at Each Time Slice (yr)							
		0	1	3	13	42	100	300	1000
1	Shallow Zone	4.59E+00	4.37E+00	3.95E+00	2.41E+00	6.60E-01	8.88E-02	7.06E-04	7.09E-11
2	Deep Zone	3.71E-25	2.43E-04	7.80E-04	2.79E-03	4.66E-03	2.91E-03	8.57E-05	2.69E-11
Total All Pathway Dose Rate (mrem/yr)		4.59E+00	4.37E+00	3.95E+00	2.41E+00	6.65E-01	9.17E-02	7.92E-04	9.77E-11
3	Overburden	1.66E+00	1.57E+00	1.40E+00	8.04E-01	1.67E-01	7.78E-03	2.33E-07	5.39E-16

2) Radionuclide Excess Cancer Risk

The radionuclide excess lifetime cancer risk results are shown in Table 4. The maximum excess lifetime cancer risk (5.45×10^{-5}) for the combined shallow and deep zone occurs at year zero (2005). The maximum excess lifetime cancer risk from the overburden (1.83×10^{-5}) also occurs at year zero (2005).

Bechtel Hanford, Inc. CALCULATION SHEET

Originator:	S. W. Clark SWC	Date:	4/11/05	Calc. No.:	0100K-CA-V0046	Rev.:	0
Project:	100-K Remedial Action	Job No:	22192	Checked:	S. W. Callison SWC	Date:	4-14-05
Subject:	100-K-55:1 Pipeline RESRAD Calculation					Sheet No.	4 of 5

Table 4. Radionuclide Excess Lifetime Cancer Risk

RESRAD Run #	Vadose Zone Horizons	Excess Cancer Risk at Each Time Slice (yr)							
		0	1	3	13	42	100	300	1000
1	Shallow Zone	5.45E-05	5.19E-05	4.71E-05	2.96E-05	8.78E-06	1.35E-06	1.14E-08	1.14E-15
2	Deep Zone	5.94E-08	6.24E-08	6.80E-08	8.74E-08	9.43E-08	5.07E-08	1.38E-09	4.19E-16
Total Excess Cancer Risk		5.45E-05	5.20E-05	4.72E-05	2.97E-05	8.88E-06	1.40E-06	1.28E-08	1.56E-15
3	Overburden	1.83E-05	1.73E-05	1.55E-05	8.97E-06	1.89E-06	8.91E-08	2.68E-12	3.58E-21

3) Radionuclide Groundwater Protection

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

Table 5. RESRAD Predicted Radionuclide Groundwater (Well Water) Concentrations

Radio-nuclides	Vadose Zone Horizon	Groundwater Concentrations in pCi/L at Each Time Slice (yr)								RAGs From RDR
		0	1	3	13	42	100	300	1000	
Cs-137	Shallow Zone	0	6.82E-04	1.95E-03	6.72E-03	1.11E-02	6.91E-03	2.03E-04	6.34E-11	60
	Deep Zone	0	2.08E-03	5.94E-03	2.04E-02	3.38E-02	2.11E-02	6.20E-04	1.94E-10	
	Total	0	2.76E-03	7.90E-03	2.72E-02	4.49E-02	2.80E-02	8.24E-04	2.58E-10	
	Overburden	0	0	0	0	0	0	0	0	
Eu-152	**Total**	0	0	0	0	0	0	0	0	200
	Overburden	0	0	0	0	0	0	0	0	
Eu-154	**Total**	0	0	0	0	0	0	0	0	60
	Overburden	0	0	0	0	0	0	0	0	

CONCLUSIONS:

- The maximum combined all-pathways dose rate for the shallow zone and deep zone is 4.59 mrem/yr and occurs at year zero (2005).
- The dominant pathway for the dose rate is direct external exposure.
- The primary radionuclide contributing to the direct exposure pathway is europium-152.
- None of the site COCs are projected to exceed remedial action goals (RAGs).
- Maximum lifetime cancer risk (5.45×10^{-5}) for the combined shallow zone and deep zone occurs at year zero (2005).

Bechtel Hanford, Inc. CALCULATION SHEET

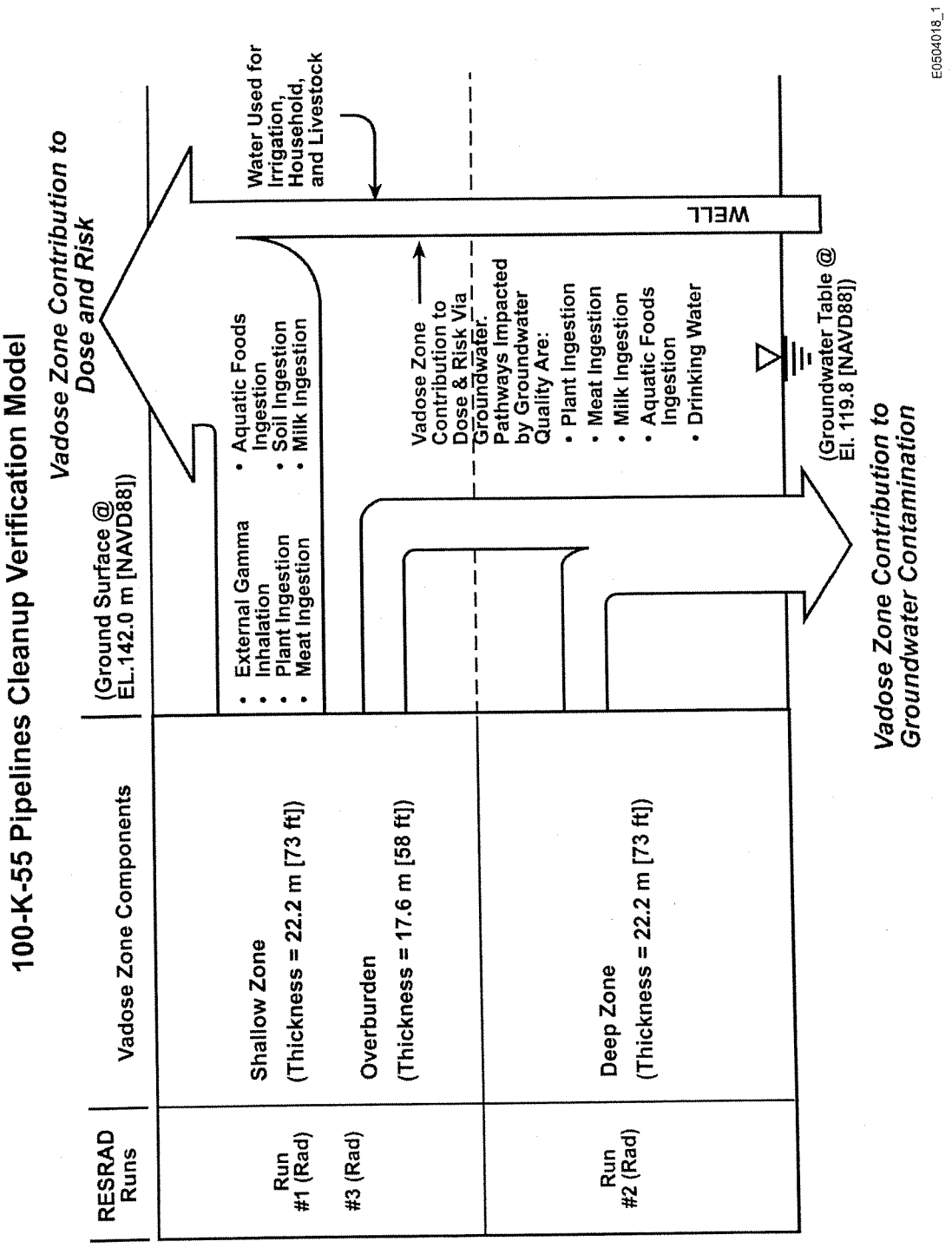
Originator:	S. W. Clark	Date:	4/11/05	Calc. No.:	0100K-CA-V0046	Rev.:	0
Project:	100-K Remedial Action	Job No:	22192	Checked:	S. W. Callison	Date:	4-14-05
Subject:	100-K-55:1 Pipeline RESRAD Calculation					Sheet No.	5 of 5

- Among the radionuclide contaminants of concern only cesium-137 is calculated to reach groundwater in the 1,000 years of the RESRAD model run. Cesium-137 is predicted to reach groundwater at concentrations significantly below the RAGs.

ATTACHMENTS:

1. Graphic showing 100-K-55:1 Cleanup Verification Model (1 page)
2. RESRAD Output: 100-K-55:1 Shallow Zone Radionuclides, Mixture Sums and Single Radionuclide Guidelines (18 pages)
3. RESRAD Output: 100-K-55:1 Shallow Zone Radionuclides, Intake Quantities and Health Risk Factors (18 pages)
4. RESRAD Output: 100-K-55:1 Shallow Zone Radionuclides, Concentration of Radionuclides, (9 pages)
5. RESRAD Output: 100-K-55:1 Deep Zone Radionuclides, Mixture Sums and Single Radionuclide Guidelines (18 pages)
6. RESRAD Output: 100-K-55:1 Deep Zone Radionuclides, Intake Quantities and Health Risk Factors (18 pages)
7. RESRAD Output: 100-K-55:1 Deep Zone Radionuclides, Concentration of Radionuclides, (9 pages)
8. RESRAD Output: 100-K-55:1 Overburden Radionuclides, Mixture Sums and Single Radionuclide Guidelines (18 pages)
9. RESRAD Output: 100-K-55:1 Overburden Radionuclides, Intake Quantities and Health Risk Factors (18 pages)
10. RESRAD Output: 100-K-55:1 Overburden Radionuclides, Concentration of Radionuclides, (9 pages)

Attachment 1



Attachment 1 Page 1 of 1
Originator S. W. Clark SWC Date 4/11/05
Chk'd By S. W. Callison SWC Date 4-14-05
Calc No. 100K-CA-V0046 Rev. No. 0

CALCULATION COVER SHEET
(Sample Design, Verification, or Waste Characterization Calculation)

Project Title:	100-K Remedial Action	**Job No.**	22192
Area	100 K Area		
Discipline	Environmental	***Calc. No.**	0100K-CA-V0047
Subject	100-K-55:1 Comparison to Drinking Water Standards (MCL) Calculation Brief		
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 X **Preliminary** **Superseded** **Voided**

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover - 1 Calculations - 3 Total - 4	S. W. Clark 4/4/05	S. W. Callison 4-14-05	R. A. Carlson 4/14/05	M. A. Buckmaster 4/20/05	4/20/05

SUMMARY OF REVISIONS

*Obtain Calc. No. from DIS

Bechtel Hanford, Inc.

CALCULATION SHEET

Originator	S. W. Clark	Date 4/11/05	Calc. No. 0100K-CA-V0047	Rev. No.	0
Project	100-K Remedial Action	Job No. 22192	Checked S. W. Callison	Date	4-14-05
Subject	100-K-55:1 Comparison to Drinking Water Standards (MCL) Calculation Brief			Sheet No.	1 of 3

Purpose:
Compare RESRAD derived groundwater radionuclide concentrations to remedial action goals and maximum contaminant levels (MCLs) for groundwater. Compare beta/gamma emitter dose contributions to the maximum allowable dose of 4 mrem/yr. Compare alpha emitter dose contributions to the maximum allowable gross particle activity of 15 pCi/L or 1/25th of the derived concentration guide (DCG). Alph-emitting COCs were undetected so no comparison was performed

Table of Contents:

SWC 4-14-05

46 100-K-55:1

Given/References:

1) RESRAD derived groundwater radionuclide concentrations from Calculation 0100K-CA-V0021, ~~1110-KW-3~~ *Cleanup Verification RESRAD Calculation Brief.*

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

3) Maximum allowable dose of 4 mrem/yr for beta/gamma emitters and maximum allowable gross particle activity of 15 pCi/L for alpha emitters from: 40 CFR 141, "National Primary Drinking Water Regulation," *Code of Federal Regulations*, as amended (40 CFR Part 141, Subpart G, 141.66).

4) 1/25th of the derived concentration guide values from *Radiation Protection of the Public and Environment*, DOE Order 5400.5, U.S. Department of Energy, Washington D.C.

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

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

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

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

4. The cumulative dose for each organ for all beta and gamma emitting COCs (Cs-137, Eu-152, and Eu-154) at time t is calculated separately using the concentration corresponding to 4 mrem/year dose (C4) and the sum of fractions equation shown below (from EPA-570/9-76-003). The organs for which doses need to be computed are total body, bone, liver and gastrointestinal tract [lower large intestine] (GI(LLI)). The individual organ doses are compared to 4 mrem/yr.

$$\text{Dose}_{\text{organ x}}(t) = [\text{ConcA}(t)/\text{C4A}(x) + \text{ConcB}(t)/\text{C4B}(x) + \ldots.] \times (4 \text{ mrem/yr})$$

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

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

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

3. There are no alpha emitting COCs at this site. Therefore, concentrations for the alpha emitting COCs are less than the maximum allowable gross particle activity of 15 pCi/L and the 1/25th of the DCG.

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

Radionuclide	Time (years) 0	1	3	13	42	100	300	1000	MCL	Exceeds MCL?	Peak Conc.	Year of Peak
Cs-137	0	2.76E-03	7.90E-03	2.72E-02	4.49E-02	2.80E-02	8.24E-04	2.58E-10	60	No	4.49E-02	42
Eu-152	0	0	0	0	0	0	0	0	200	No	0.00E+00	0
Eu-154	0	0	0	0	0	0	0	0	60	No	0.00E+00	0

Bechtel Hanford, Inc.

CALCULATION SHEET

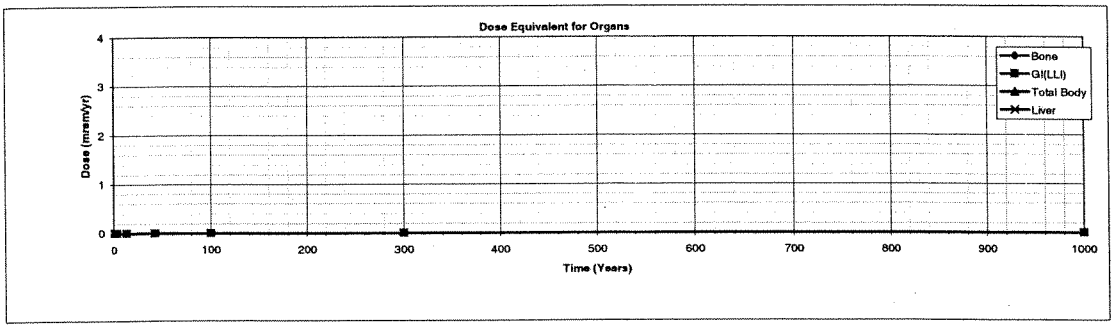
Originator: S. W. Clark — Date: 4/11/05 — Calc. No. 0100K-CA-V0047 — Rev. No. 0
Project: 100-K Remedial Action — Job 22192 — Checked S. W. Callison — Date 4-14-05
Subject: 100-K-55:1 Comparison to Drinking Water Standards (MCL) Calculation Brief — Sheet No. 3 of 3

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

Radionuclide	Time (years)								Organ	C_x	Exceeds 4 mrem/yr?	Peak Conc.	Year of Peak Conc.
	0	1	3	13	42	100	300	1000					
Cs-137	0	2.76E-03	7.90E-03	2.72E-02	4.49E-02	2.80E-02	8.24E-04	2.58E-10	Bone	80	No	4.49E-02	42
									GI(LLI)	2,000	No		
									Total Body	200	No		
									Liver	60	No		
Eu-152	0	0	0	0	0	0	0	0	Bone	30,000	No	0	NA
									GI(LLI)	200	No		
									Total Body	200,000	No		
									Liver	100,000	No		
Eu-154	0	0	0	0	0	0	0	0	Bone	5,000	No	0	NA
									GI(LLI)	60	No		
									Total Body	70,000	No		
									Liver	60,000	No		

Cumulative dose for each organ (with time)

Organ	Time (years)								Exceeds 4 mrem/yr?	Peak Conc.	Year of Peak Conc.		
	0	1	3	13	42	100	300	1000					
Bone	0.00E+00	1.38E-04	3.95E-04	1.36E-03	2.25E-03	1.40E-03	4.12E-05	1.29E-11	No	2.25E-03	42		
GI(LLI)	0.00E+00	5.52E-06	1.58E-05	5.44E-05	8.98E-05	5.60E-05	1.65E-06	5.16E-13	No	8.98E-05	42		
Total Body	0.00E+00	5.52E-05	1.58E-04	5.44E-04	8.98E-04	5.60E-04	1.65E-05	5.16E-12	No	8.98E-04	42		
Liver	0.00E+00	1.84E-04	5.27E-04	1.81E-03	2.99E-03	1.87E-03	5.49E-05	1.72E-11	No	2.99E-03	42		



CALCULATION COVER SHEET

Project Title:	100-K Remedial Action	**Job No.**	**22192**
Area	100-K		
Discipline	Environmental	***Calc. No.**	0100K-CA-V0052
Subject	100-K-56:1 Pipeline Variance Calculation		
Computer Program	Excel	**Program No.**	Excel 97

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 **X** **Preliminary** **Superseded**

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover - 1 Summary - 1 Calculations - 3 Total - 5	S. W. Callison SW Callison 7-12-05	M. T. Stankovich MTS 7/18/05	M. A. Buckmaster	M. A. Buckmaster	7/20/05

SUMMARY OF REVISIONS

Scanned	Rev.	Date	Bar Code No.

* Obtain Calc. No. from DIS.

DE01437.03 (12/09/2004)

CALCULATION SHEET

Bechtel Hanford Inc.

Originator	S. W. Callison SWC	Date	7/12/2005	Calc. No.	0100K-CA-V0052	Rev. No.	0
Project	100-K Remedial Action	Job No.	22192	Checked	M. T. Stankovich MTS	Date	7/19/05
Subject	100-K-56:1 Pipeline Variance Calculation					Sheet No.	1 of 4

Conclusion:
The required number of samples calculated (1 or 2 sample) for each decision sub-unit is less than the default number (4 samples) specified in the DOE/RL-96-22, Rev 4. Therefore, the default number of samples will be collected from each shallow zone decision sub-unit.

Problem:
Calculate the number of close out samples required for 100-K-56:1 Pipeline Shallow Unit verification sampling as required in "100 Area Remedial Action Sampling and Analysis Plan" (DOE/RL-96-22, Rev 4) and "Instruction Guide for the Remediation of 100 Areas Waste Sites" (0100X-IG-G0001, Rev 5).

Given:
1) Sample locations for the 100-K-56:1 Pipeline Decision Unit are identified on the 100-K-56:1 Pipelines Shallow Sample Design, Calculation number 0100K-CA-V0053, Rev. 0. SWC 7-20-05
2) Lookup values from DOE/RL-96-22, Rev 4.
3) Sample Design requirements from DOE/RL-96-22, Rev 4 and 0100X-IG-G0001, Rev 5.
4) Field sampling information from sampling logbook EL-1572-2 and EL-1572-3.

Solution:
Calculation methodology is described in Appendix A of DOE/RL-96-22, Rev 4. Data from attached worksheets are used to calculate the required number of closeout samples. Variance calculation is based on the same three isotopes used to develop the statistical approach in DOE/RL-96-22, Rev 4. The statistical design is based on the premise that these isotopes are the predominant components of the contamination and are representative of the contamination distribution.

Sheet No.	Contents	Topic
1	Calc. Summary	Summary of Calc Brief
2-4	Shallow Zone	Required Number of Samples Calculation

CALCULATION SHEET

Bechtel Hanford Inc.

Originator	S. W. Callison SWC	Date 7/12/2005	Calc. No.	0100K-CA-V0052	Rev. No.	0	
Project	100-K Remedial Action	Job No. 22192	Checked	M. T. Stankovich MTS	Date	7/18/05	
Subject	100-K-56:1 Pipeline Variance Calculation				Sheet No.	2 of 4	

Statistical Evaluation of Analytical Data

The required number of samples resulting from the calculation is highlighted at the bottom of the page.
Each value is reflective of the specific analyte evaluated.
The highest value of the three evaluations is used to determine the required number of samples as compared against the default of four.
Sample locations are from Calculation 0100K-CA-V0053. SWC 7-20-05
Mean, Standard Deviation, *t*, and Number of Samples formulas are from DOE/RL-96-22, Appendix A.

Decision Unit: Pipeline Shallow Zone
Samples values from GEA analysis
Sample Areas **A, B, C, D, & E**

Sample #	Sample Date	Location	Constituent: Cesium-137 pCi/g	Q	Europium-152 pCi/g	Q	Europium-154 pCi/g	Q
Look-up Value (HT) ==========>			**6.2**		**3.3**		**3.0**	
J03749	6/2/2005	S-A1-2	0.29		0.675		0.19	U
J03750	6/2/2005	S-A1-3	0.064	U	0.22	U	0.26	U
J03751	6/2/2005	S-A1-4	0.234		0.734		0.22	U
J03752	6/2/2005	S-A1-10	0.054	U	0.19	U	0.19	U
J03753	6/2/2005	S-A1-13	0.189		0.385		0.25	U
J03754	6/2/2005	S-A1-16	0.099		0.269		0.22	U
J03755	6/2/2005	S-A2-3	0.044	U	0.109		0.15	U
J03756	6/2/2005	S-A2-6	0.137		0.21	U	0.21	U
J03757	6/2/2005	S-A2-7	0.064	U	0.18	U	0.23	U
J03758	6/2/2005	S-A2-10	0.060	U	0.14	U	0.18	U
J03759	6/2/2005	S-A2-14	0.139		0.27	U	0.26	U
J03760	6/2/2005	S-A2-15	0.662		5.45		0.685	
J03761	6/2/2005	S-A3-1	0.162		0.400		0.22	U
J03762	6/2/2005	S-A3-2	0.233		0.24	U	0.19	U
J03763	6/2/2005	S-A3-4	0.124		0.217		0.22	U
J03764	6/2/2005	S-A3-5	0.045	U	0.14	U	0.14	U
J03765	6/2/2005	S-A3-9	0.353		0.093	U	0.25	U
J03766	6/2/2005	S-A3-11	0.427		0.178		0.17	U
J03767	6/6/2005	S-A4-3	0.095		0.470		0.18	U
J03768	6/6/2005	S-A4-4	0.174		1.11		0.15	U
J03769	6/6/2005	S-A4-7	0.390		1.25		0.249	
J03770	6/6/2005	S-A4-9	0.311		0.17	U	0.17	U
J03771	6/6/2005	S-A4-12	0.150		0.19	U	0.16	U
J03772	6/6/2005	S-A4-13	0.183		0.344		0.19	U
J03773	6/6/2005	S-B5-1	0.058	U	0.19	U	0.20	U
J03774	6/6/2005	S-B5-2	0.611		1.14		0.17	U
J03775	6/6/2005	S-B5-5	0.298		0.254		0.17	U
J03776	6/6/2005	S-B5-7	2.33		2.14		0.28	U
J03777	6/6/2005	S-B5-13	0.206		0.122	U	0.24	U
J03778	6/6/2005	S-B5-15	0.492		0.16	U	0.19	U
J03779	6/6/2005	S-B6-1	1.51		0.27	U	0.20	U
J03780	6/6/2005	S-B6-10	0.052	U	0.13	U	0.17	U
J03781	6/6/2005	S-B6-12	0.261		0.29	U	0.24	U
J03782	6/6/2005	S-B6-13	0.068	U	0.15	U	0.26	U
J03783	6/6/2005	S-B6-15	0.277		0.67		0.20	U
J03784	6/6/2005	S-B6-16	0.607		0.966		0.24	U
J03785	6/6/2005	S-B7-1	0.064	U	0.20	U	0.24	U
J03786	6/6/2005	S-B7-3	3.56		7.00		0.748	
J03787	6/6/2005	S-B7-4	1.32		1.84		0.28	U
J03788	6/6/2005	S-B7-5	0.091		0.17	U	0.20	U
J03789	6/6/2005	S-B7-8	0.117		0.21	U	0.18	U
J03790	6/6/2005	S-B7-11	0.051	U	0.12	U	0.19	U
J03791	6/6/2005	S-B8-2	0.066		0.24	U	0.25	U
J03792	6/6/2005	S-B8-3	0.057	U	0.19	U	0.18	U
J03793	6/6/2005	S-B8-4	0.057	U	0.11	U	0.20	U
J03794	6/6/2005	S-B8-8	0.065	U	0.22	U	0.24	U
J03795	6/6/2005	S-B8-12	0.054	U	0.19	U	0.19	U
J03796	6/6/2005	S-B8-13	0.057	U	0.12	U	0.16	U
J03797	6/7/2005	S-C9-3	0.042	U	0.15	U	0.15	U
J03798	6/7/2005	S-C9-4	0.071	U	0.18	U	0.18	U
J03799	6/7/2005	S-C9-5	0.049	U	0.17	U	0.19	U
J037B0	6/7/2005	S-C9-10	0.047	U	0.17	U	0.16	U
J037B1	6/7/2005	S-C9-14	0.054	U	0.14	U	0.20	U
J037B2	6/7/2005	S-C9-16	0.064	U	0.22	U	0.27	U
J037B3	6/7/2005	S-C10-3	0.043	U	0.15	U	0.14	U
J037B4	6/7/2005	S-C10-4	0.064		0.12	U	0.17	U
J037B5	6/7/2005	S-C10-8	0.054	U	0.17	U	0.20	U
J037B6	6/7/2005	S-C10-10	0.567		0.19	U	0.17	U

Shallow Zone

CALCULATION SHEET

Bechtel Hanford Inc.

Originator	S. W. Callison SWC	Date	7/12/2005	Calc. No.	0100K-CA-V0052	Rev. No.	0
Project	100-K Remedial Action	Job No.	22192	Checked	M. T. Stankovich MTS	Date	7/19/05
Subject	100-K-56:1 Pipeline Variance Calculation					Sheet No.	3 of 4

1 Statistical Evaluation of Analytical Data
2
3 The required number of samples resulting from the calculation is highlighted at the bottom of the page.
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6 against the default of four.
7 Sample locations are from Calculation 0100K-CA-V00 53. SWC 7-20-05
8 Mean, Standard Deviation,*t*, and Number of Samples formulas are from DOE/RL-96-22, Appendix A.
9
10
11 Decision Unit: Pipeline Shallow Zone
12 Samples values from GEA analysis
13 Sample Areas **A, B, C, D, & E**

14 Sample #	Sample Date	Location	Constituent: Cesium-137 pCi/g	Q	Europium-152 pCi/g	Q	Europium-154 pCi/g	Q
15								
16 **Look-up Value (HT) ==========>**			**6.2**		**3.3**		**3.0**	
17 J037B7	6/7/2005	S-C10-14	0.068	U	0.13	U	0.20	U
18 J037B8	6/7/2005	S-C10-16	0.300		0.21	U	0.26	U
19 J037B9	6/8/2005	S-C1-2	0.088	U	0.18	U	0.24	U
20 J037C0	6/8/2005	S-C1-3	0.069		0.24	U	0.25	U
21 J037C1	6/8/2005	S-C1-4	0.064	U	0.22	U	0.24	U
22 J037C2	6/8/2005	S-C1-10	0.427		0.29	U	0.30	U
23 J037C3	6/8/2005	S-C1-13	0.153		0.22	U	0.24	U
24 J037C4	6/8/2005	S-C1-16	0.050	U	0.25	U	0.12	U
25 J037C5	6/9/2005	S-C2-3	0.12	U	0.13	U	0.25	U
26 J037C6	6/9/2005	S-C2-6	0.055	U	0.14	U	0.24	U
27 J037C7	6/9/2005	S-C2-7	0.158		0.24	U	0.26	U
28 J037C8	6/9/2005	S-C2-10	0.12	U	0.18	U	0.26	U
29 J037C9	6/9/2005	S-C2-14	0.106		0.133		0.17	U
30 J037D0	6/9/2005	S-C2-15	0.071	U	0.22	U	0.23	U
31 J037D1	6/9/2005	S-D3-1	0.527		1.48		0.36	U
32 J037D2	6/9/2005	S-D3-2	0.051	U	0.12	U	0.23	U
33 J037D3	6/9/2005	S-D3-4	0.061	U	0.22	U	0.25	U
34 J037D4	6/9/2005	S-D3-5	0.071	U	0.16	U	0.22	U
35 J037D5	6/9/2005	S-D3-9	0.064	U	0.12	U	0.21	U
36 J037D6	6/9/2005	S-D3-11	0.066	U	0.24	U	0.25	U
37 J037D7	6/8/2005	S-D4-3	0.070	U	0.17	U	0.24	U
38 J037D8	6/8/2005	S-D4-4	0.052	U	0.12	U	0.20	U
39 J037D9	6/8/2005	S-D4-7	0.066	U	0.23	U	0.23	U
40 J037F0	6/8/2005	S-D4-9	0.076	U	0.22	U	0.31	U
41 J037F1	6/8/2005	S-D4-12	0.074	U	0.17	U	0.25	U
42 J037F2	6/8/2005	S-D4-13	0.086	U	0.29	U	0.32	U
43 J037F3	6/9/2005	S-D5-1	0.061	U	0.13	U	0.19	U
44 J037F4	6/9/2005	S-D5-2	0.032	U	0.090	U	0.15	U
45 J037F5	6/9/2005	S-D5-5	0.046		0.17	U	0.19	U
46 J037F6	6/9/2005	S-D5-7	0.080	U	0.476		0.26	U
47 J037F7	6/9/2005	S-D5-13	0.045	U	0.11	U	0.15	U
48 J037F8	6/9/2005	S-D5-15	0.055	U	0.19	U	0.19	U
49 J037F9	6/9/2005	S-D6-1	0.060	U	0.17	U	0.29	U
50 J037H0	6/9/2005	S-D6-10	0.060	U	0.14	U	0.26	U
51 J037H1	6/9/2005	S-D6-12	0.414		0.582		0.27	U
52 J037H2	6/9/2005	S-D6-13	1.88		1.35		0.30	U
53 J037H3	6/9/2005	S-D6-15	0.160		1.41		0.28	U
54 J037H4	6/9/2005	S-D6-16	0.214		1.06		0.27	U
55 J037H5	6/13/2005	S-E7-1	0.347		1.42		0.30	U
56 J037H6	6/13/2005	S-E7-3	0.788		1.10		0.36	U
57 J037H7	6/13/2005	S-E7-4	0.703		0.923		0.28	U
58 J037H8	6/13/2005	S-E7-5	0.137		0.26	U	0.27	U
59 J037H9	6/13/2005	S-E7-8	0.320		0.747		0.32	U
60 J037J0	6/13/2005	S-E7-11	0.104		0.271		0.24	U
61 J037J1	6/13/2005	S-E8-2	0.303		0.788		0.32	U
62 J037J2	6/13/2005	S-E8-3	0.069	U	0.19	U	0.26	U
63 J037J3	6/13/2005	S-E8-4	0.220		0.806		0.26	U
64 J037J4	6/13/2005	S-E8-8	0.117		0.28	U	0.28	U
65 J037J5	6/13/2005	S-E8-12	0.11	U	0.282		0.24	U
66 J037J6	6/13/2005	S-E8-13	0.053	U	0.14	U	0.20	U
67 J037J7	6/13/2005	S-E9-3	0.080	U	0.25	U	0.25	U
68 J037J8	6/13/2005	S-E9-4	0.117		0.21	U	0.29	U
69 J037J9	6/13/2005	S-E9-5	0.127		0.658		0.30	U
70 J037K0	6/13/2005	S-E9-10	0.235		0.27	U	0.28	U
71 J03JN1*	6/28/2005	S-E9-14	0.293		13.3		1.97	
72 J037K2	6/13/2005	S-E9-16	0.552		0.824		0.23	U
73 J037K3	6/13/2005	S-E10-3	0.066	U	0.22	U	0.26	U
74 J037K4	6/13/2005	S-E10-4	0.16	U	0.207		0.34	U
75 J037K5	6/13/2005	S-E10-8	0.158		0.121	U	0.24	U

Shallow Zone

CALCULATION SHEET

Bechtel Hanford Inc.

Originator	S. W. Callison SWC	Date	7/12/2005	Calc. No.	0100K-CA-V0052	Rev. No.	0
Project	100-K Remedial Action	Job No.	22192	Checked	M. T. Stankovich MTS	Date	7/25/05
Subject	100-K-56:1 Pipeline Variance Calculation					Sheet No.	1 of 4

Statistical Evaluation of Analytical Data

The required number of samples resulting from the calculation is highlighted at the bottom of the page.
Each value is reflective of the specific analyte evaluated.
The highest value of the three evaluations is used to determine the required number of samples as compared against the default of four.
Sample locations are from Calculation 0100K-CA-V00 53 SWC 7-20-05
Mean, Standard Deviation, t, and Number of Samples formulas are from DOE/RL-96-22, Appendix A.

Decision Unit: Pipeline Shallow Zone
Samples values from GEA analysis
Sample Areas **A, B, C, D, & E**

Sample #	Sample Date	Location	Constituent: Cesium-137 pCi/g	Q	Europium-152 pCi/g	Q	Europium-154 pCi/g	Q
Look-up Value (HT) ==========>			**6.2**		**3.3**		**3.0**	
J037K6	6/13/2005	S-E10-10	0.465		0.26	U	0.27	U
J037K7	6/13/2005	S-E10-14	0.341		0.347		0.26	U
J037K8	6/13/2005	S-E10-16	0.083		0.121		0.20	U
Mean (LV) ==========>			0.26		0.52		0.25	
Standard Deviation (S) ==========>			0.48		1.35		0.19	
α (5%) ==========>			1.645		1.645		1.645	
β (20%) ==========>			0.842		0.842		0.842	
Number of Samples ==========>			**1**		**2**		**1**	

* - Sample J03JN1 was collected following additional remediation in the area. Replaced sample J037K1.

CALCULATION COVER SHEET

(Sample Design, Verification, or Waste Characterization Calculation)

Project Title:	**100-K-56:1 Pipelines Sample Design**	**Job No.**	**22192**
Area	**100-K**		
Discipline	**Environmental Engineering**	**Calc. No.**	**0100K-CA-V0053**
Subject	**100-K-56:1 Pipelines Shallow and Deep Zone Sampling Plan**		
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 conjuction with other relevent documents in the administrative record.

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

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover = 1 Sht Calc = 2 Shts Attach1 = 1 Sht Attach2 = 1 Sht Attach3 = 3 Shts Total = 8 Shts	G. Cruz 7/14/05	C.A. Bentz 7/14/05	R.T. Coffman 7/14/05	S.W. Callison 7-18-05	7-18-05
SUMMARY OF REVISIONS						

*Obtain Calc. No. from DIS

January 2003

DE01-437.03

Bechtel Hanford, Inc. **CALCULATION SHEET**

Originator G. Cruz Date 7/13/2005 Calc. No. 0100K-CA-V0053 Rev. No. 0

Project 100-K-56:1 Pipelines Sample Design Job No. 22192 Checked CAB Date 7/14/05

Subject 100-K-56:1 Pipelines Shallow and Deep Zone Sampling Plan Sheet No. 1 of 2

1	**Problem:**	Calculate and display required sampling nodes in concurrence with 100 Area		
2		SAP DOE/RL-96-22 Rev. 3 for verification and closure.		
3				
4	**Given:**	-SAP (DOE/RL-96-22 Rev. 3) and IG (0100X-IG-G0001 Rev. 5) requirements		
5		-Shallow Sampling Area (Surface area of each zone determined from CAD program,		
6		Attachment 3, Sht 1of3, CAD file 1K:071305A, 100-K-56:1 Pipelines Shallow Zone Sampling Plan		
7		Attachment 3, Sht 2of3, CAD file 1K:071305B, 100-K-56:1 Pipelines Sample Location Table		
8		Attachment 3, Sht 3of3, CAD file 1K:071305C, 100-K-56:1 Pipelines Deep Zone Sampling Plan		
9				
10				
11				
12				
13	**SAP and IG Requirements:**			
14		-Develop a 16 node sampling grid for the sampling area		
15	Shallow Zone	-Use appendix A of the IG to determine which six of the sixteen will be sampled		
16		to collect variance and verification samples		
17				
18		-Develop a 16 node sampling grid for the sampling area		
19	Overburden:	-Use appendix A of the IG to determine which six of the sixteen will be sampled		
20		to collect variance and verification samples		
21				
22		-Develop a 16 node sampling grid for the sampling area		
23	Deep Zone:	-Use appendix A of the IG to determine which four of the sixteen will be sampled		
24		to collect verification samples		
25				
26	**Determination of Shallow Zone Sampling Grid:**			
27				
28	Shallow Zone Sampling Grid Area determined from Table 5-1, IG			
29	Attachment 2, Number of Decision Subunits Based on Area (Converted to Sq Meters)			
30				
31	Total Area:	19843.66	m^2	
32	Area of Decision Subunits (total area 5 subunits)	3968.73	m^2	
33				
34	Decision Subunit divided into 4 Sampling Areas:	992.18	m^2	
35				
36	Sampling Areas divided into a 16 node grid (node numbers 1-16):	62.01	m^2	
37				
38	Nodes to be Sampled (as determined from Attachment 1, Sample Grid Point Lookup Table)			
39		See Attachment 3, Sht 2of3, 100-K-56:1 Pipelines Sample Location Table,		
40		for Sample Location Table		
41				
42				
43				
44				

Bechtel Hanford, Inc. **CALCULATION SHEET**

Originator G. Cruz Date 7/13/2005 Calc. No. 0100K-CA-V0053 Rev. No. 0

Project 100-K-56:1 Pipelines Sample Design Job No. 22192 Checked CAB Date 7/14/05

Subject 100-K-56:1 Pipelines Shallow and Deep Zone Sampling Plan Sheet No. 2 of 2

Determination of Deep Zone Sampling Grid:

Deep Zone Sampling Grid Area determined from Table 5-1, IG
Attachment 2, Number of Decision Subunits Based on Area (Converted to Sq Meters)

Total Area:	11131.02	m^2
Area of Decision Subunits (total area 3 subunits)	3710.34	m^2
Decision Subunits divided into 3 Sampling Areas:	1236.78	m^2
Sampling Areas divided into a 16 node grid (node numbers 1-16):	77.29	m^2

Nodes to be Sampled (as determined from Attachment 1, Table A-1, Sample Grid Point Lookup Table)

See Attachment 3, Sht 3of3, 100-K-56:1 Pipelines Deep Zone Sampling Plan, for Sample Location Table

Bechtel Hanford, Inc.

Originator G. Cruz Date 7/13/2005 Calc. No. 0100K-CA-V0053 Rev. No. 0

Project 100-K-56:1 Pipelines Sample Design Job No. 22192 Checked CSB Date 7/14/05

Subject 100-K-56:1 Pipelines Shallow and Deep Zone Sampling Plan Sheet No 1 of 1

ATTACHMENT 1

Sample Grid Point Lookup Table.

Default Plan	Sampling Area 1	Sampling Area 2	Sampling Area 3	Sampling Area 4	Sampling Area 5	Sampling Area 6	Sampling Area 7	Sampling Area 8	Sampling Area 9	Sampling Area 10
Variance/Verification	3	6	1	4	5	1	3	3	4	16
Variance/Verification	4	7	11	3	15	15	5	13	10	10
Variance/Verification	16	3	2	7	7	10	11	4	3	14
Variance/Verification	10	15	4	12	1	13	4	8	16	4
Variance	2	14	5	9	13	12	8	2	14	8
Variance	13	10	9	13	2	16	1	12	5	3
Not Sampling	6	1	10	8	14	4	16	5	8	6
Not Sampling	1	9	13	1	10	5	12	1	1	15
Not Sampling	9	12	7	5	6	2	6	7	15	9
Not Sampling	15	16	15	14	16	6	2	15	11	1
Not Sampling	8	13	8	10	12	11	13	14	2	12
Not Sampling	5	2	3	11	4	3	9	10	7	11
Not Sampling	7	11	14	15	11	14	14	6	13	2
Not Sampling	11	4	6	2	9	7	7	11	9	7
Not Sampling	12	8	16	16	3	8	15	9	6	13
Not Sampling	14	5	12	6	8	9	10	16	12	5

** **Note:** Grid nodes for each sampling area in each waste site should be numbered consistently, e.g., begin numbering the nodes in the northwestern-most node, then number consecutively left to right.

Bechtel/Hanford, Inc.

Originator G. Cruz Date 7/13/2005 Calc. No. 0100K-CA-V0053 Rev. No. 0

Project 100-K-56:1 Pipelines Sample Design Job No. 22192 Checked CAB Date 7/14/05

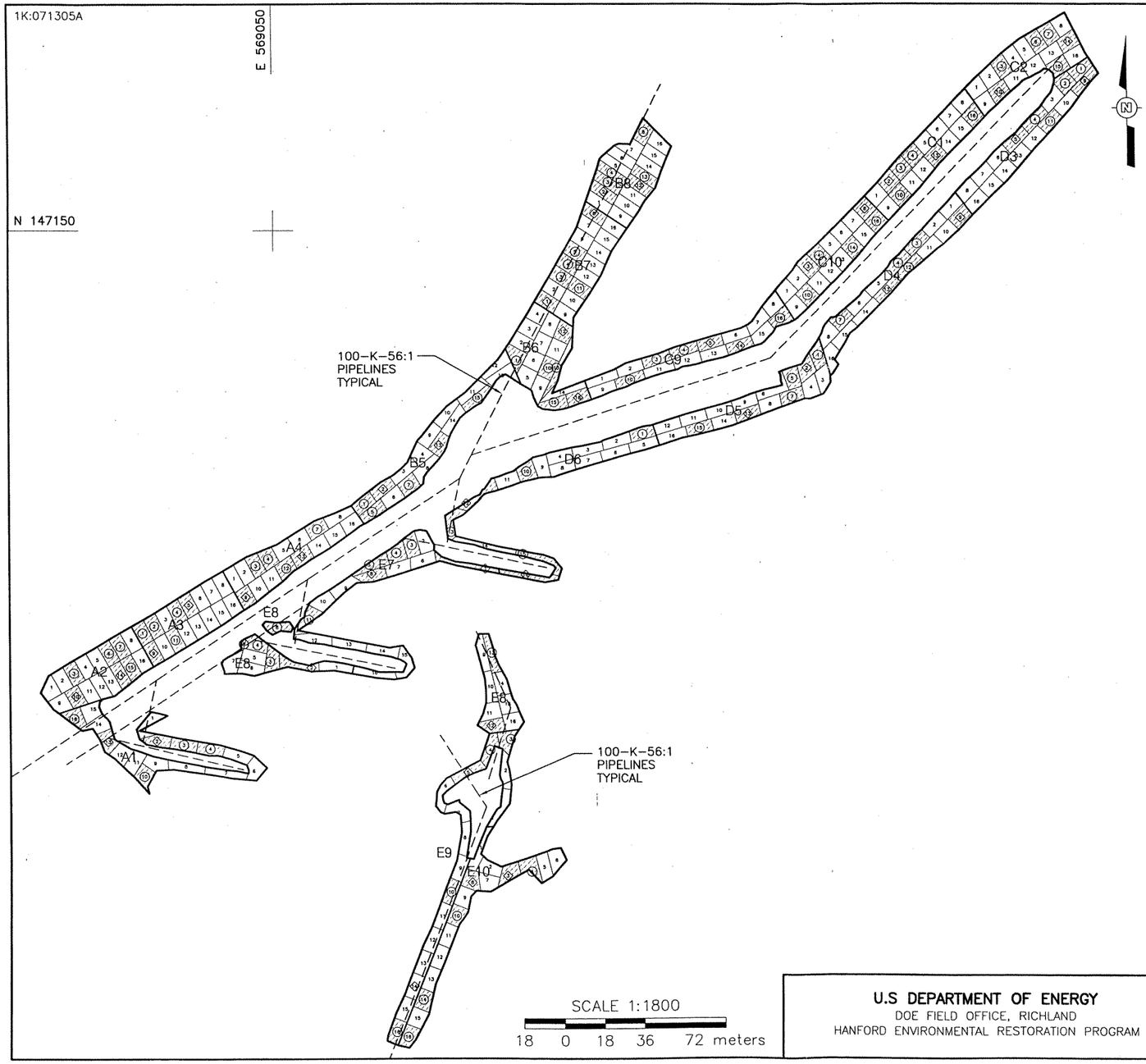
Subject 100-K-56:1 Pipelines Shallow and Deep Zone Sampling Plan Sheet No. 1 of 1

ATTACHMENT 2

Number of Decision Subunits Based on Area.

Area of Primary Decision Unit (m2)	Number of Subunits
<1,394	1
>1,394 to <2,326	2
>2,326 to <3,256	3
>3,256 to <4,186	4
>4,186 to <9,303	2
>9,303 to <13,024	3
>13,024 to <16,745	4
>16,745 to <20,466	5
>20,466	ROUNDa (Area/3,720)

a ROUND is an integer rounding function.



SCALE 1:1800

18 0 18 36 72 meters

NOTES

1. SHALLOW ZONE NODE AREAS ARE APPROXIMATELY 62.01 SQUARE METERS.
2. SAMPLES ARE TAKEN FROM THE APPROXIMATE CENTER OF EACH NODE.
3. THE SHALLOW ZONE CONSISTS OF SAMPLING AREAS A1, A2, A3 AND A4 WITHIN DECISION SUBUNIT 1. AREAS B5, B6, B7, AND B8 WITHIN DECISION SUBUNIT 2. AREAS C9, C10, C1, AND C2 WITHIN DECISION SUBUNIT 3. AREAS D3, D4, D5, AND D6 WITHIN DECISION SUBUNIT 4. AREAS E7, E8, E9, AND E10 WITHIN DECISION SUBUNIT 5.
4. SEE ATTACHMENT 3 SHEET 2 OF 3 FOR SAMPLE LOCATION TABLE.

LEGEND

(8) VARIANCE AND VERIFICATION SAMPLING NODE

(8) VERIFICATION SAMPLING NODE

Attachment 3 Sheet No. 1 of 3
Originator G.C.B.L Date 7/14/05
Chk'd By AB Date 7/14/05
Calc. No. D100K-CA-V0053 Rev. No. 0

ATTACHMENT 3

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

100 K AREA
100–K–56:1 PIPELINES
SHALLOW ZONE SAMPLING PLAN

1K:071305B

SAMPLE LOCATION TABLE

DECISION SUBUNIT	SAMPLING AREA	SAMPLE NODE	NORTHING	EASTING
1	A1	S-A1-2	146920.60	568995.62
		S-A1-3	146918.93	569008.01
		S-A1-4	146917.18	569019.75
		S-A1-10	146904.84	568989.87
		S-A1-13	146920.36	568973.78
		S-A1-16	146930.64	568958.78
	A2	S-A2-3	146951.07	568958.79
		S-A2-6	146960.05	568974.39
		S-A2-7	146963.04	568979.44
		S-A2-10	146940.68	568959.72
		S-A2-14	146950.35	568979.44
		S-A2-15	146953.75	568984.16
	A3	S-A3-1	146969.03	568989.53
		S-A3-2	146972.12	568994.88
		S-A3-4	146978.51	569005.48
		S-A3-5	146981.68	569010.70
		S-A3-9	146960.07	568994.52
		S-A3-11	146965.97	569004.69
	A4	S-A4-3	146999.18	569040.92
		S-A4-4	147002.29	569046.77
		S-A4-7	147015.64	569068.91
		S-A4-9	146985.18	569036.39
		S-A4-12	146998.13	569054.99
		S-A4-13	147003.47	569062.10
2	B5	S-B5-1	147026.96	569089.94
		S-B5-2	147033.60	569098.49
		S-B5-5	147023.34	569093.72
		S-B5-7	147035.43	569110.07
		S-B5-13	147053.26	569123.54
		S-B5-15	147074.73	569141.51
	B6	S-B6-1	147091.45	569159.20
		S-B6-10	147088.08	569173.29
		S-B6-12	147104.66	569179.96
		S-B6-13	147088.24	569176.91
		S-B6-15	147072.72	569175.64
		S-B6-16	147074.78	569186.61
	B7	S-B7-1	147118.02	569172.88
		S-B7-3	147129.12	569179.19
		S-B7-4	147134.71	569182.38
		S-B7-5	147140.34	569185.60
		S-B7-8	147157.40	569194.15
		S-B7-11	147123.95	569187.44
	B8	S-B8-2	147167.00	569198.36
		S-B8-3	147171.32	569200.31
		S-B8-4	147175.48	569202.08
		S-B8-8	147193.72	569216.63
		S-B8-12	147169.93	569214.54
		S-B8-13	147173.69	569217.01
3	C9	S-C9-3	147092.02	569222.12
		S-C9-4	147096.21	569234.41
		S-C9-5	147099.52	569246.12
		S-C9-10	147082.87	569210.06
		S-C9-14	147098.25	569259.69
		S-C9-16	147110.50	569277.83
	C10	S-C10-3	147133.74	569290.35
		S-C10-4	147138.71	569295.17
		S-C10-8	147159.55	569316.04
		S-C10-10	147120.98	569290.04
		S-C10-14	147142.15	569310.64
		S-C10-16	147153.83	569321.39
	C1	S-C1-2	147171.61	569327.14
		S-C1-3	147177.43	569332.53
		S-C1-4	147183.01	569337.88
		S-C1-10	147165.38	569332.15
		S-C1-13	147183.05	569348.29
		S-C1-16	147200.81	569365.09
	C2	S-C2-3	147222.79	569378.36
		S-C2-6	147233.80	569393.53
		S-C2-7	147237.33	569399.04
		S-C2-10	147211.42	569377.05
		S-C2-14	147234.07	569407.66
		S-C2-15	147222.78	569403.14

DECISION SUBUNIT	SAMPLING AREA	SAMPLE NODE	NORTHING	EASTING
4	D3	S-D3-1	147221.89	569413.31
		S-D3-2	147215.31	569406.24
		S-D3-4	147199.19	569392.70
		S-D3-5	147190.28	569384.13
		S-D3-9	147216.53	569414.96
		S-D3-11	147198.42	569399.35
	D4	S-D4-3	147143.95	569339.59
		S-D4-4	147135.14	569331.25
		S-D4-7	147109.71	569304.67
		S-D4-9	147155.54	569359.16
		S-D4-12	147133.19	569335.93
		S-D4-13	147123.28	569326.15
	D5	S-D5-1	147093.97	569294.49
		S-D5-2	147088.17	569289.53
		S-D5-5	147083.40	569283.00
		S-D5-7	147075.17	569282.97
		S-D5-13	147067.56	569263.07
		S-D5-15	147061.16	569241.07
	D6	S-D6-1	147058.36	569215.49
		S-D6-10	147041.47	569163.28
		S-D6-12	147027.18	569136.01
		S-D6-13	147014.27	569128.86
		S-D6-15	147004.32	569161.48
		S-D6-16	146995.03	569162.61
5	E7	S-E7-1	146997.78	569144.47
		S-E7-3	147008.40	569111.15
		S-E7-4	147004.90	569104.21
		S-E7-5	146999.58	569092.04
		S-E7-8	146995.55	569093.09
		S-E7-11	146974.97	569064.80
	E8	S-E8-2	146953.46	569065.80
		S-E8-3	146956.23	569047.26
		S-E8-4	146963.70	569041.51
		S-E8-8A	146964.16	569035.33
		S-E8-8B	146971.67	569050.55
		S-E8-12	146927.31	569146.55
		S-E8-13	146960.03	569147.14
	E9	S-E9-3	146921.21	569155.43
		S-E9-4	146916.39	569146.03
		S-E9-5	146906.36	569135.79
		S-E9-10	146853.41	569127.60
		S-E9-14	146811.64	569110.73
		S-E9-16	146791.53	569102.87
	E10	S-E10-3	146860.49	569153.58
		S-E10-4	146862.41	569164.29
		S-E10-8	146857.63	569137.37
		S-E10-10	146842.84	569130.12
		S-E10-14	146805.73	569114.75
		S-E10-16	146789.30	569107.97

NOTES

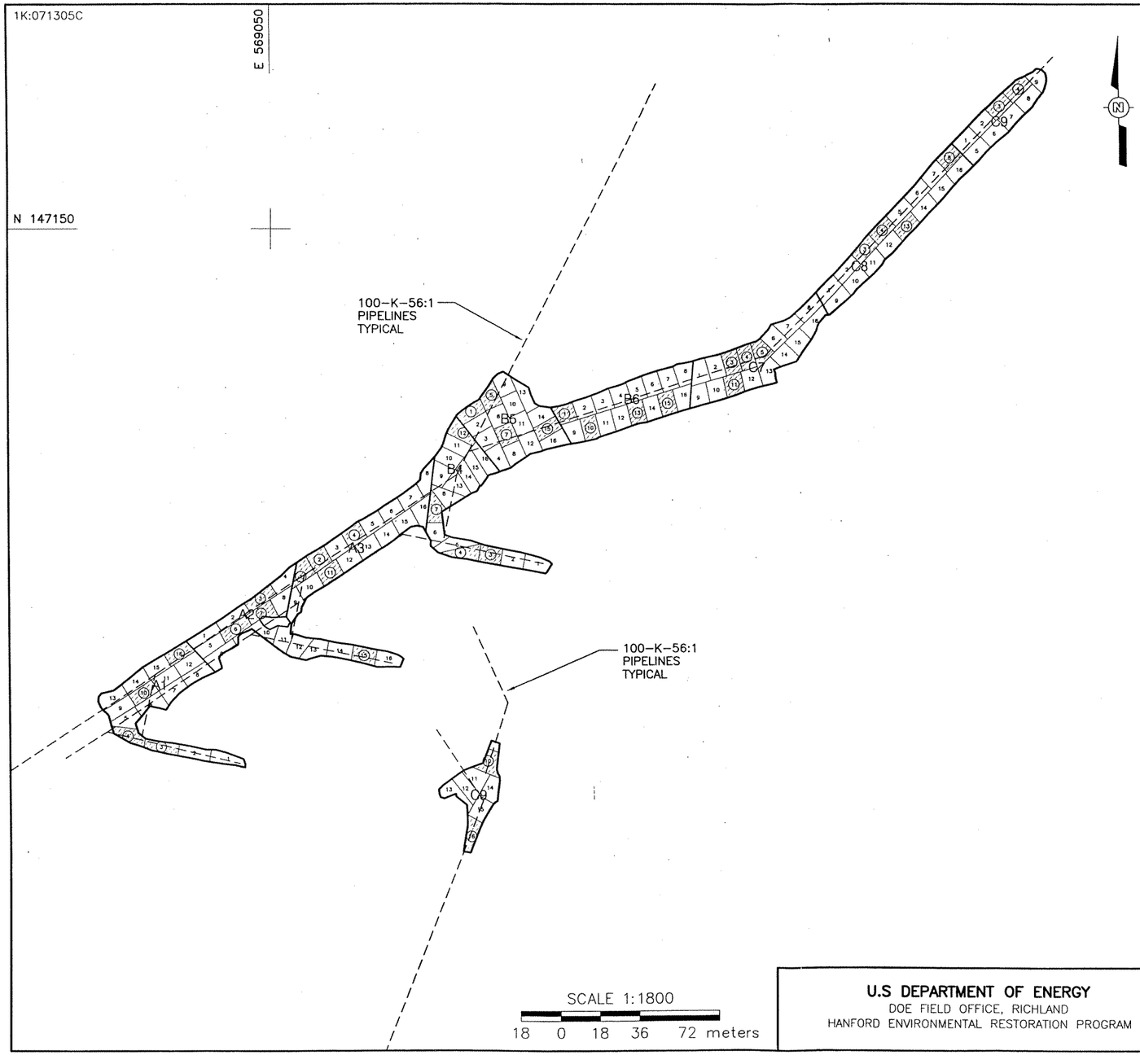
1. SEE ATTACHMENT 3 SHEET 1 OF 3 FOR SAMPLING PLAN.

Attachment 3 Sheet No. 2 of 3
Originator G. CRUZ Date 7/14/05
Chk'd By CAB Date 7/14/05
Calc. No. 0100K-CA-V0053 Rev. No. 0

ATTACHMENT 3

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

100 K AREA
100-K-56:1 PIPELINES
SHALLOW ZONE SAMPLE LOCATION TABLE



NOTES

1. DEEP ZONE NODE AREAS ARE APPROXIMATELY 77.29 SQUARE METERS.
2. SAMPLES ARE TAKEN FROM THE APPROXIMATE CENTER OF EACH NODE.
3. THE DEEP ZONE CONSISTS OF SAMPLING AREAS A1, A2, AND A3 WITHIN DECISION SUBUNIT 1. AREAS B4, B5, AND B7 WITHIN DECISION SUBUNIT 2. AREAS C8, C9, AND C10, WITHIN DECISION SUBUNIT 3.

LEGEND

VARIANCE AND VERIFICATION SAMPLING NODE

VERIFICATION SAMPLING NODE

SAMPLE LOCATION TABLE

DECISION SUBUNIT	SAMPLING AREA	SAMPLE NODE	NORTHING	EASTING
1	A1	D-A1-3	146915.39	568998.38
		D-A1-4	146920.25	568982.92
		D-A1-10	146939.74	568990.26
		D-A1-16	146957.29	569007.05
	A2	D-A2-3	146982.35	569044.36
		D-A2-6	146968.55	569033.00
		D-A2-7	146975.61	569044.73
		D-A2-15	146956.50	569090.68
	A3	D-A3-1	146992.29	569062.76
		D-A3-2	147000.01	569071.14
		D-A3-4	147010.93	569086.75
		D-A3-11	146994.01	569075.83
2	B4	D-B4-3	147002.17	569148.24
		D-B4-4	147003.11	569134.53
		D-B4-7	147022.64	569123.80
		D-B4-12	147057.28	569136.15
	B5	D-B5-1	147067.05	569139.68
		D-B5-5	147074.58	569149.02
		D-B5-7	147056.56	569155.70
		D-B5-15	147059.34	569174.25
	B6	D-B6-1	147066.11	569182.10
		D-B6-10	147059.72	569193.85
		D-B6-13	147066.58	569215.33
		D-B6-15	147070.98	569229.27
3	C7	D-C7-3	147089.62	569258.23
		D-C7-4	147092.02	569265.03
		D-C7-5	147094.11	569272.18
		D-C7-11	147079.49	569259.19
	C8	D-C8-3	147140.47	569318.79
		D-C8-4	147149.05	569326.71
		D-C8-8	147181.73	569357.26
		D-C8-13	147150.85	569337.74
	C9	D-C9-3	147204.85	569380.01
		D-C9-4	147212.67	569388.65
		D-C9-10	146908.96	569146.32
		D-C9-16	146875.16	569138.56

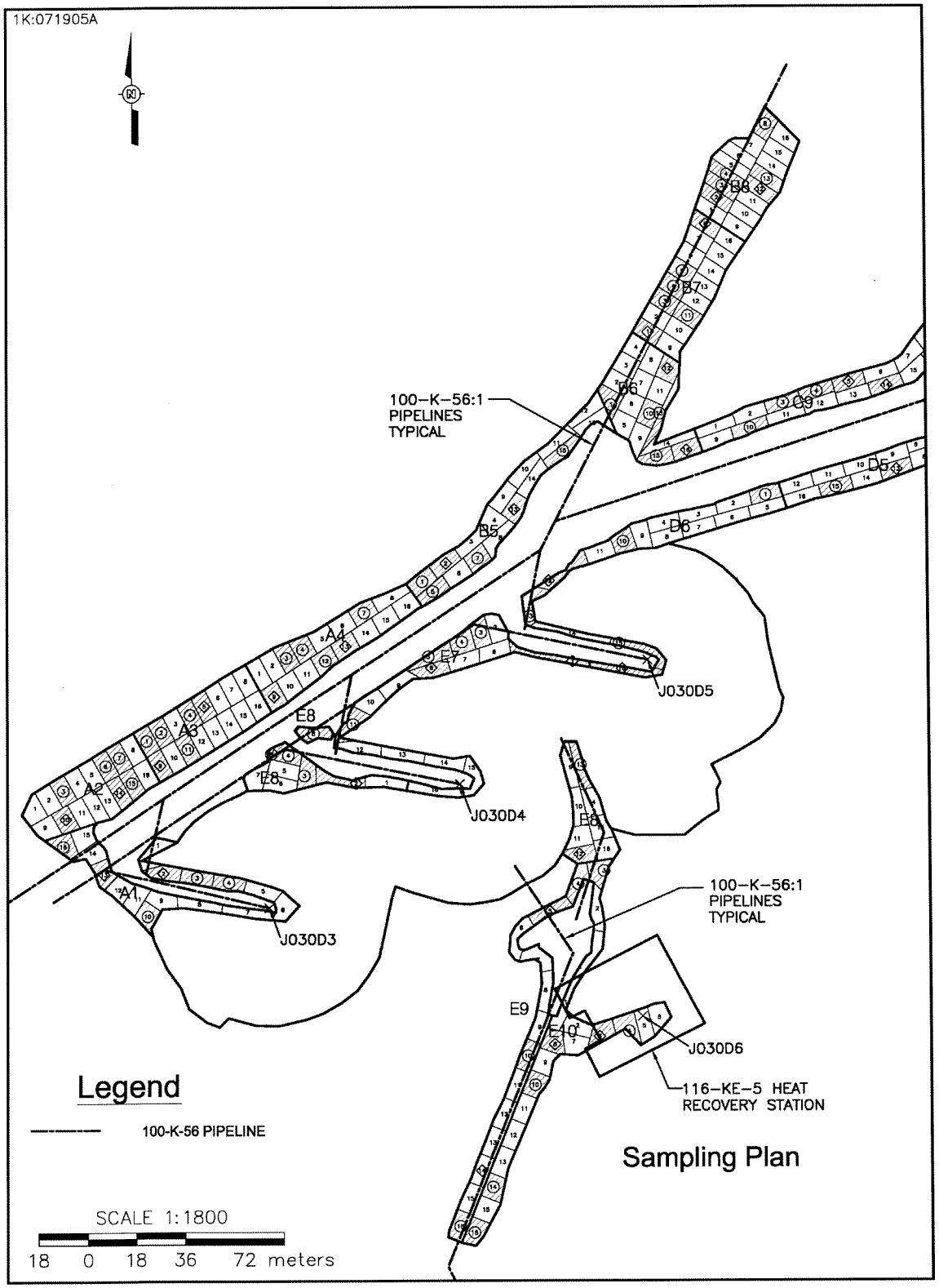
Attachment 3 Sheet No. 3 of 3
Originator G. CRUZ Date 7/14/05
Chk'd By CSB Date 7/14/05
Calc. No. 0100K-CA-V0053 Rev. No. 0

ATTACHMENT 3

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

100 K AREA
100-K-56:1 PIPELINES
DEEP ZONE SAMPLING PLAN

116-KE-4 and 116-KE-5 Discrete Sample Location Map



CALCULATION COVER SHEET

Project Title:	100-K Area Remedial Action	**Job No.**	22192
Area	100-K		
Discipline	Environmental	***Calc. No.**	0100K-CA-V0049
Subject	100-K-56:1 Pipeline Cleanup Verification 95% UCL Calculation		
Computer Program	Excel	**Program No.**	Excel 2003

The attached calculations have been generated to document compliance with established cleanup levels. These 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 Sheets = 5 Total = 6	J. M. Capron 7/21/05	T. M. Blakley 7/21/05 T. B. Miley 7-22-05	L. M. Dittmer 7/25/05	S. W. Callison 7-26-05	7-26-05

SUMMARY OF REVISIONS

* Obtain calc no. from DIS

DE01437.03 (12/09/2004)

Bechtel Hanford, Inc.

CALCULATION SHEET

Originator J. M. Capron JMC
Project 100-K Area Remedial Action
Subject 100-K-56:1 Pipeline Cleanup Verification 95% UCL Calculation

Date 07/21/05
Job No. 22192

Calc. No. 0100K-CA-V0049
Checked T. M. Blakley TMB
Checked T. B. Miley TBM

Rev. No. 0
Date 7/21/05
Date 7.22.05
Sheet No. 1 of 5

Purpose:
Calculate the 95% upper confidence limit (UCL) to evaluate compliance with cleanup standards for the subject site. Also, calculate the carcinogenic risk for applicable nonradionuclide analytes, perform the *Washington Administrative Code* (WAC) 173-340 (Model Toxics Control Act [MTCA]) 3-part test, if required, and calculate the relative percent difference (RPD) for each contaminant of concern (COC). There are no nonradionuclide COCs for this site; therefore, the carcinogenic risk and MTCA 3-part test are not required.

Table of Contents:

Given/References:
1) Sample Results
2) All lookup values and remedial action goals (RAGs) are taken from the Remedial Design Report/Remedial Action Work Plan (RDR/RAWP) (DOE-RL 2005b) and Ecology (1996) unless otherwise specified.
3) DOE-RL, 2005a, *100 Area Remedial Action Sampling and Analysis Plan*, DOE/RL-96-22, Rev. 4, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
4) DOE-RL, 2005b, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, DOE/RL-96-17, Rev. 5, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
5) Ecology, 1992, *Statistical Guidance for Ecology Site Managers*, Publication #92-54, Washington State Department of Ecology, Olympia, Washington.
6) Ecology, 1993, *Statistical Guidance for Ecology Site Managers, Supplement S-6, Analyzing Site or Background Data with Below-Detection Limit or Below-PQL Values (Censored Data Sets)*, Publication #92-54, Washington State Department of Ecology, Olympia, Washington.
7) Ecology, 1996, *Model Toxics Control Act Cleanup Levels and Risk Calculations (CLARC II)*, Publication #94-145, Washington State Department of Ecology, Olympia, Washington.
8) EPA, 1994, *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*, EPA 540/R-94/013, U.S. Environmental Protection Agency, Washington, D.C.
9) WAC 173-340, 1996, "Model Toxics Control Act--Cleanup," *Washington Administrative Code*.

Solution:
Calculation methodology is described in Ecology Pub. #92-54 (Ecology 1992, 1993), below, and in the RDR/RAWP (DOE-RL 2005b). Use data from the attached worksheets to calculate the 95% UCL, carcinogenic risk, perform the WAC 173-340 3-part test for nonradionuclides, and calculate the RPD for each COC.

Calculation Description:
The subject calculations were performed on data from soil verification samples from waste site 100-K-56:1. The data were entered into an EXCEL 2003 spreadsheet and calculations performed by utilizing the built-in spreadsheet functions and/or creating formulae within the cells. The statistical evaluation of data for use in accordance with the RDR/RAWP (DOE-RL 2005b) is documented by this calculation. Split and duplicate RPD results are used in evaluation of data quality and are presented in the cleanup verification package (CVP) for this site.

Methodology:
The statistical value calculated to evaluate the effectiveness of cleanup was the 95% UCL. For nonradioactive analytes with > 50% of the data below detection limits, the maximum value for the sample data is used instead of the 95% UCL. All nonradionuclide data reported as being below detection limits are set to ½ the detection limit value for calculation of the statistics (Ecology 1993). For radionuclide data, calculation of the statistics was done on the reported value. In cases where the laboratory does not report a value below the minimal detectable activity (MDA), half of the MDA is used in the calculation. For the statistical evaluation of duplicate sample pairs, the samples are averaged before being included in the data set, after adjustments for censored data as described above.

For nonradionuclides, the WAC 173-340 statistical guidance suggests that a test for distributional form be performed on the data and the 95% UCL calculated on the appropriate distribution using Ecology software. For nonradionuclide small data sets (n < 10) and all radionuclide data sets, the calculations are performed assuming nonparametric distribution, so no test for distribution is performed. For nonradionuclide data sets of ten or greater, distributional testing is done using Ecology's MTCAStat software (Ecology 1993). Note that no nonradionuclide COCs have been identified for the 100-K-56:1 pipelines.

The estimated hazard quotient (for applicable nonradionuclide COCs) is determined by dividing the statistical value (derived in this calculation) by the WAC 173-340 non-carcinogenic cleanup limit. The nonradionuclide carcinogenic risk, above background, is determined by dividing the statistical value by the WAC 173-340 carcinogenic cleanup limit and then multiplying by 10^{-5}. For data sets where all values are below detection, neither of these calculations are required. Because there were no nonradionuclide COCs identified for the 100-K-56:1 pipelines, neither of these calculations was performed.

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

The RPD is calculated when both the main value and either the duplicate or split values are above detection limits and are greater than 5 times the target detection limit (TDL). The TDL is a laboratory detection limit pre-determined for each analytical method. These detection limit requirements are listed in Table II-1 of the sampling and analysis plan (DOE-RL 2005a). The RPD calculations use the following formula: $RPD = \{ |M-S|/((M+S)/2)\}*100$

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

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

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

No regulatory split samples were collected for this site.

Bechtel Hanford, Inc.

CALCULATION SHEET

Originator J. M. Capron JMC
Project 100-K Area Remedial Action
Subject 100-K-56:1 Pipeline Cleanup Verification 95% UCL Calculation

Date 07/21/05
Job No. 22192

Calc. No. 0100K-CA-V0049
Checked T. M. Blakley TMB
Checked T. B. Miley TBM

Rev. No. 0
Date 7/21/05
Date 7-22-05
Sheet No. 2 of 5

Summary (continued)

Results:

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

Results Summary - Shallow Zone

Analyte	Result	Qualifier	Units
Cesium-137	6.1E-01		pCi/g
Europium-152	1.7E+00		pCi/g
Europium-154	1.4E-01	U	pCi/g

Results Summary - Deep Zone

Analyte	Result	Qualifier	Units
Cesium-137	1.32E+01		pCi/g
Europium-152	1.37E+01		pCi/g
Europium-154	1.87E+00		pCi/g

Relative Percent Difference (RPD) Results (Shallow Zone)* QA/QC Analysis

Analyte	Duplicate Analysis	Split Analysis
Cesium-137		
Europium-152		
Europium-154		

Relative Percent Difference (RPD) Results (Deep Zone)* QA/QC Analysis

Analyte	Duplicate Analysis	Split Analysis
Cesium-137		47.5%
Europium-152		51.3%
Europium-154		

*A blank cell indicates that RPD evaluation was not required.
CVP = cleanup verification package
QA/QC = quality assurance/quality control
RESRAD = RESidual RADioactivity (dose model)
U = undetected

CALCULATION SHEET

Bechtel Hanford, Inc.

Originator J. M. Capron JMC | Date 7/21/05 | Calc. No. 0100K-CA-V0049 | Rev. No. 0
Project 100-K Area Remedial Action | Job No. 22192 | Checked T. M. Blakley TMB | Date 7/21/05
Subject 100-K-56:1 Pipeline Cleanup Verification 95% UCL Calculation | Checked T. B. Miley TBM | Date 7-22-05
Sheet No. 3 of 5

Shallow Zone Sample Data

Sampling Area	HEIS Number	Sample Date	Cesium-137			Europium-152			Europium-154		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
A1	J03D45	6/23/2005	1.21E-01		4.6E-02	3.42E-01		7.0E-02	1.3E-01	U	1.3E-01
Duplicate of J03D45	J03D46	6/23/2005	1.17E-01		4.8E-02	4.89E-01		8.9E-02	1.6E-01	U	1.6E-01
A2	J03D47	6/23/2005	1.44E-01		4.0E-02	1.41E+00		1.2E-01	2.2E-01	U	2.2E-01
A3	J03D48	6/23/2005	3.10E-01		5.0E-02	4.10E-01		1.0E-01	1.7E-01	U	1.7E-01
A4	J03D49	6/23/2005	1.50E-01		4.0E-02	1.5E-01	U	1.5E-01	1.1E-01	U	1.1E-01
B5	J03D50	6/23/2005	2.38E+00		7.2E-02	1.48E+00		1.3E-01	2.4E-01	U	2.4E-01
B6	J03D51	6/23/2005	2.62E-01		3.5E-02	1.3E-01	U	1.3E-01	1.0E-01	U	1.0E-01
B7	J03D52	6/23/2005	2.05E+00		6.2E-02	2.17E+00		1.1E-01	4.7E-01	U	4.7E-01
B8	J03D53	6/23/2005	3.9E-02	U	3.9E-02	9.4E-02	U	9.4E-02	1.3E-01	U	1.3E-01
C9	J03D54	6/23/2005	2.8E-02	U	2.8E-02	1.1E-01	U	1.1E-01	1.0E-01	U	1.0E-01
C10	J03D55	6/23/2005	3.98E-01		3.7E-02	7.7E-02	U	7.7E-02	1.0E-01	U	1.0E-01
C1	J03D56	6/23/2005	1.96E-01		5.3E-02	1.1E-01	U	1.1E-01	1.5E-01	U	1.5E-01
C2	J03D57	6/23/2005	9.3E-02		3.4E-02	1.1E-01	U	1.1E-01	1.0E-01	U	1.0E-01
D3	J03D58	6/23/2005	3.0E-02	U	3.0E-02	7.0E-02	U	7.0E-02	1.0E-01	U	1.0E-01
D4	J03D59	6/23/2005	3.3E-02	U	3.3E-02	1.0E-01	U	1.0E-01	1.2E-01	U	1.2E-01
D5	J03D60	6/23/2005	4.0E-02	U	4.0E-02	1.1E-01	U	1.1E-01	1.3E-01	U	1.3E-01
D6	J03D61	6/23/2005	4.42E-01		4.3E-02	1.6E-01	U	1.6E-01	1.1E-01	U	1.1E-01
E7	J03D62	6/23/2005	3.81E-01		8.7E-02	1.04E+01		1.6E-01	1.1E+00	U	1.1E+00
E8	J03D63	6/23/2005	7.3E-02		3.9E-02	3.42E-01		9.9E-02	1.6E-01	U	1.6E-01
E9	J03D64	6/23/2005	2.86E-01		4.8E-02	2.40E-01		1.0E-01	1.4E-01	U	1.4E-01
E10	J03D65	6/23/2005	9.3E-02		3.6E-02	1.2E-01	U	1.2E-01	9.6E-02	U	9.6E-02

Statistical Computation Input Data

Sampling Area	HEIS Number	Sample Date	Cs-137 pCi/g			Eu-152 pCi/g			Eu-154 pCi/g		
A1	J03D45/ J03D46	6/23/2005	1.19E-01			4.16E-01			7.3E-02		
A2	J03D47	6/23/2005	1.44E-01			1.41E+00			1.1E-01		
A3	J03D48	6/23/2005	3.10E-01			4.10E-01			8.5E-02		
A4	J03D49	6/23/2005	1.50E-01			7.5E-02			5.5E-02		
B5	J03D50	6/23/2005	2.38E+00			1.48E+00			1.2E-01		
B6	J03D51	6/23/2005	2.62E-01			6.5E-02			5.0E-02		
B7	J03D52	6/23/2005	2.05E+00			2.17E+00			2.4E-01		
B8	J03D53	6/23/2005	2.0E-02			4.7E-02			6.5E-02		
C9	J03D54	6/23/2005	1.4E-02			5.5E-02			5.0E-02		
C10	J03D55	6/23/2005	3.98E-01			3.9E-02			5.0E-02		
C1	J03D56	6/23/2005	1.96E-01			5.5E-02			7.5E-02		
C2	J03D57	6/23/2005	9.3E-02			5.5E-02			5.0E-02		
D3	J03D58	6/23/2005	1.5E-02			3.5E-02			5.0E-02		
D4	J03D59	6/23/2005	1.7E-02			5.0E-02			6.0E-02		
D5	J03D60	6/23/2005	2.0E-02			5.5E-02			6.5E-02		
D6	J03D61	6/23/2005	4.42E-01			8.0E-02			5.5E-02		
E7	J03D62	6/23/2005	3.81E-01			1.04E+01			5.5E-01		
E8	J03D63	6/23/2005	7.3E-02			3.42E-01			8.0E-02		
E9	J03D64	6/23/2005	2.86E-01			2.40E-01			7.0E-02		
E10	J03D65	6/23/2005	9.3E-02			6.0E-02			4.8E-02		

Statistical Computations

	Cs-137			Eu-152			Eu-154		
Statistical value based on	Radionuclide data set. Use nonparametric z-statistic.			Radionuclide data set. Use nonparametric z-statistic.			Radionuclide data set. Use nonparametric z-statistic.		
N	20			20			20		
% < Detection limit	25%			60%			100%		
mean	3.7E-01			9.E-01			1.0E-01		
st. dev.	6.5E-01			2.3E+00			1.1E-01		
Z-statistic	1.645			1.645			1.645		
95% UCL on mean	6.1E-01			1.7E+00			1.4E-01		
max value	2.38E+00			1.04E+01			1.1E+00		
Statistical value	6.1E-01			1.7E+00			1.4E-01		
Background	NA			NA			NA		
Statistical value above background	6.1E-01			1.7E+00			1.4E-01		
Lookup Value - 15 mrem/yr for rad	6.2			3.3			3.05		

HEIS = Hanford Environmental Information System
MDA = minimum detectable activity
NA = not applicable
Q = qualifier
U = undetected

CALCULATION SHEET

Bechtel Hanford, Inc.

Originator J. M. Capron JMC | Date 7/21/05 | Calc. No. 0100K-CA-V0049 | Rev. No. 0
Project 100-K Area Remedial Action | Job No. 22192 | Checked T. M. Blakley TMB | Date 7/21/05
Subject 100-K-56:1 Pipeline Cleanup Verification 95% UCL Calculation | Checked T. B. Miley TBM | Date 7-22-05
Sheet No. 4 of 5

1 **Deep Zone Sample Data**

2	Sampling Area	HEIS Number	Sample Date	Cesium-137			Europium-152			Europium-154		
3				pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
4	A1	J037K9	6/15/2005	4.57E+00		1.0E-01	3.14E+01		3.5E-01	4.08E+00		3.1E-01
5	A2	J037L0	6/15/2005	2.83E+00		8.5E-02	1.02E+01		1.5E-01	1.42E+00		1.4E-01
6	A3	J037L1	6/15/2005	2.16E+01		1.2E-01	8.83E+00		3.7E-01	1.18E+00		2.3E-01
7	B4	J037L2	6/15/2005	5.40E+00		9.2E-02	5.23E+00		1.5E-01	5.68E-01		1.7E-01
8	B5	J037L3	6/15/2005	2.86E+01		1.1E-01	1.04E+01		2.4E-01	1.78E+00		1.7E-01
9	B6	J037L4	6/16/2005	8.49E-01		3.6E-02	5.06E-01		9.4E-02	1.4E-01	U	1.4E-01
10	C7	J037L5	6/16/2005	1.15E-01		4.9E-02	1.0E-01	U	1.0E-01	1.3E-01	U	1.3E-01
11	C8	J037L6	6/16/2005	3.28E+00		8.6E-02	8.48E+00		1.6E-01	1.31E+00		1.9E-01
12	C9	J037L7	6/16/2005	9.24E-01		5.1E-02	1.55E+00		1.2E-01	1.8E-01	U	1.8E-01
13	Duplicate of J037L7	J037L8	6/16/2005	4.5E-02	U	4.5E-02	1.2E-01	U	1.2E-01	1.6E-01	U	1.6E-01

14 **Statistical Computation Input Data**

15	Sampling Area	HEIS Number	Sample Date	Cs-137 pCi/g			Eu-152 pCi/g			Eu-154 pCi/g		
16												
17	A1	J037K9	6/15/2005	4.57E+00			3.14E+01			4.08E+00		
18	A2	J037L0	6/15/2005	2.83E+00			1.02E+01			1.42E+00		
19	A3	J037L1	6/15/2005	2.16E+01			8.83E+00			1.18E+00		
20	B4	J037L2	6/15/2005	5.40E+00			5.23E+00			5.68E-01		
21	B5	J037L3	6/15/2005	2.86E+01			1.04E+01			1.78E+00		
22	B6	J037L4	6/16/2005	8.49E-01			5.06E-01			7.0E-02		
23	C7	J037L5	6/16/2005	1.15E-01			5.0E-02			6.5E-02		
24	C8	J037L6	6/16/2005	3.28E+00			8.48E+00			1.31E+00		
25	C9	J037L7/ J037L8	6/16/2005	4.73E-01			8.1E-01			8.5E-02		

26 **Statistical Computations**

27		Cs-137			Eu-152			Eu-154		
28	Statistical value based on	Radionuclide data set. Use nonparametric z-statistic.			Radionuclide data set. Use nonparametric z-statistic.			Radionuclide data set. Use nonparametric z-statistic.		
29	N	9			9			9		
30	% < Detection limit	0%			11%			33%		
31	mean	7.5E+00			8.4E+00			1.17E+00		
32	st. dev.	1.03E+01			9.59E+00			1.27E+00		
33	Z-statistic	1.645			1.645			1.645		
34	95% UCL on mean	1.32E+01			1.37E+01			1.87E+00		
35	max value	2.86E+01			3.14E+01			4.08E+00		
36	Statistical value	1.32E+01			1.37E+01			1.87E+00		
37	Background	NA			NA			NA		
38	Statistical value above background	1.32E+01			1.37E+01			1.87E+00		
39	**Lookup Value - Protection of Groundwater and River**	1,465			NV			NV		

40 HEIS = Hanford Environmental Information System
41 MDA = minimum detectable activity
42 NA = not applicable
43 NV = no value
44 Q = qualifier
45 U = undetected

CALCULATION SHEET

Bechtel Hanford, Inc.

Originator J. M. Capron **Date** 7/21/05 **Calc. No.** 0100K-CA-V0049 **Rev. No.** 0
Project 100-K Area Remedial Action **Job No.** 22192 **Checked** T. M. Blakley **Date** 7/21/05
Subject 100-K-56:1 Pipeline Cleanup Verification 95% UCL Calculation **Checked** T. B. Miley **Date** 7-22-05
Sheet No. 5 of 5

Split-Duplicate Analysis

Shallow Zone Sample Results:

Sampling Area	HEIS Number	Cesium-137			Europium-152			Europium-154		
		pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
A1	J03D45	1.21E-01		4.6E-02	3.42E-01		7.0E-02	1.3E-01	U	1.3E-01
Duplicate of J03D45	J03D46	1.17E-01		4.8E-02	4.89E-01		8.9E-02	1.6E-01	U	1.6E-01
Split of J03D45	J03D86	1.51E-01		1.52E-02	4.68E-01		3.76E-02	3.48E-02	U	5.03E-02

Shallow Zone Analysis:

TDL		0.05	0.1	0.1
Duplicate Analysis	Both > MDA?	**Yes (continue)**	**Yes (continue)**	No-Stop (acceptable)
	Both > 5xTDL?	No-Stop (acceptable)	No-Stop (acceptable)	
	RPD			
Split Analysis	Both > MDA?	**Yes (continue)**	**Yes (continue)**	No-Stop (acceptable)
	Both > 5xTDL?	No-Stop (acceptable)	No-Stop (acceptable)	
	RPD			

Deep Zone Sample Results:

Sampling Area	HEIS Number	Cesium-137			Europium-152			Europium-154		
		pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
C9	J037L7	9.24E-01		5.1E-02	1.55E+00		1.2E-01	1.8E-01	U	1.8E-01
Duplicate of J037L7	J037L8	4.5E-02	U	4.5E-02	1.2E-01	U	1.2E-01	1.6E-01	U	1.6E-01
Split of J037L7	J037L9	1.50E+00		2.19E-02	2.62E+00		5.51E-02	2.39E-01	U	9.10E-02

Deep Zone Analysis:

TDL		0.05	0.1	0.1
Duplicate Analysis	Both > MDA?	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)
	Both > 5xTDL?			
	RPD			
Split Analysis	Both > MDA?	**Yes (continue)**	**Yes (continue)**	No-Stop (acceptable)
	Both > 5xTDL?	**Yes (calc RPD)**	**Yes (calc RPD)**	
	RPD	47.52%	51.32%	

HEIS = Hanford Environmental Information System
MDA = minimum detectable activity
Q = qualifier
RPD = relative percent difference
TDL = target detection limit
U = undetected

CALCULATION COVER SHEET

Project Title 100-K Remedial Action **Job No.** 22192
Area 100-K Area
Discipline Environmental ***Calc. No.** 0100K-CA-V0050
Subject 100-K-56:1 Pipeline RESRAD Calculation
Computer Program RESRAD **Program No.** Version 6.22

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 pg Summary – 4 pg Attm. 1 - 1 pg Attm. 2 - 18 pg Attm. 3 - 18 pg Attm. 4 - 9 pg Attm. 5 - 18 pg Attm. 6 - 18 pg Attm. 7 - 9 pg Total – 96 pages	S. W. Clark S.W. Clark 7/22/05	S. W. Callison SW Callison 7-26-05	K. E. Cook M.A. Buckmaster	M. A. Buckmaster	7/26/05

SUMMARY OF REVISION

*Obtain Calc. No. from DIS

Bechtel Hanford, Inc. CALCULATION SHEET

Originator:	S. W. Clark SWC	Date:	7/22/05	Calc. No.:	0100K-CA-V0050	Rev.:	0
Project:	100-K-56:1 Cleanup Verification	Job No:	22192	Checked:	S. W. Callison SWC	Date:	7-26-05
Subject:	100-K-56:1 Pipeline Cleanup Verification RESRAD Calculation					Sheet No.	1 of 4

PURPOSE:

Calculate the soil and groundwater concentrations, dose, and risk contributions from remaining radionuclide contaminants in the vadose zone over a period of 1,000 years.

GIVEN/REFERENCES:

1) Cleanup verification data from *100-K-56:1 Pipeline Cleanup Verification 95% UCL Calculation*, Calculation No. 0100K-CA-V0049, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.
2) *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP), DOE/RL-96-17, Rev. 4, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
3) Radioactive and nonradioactive contaminants of concern from the *100 Area Remedial Action Sampling and Analysis Plan* (100 Area SAP), DOE/RL-96-22, Rev. 3, U.S. Department of Energy, Richland Operations Office, Richland, Washington. For the purpose of these RESRAD calculations, the radioactive contaminants of concern (COCs) are cesium-137, europium-152, and europium-154.
4) For the purpose of these RESRAD calculations there are no nonradionuclide contaminants of concern.
5) RESidual RADioactivity (RESRAD) computer code, version 6.22, 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.
6) Sample design data from the *100-K-56:1 Pipeline Sample Design,* Calculation No. 0100K-CA-V0053, Rev. 0, Bechtel Hanford, Inc., Richland, Washington. For the purpose of these RESRAD calculations, the sampling areas identified in the sampling plan calculation brief are 19,844 m^2 for the Shallow Zone and 11,131 m^2 for the Deep Zone.

SOLUTION:

1) Table 1 shows the waste site parameters used for RESRAD modeling. The model for the RESRAD runs uses the conservative assumption that the residual contamination levels from the Deep Zone data set extend uniformly from 4.6 m (15 ft) below the ground surface to groundwater.

2) Table 2 shows the radionuclide activities for each COC. Input factors for each RESRAD run are shown in the "Summary" section of the RESRAD "Mixture Sums and Single Radionuclide Guidelines" printouts in Attachments to this Calculation Summary.

Bechtel Hanford, Inc. CALCULATION SHEET

Originator:	S. W. Clark SWC	Date:	7/22/05	Calc. No.:	0100K-CA-V0050	Rev.:	0
Project:	100-K-56:1 Cleanup Verification	Job No:	22192	Checked:	S. W. Callison SWC	Date:	7-26-05
Subject:	100-K-56:1 Pipeline Cleanup Verification RESRAD Calculation					Sheet No.	2 of 4

3) The year where the peak dose (or concentration) occurs from each individual radionuclide COC was determined by a preliminary run. This year was then included in all final RESRAD runs. For the direct exposure pathway (i.e. soil ingestion and inhalation and external radiation), the peak year occurred at year zero (year 2005) for all COCs. For the water pathways (i.e., drinking water and food ingestion) the peak year was 43 for cesium-137. The 43-year time period was included in all RESRAD runs.

Table 1. Waste Site Dimensions for RESRAD Modeling

Parameter	Units	Value	Comments
Cover Depth	m	0	
Area of Shallow Zone	m^2	19,844	Based on Sample Design [a]
Thickness: Shallow Zone	m	4.6	Appendix B of 100 Area RDR/RAWP
Elevation: Ground Surface	m	135.5	NAVD88
Elevation: Groundwater	m	119.8	NAVD88
Area of Deep Zone	m^2	11,131	Based on Sample Design [a]
Thickness: Contaminated Deep Zone	m	11.1	Conservative assumption for modeling
Length Parallel to Aquifer Flow	m	216	Based on Sample Design [a]

[a] Sample design data from the *100-K-56:1 Pipeline Sample Design,* Calculation No. 0100K-CA-V0053, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

METHODOLOGY:

1) Runs of RESRAD version 6.22 were completed for the shallow zone using the radionuclide concentrations shown in Table 2. RESRAD numerical output reports for dose, risk, and concentration for the shallow zone are presented in the Attachments to this calculation summary.

Table 2. Radionuclide Concentrations

COCs	Shallow Zone	Deep Zone
Radionuclide Activity (pCi/g)		
Cs-137	0.61	13.2
Eu-152	1.7	13.7
Eu-154	0.14	1.87

Bechtel Hanford, Inc. CALCULATION SHEET

Originator:	S. W. Clark SWC	Date:	7/22/05	Calc. No.:	0100K-CA-V0050	Rev.:	0
Project:	100-K-56:1 Cleanup Verification	Job No:	22192	Checked:	S. W. Callison SWC	Date:	7-26-05
Subject:	100-K-56:1 Pipeline Cleanup Verification RESRAD Calculation					Sheet No. 3 of 4	

RESULTS:

1) Radionuclide "All Pathways" Dose Rate

The "all pathways" (maximum) dose rates are shown in Table 3. The maximum total all-pathways dose rate is 9.95 mrem/yr which occurs at year zero (2005).

Table 3. All Pathway Dose Rate (mrem/yr)

RESRAD Run #	Vadose Zone Horizons	"All Pathways" Dose Contributions in mrem/yr at each time slice (yr)							
		0	1	3	13	43	100	300	1000
1	Shallow Zone	9.95E+00	9.47E+00	8.59E+00	5.32E+00	1.42E+00	1.96E-01	1.44E-03	1.17E-10
2	Deep Zone	1.38E-25	2.55E-03	8.04E-03	2.86E-02	4.77E-02	2.97E-02	8.76E-04	2.73E-10
Total All Pathways Dose Rate (mrem/yr)		9.95E+00	9.47E+00	8.59E+00	5.34E+00	1.47E+00	2.25E-01	2.32E-03	3.90E-10

2) Radionuclide Excess Cancer Risk

The radionuclide excess lifetime cancer risk results are shown in Table 4. The maximum total excess lifetime cancer risk (1.20×10^{-4}) occurs at year zero (2005).

Table 4. Radionuclide Excess Lifetime Cancer Risk

RESRAD Run #	Vadose Zone Horizons	Excess Cancer Risk at Each Time Slice (yr)							
		0	1	3	13	43	100	300	1000
1	Shallow Zone	1.20E-04	1.14E-04	1.04E-04	6.58E-05	1.89E-05	2.96E-06	2.33E-08	1.89E-15
2	Deep Zone	5.90E-07	6.20E-07	6.76E-07	8.68E-07	9.32E-07	5.03E-07	1.37E-08	4.13E-15
Total Excess Cancer Risk		1.20E-04	1.15E-04	1.05E-04	6.66E-05	1.99E-05	3.46E-06	3.70E-08	6.03E-15

3) Radionuclide Groundwater Protection

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

Bechtel Hanford, Inc. CALCULATION SHEET

Originator:	S. W. Clark SWC	Date:	7/22/05	Calc. No.:	0100K-CA-V0050	Rev.:	0
Project:	100-K-56:1 Cleanup Verification	Job No:	22192	Checked:	S. W. Callison SWC	Date:	7-26-05
Subject:	100-K-56:1 Pipeline Cleanup Verification RESRAD Calculation					Sheet No.	4 of 4

Table 5. RESRAD Predicted Radionuclide Groundwater (Well Water) Concentrations

Radio-nuclides	Vadose Zone Horizon	Groundwater Concentrations in pCi/L at Each Time Slice (yr)								RAGs From RDR
		0	1	3	8	13	42	300	1000	
Cs-137	Shallow Zone	0	0	0	0	0	0	0	0	60
	Deep Zone	0	3.30E-02	9.49E-02	3.27E-01	5.41E-01	3.37E-01	9.91E-03	3.09E-09	
	Total	0	3.30E-02	9.49E-02	3.27E-01	5.41E-01	3.37E-01	9.91E-03	3.09E-09	
Eu-152	**Total**	0	0	0	0	0	0	0	0	200
Eu-154	**Total**	0	0	0	0	0	0	0	0	60

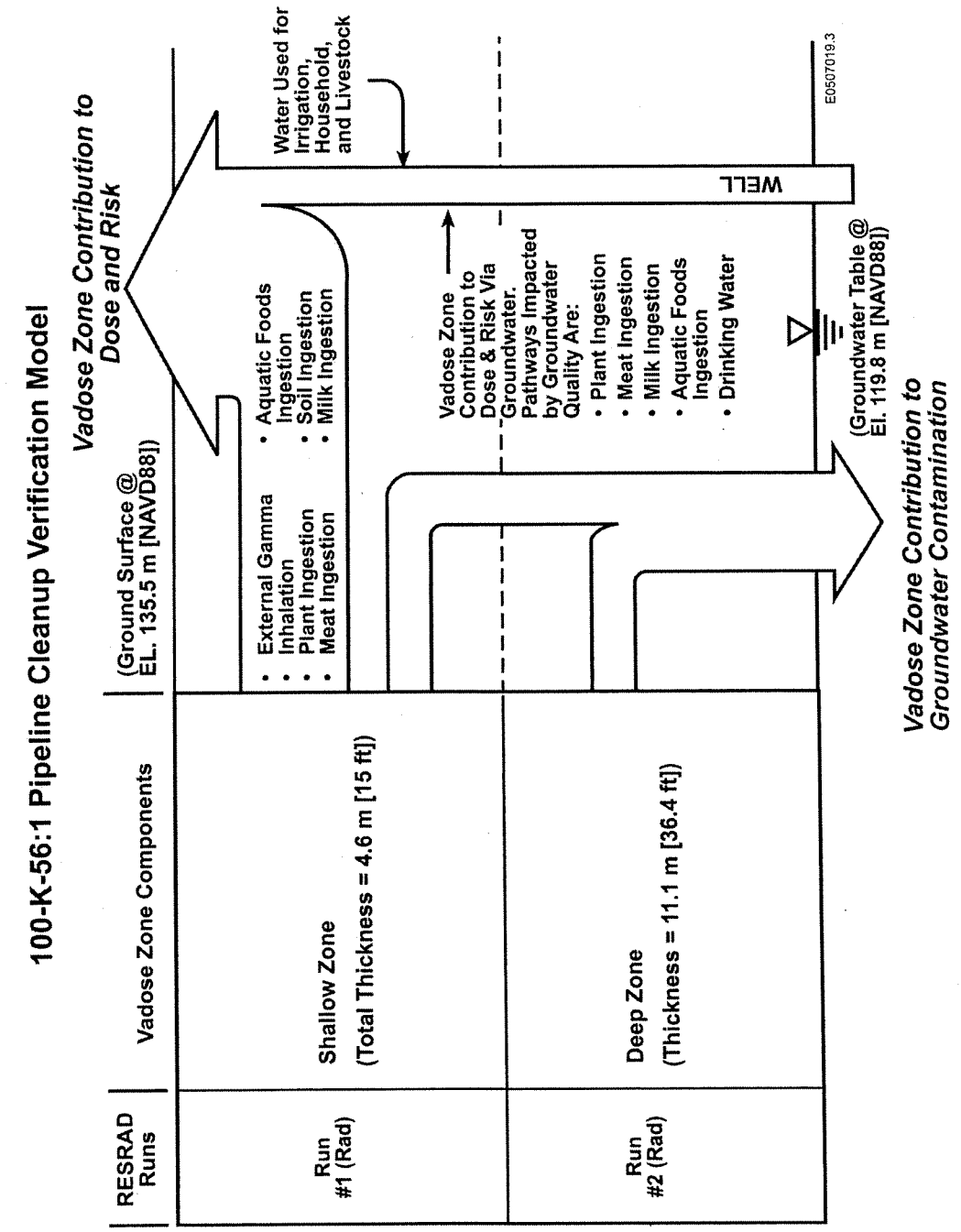
CONCLUSIONS:

- The "all pathways" (maximum) dose rates are shown in Table 3. The combined maximum all-pathways dose rate for the shallow and deep zones is 9.95 mrem/yr which occurs at year zero (2005).
- The dominant pathway for the dose rate is direct external exposure.
- The primary radionuclide contributing to the direct exposure pathway is europium-152.
- None of the site COCs are projected to exceed remedial action goals (RAGs).
- The radionuclide excess lifetime cancer risk results are shown in Table 4. The maximum combined shallow and deep zone excess lifetime cancer risk (1.20×10^{-4}) occurs at year zero (2005).
- Among the radionuclide contaminants of concern, cesium-137 is calculated to reach groundwater in the 1,000 years of the RESRAD model runs. Cesium-137 is predicted to reach groundwater at concentrations significantly below the RAGs.

ATTACHMENTS:

1. Graphic showing 100-K-56:1 Cleanup Verification Model (1 page)
2. RESRAD Output: 100-K-56:1 Shallow Zone Radionuclides, Mixture Sums and Single Radionuclide Guidelines (18 pages)
3. RESRAD Output: 100-K-56:1 Shallow Zone Radionuclides, Intake Quantities and Health Risk Factors (18 pages)
4. RESRAD Output: 100-K-56:1 Shallow Zone Radionuclides, Concentration of Radionuclides, (9 pages)
5. RESRAD Output: 100-K-56:1 Deep Zone Radionuclides, Mixture Sums and Single Radionuclide Guidelines (18 pages)
6. RESRAD Output: 100-K-56:1 Deep Zone Radionuclides, Intake Quantities and Health Risk Factors (18 pages)
7. RESRAD Output: 100-K-56:1 Deep Zone Radionuclides, Concentration of Radionuclides, (9 pages)

ATTACHMENT 1



Attachment 1 Sheet No. 1 of 1
Originator S. W. Clark Date 7/22/05
Chk'd By S. W. Callison Date 7-26-05
Calc. No. 0100K-CA-V0050 Rev. No. 0

CALCULATION COVER SHEET
(Sample Design, Verification, or Waste Characterization Calculation)

Project Title:	100-K Remedial Action	**Job No.**	22192
Area	100 K Area		
Discipline	Environmental	***Calc. No.**	0100K-CA-V0051
Subject	100-K-56:1 Comparison to Drinking Water Standards (MCL) Calculation		
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 X **Preliminary** **Superseded** **Voided**

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover - 1 Calculations - 3 Total - 4	S. W. Clark 7/22/05	S. W. Callison 7-26-05	R. A. Carlson	M. A. Buckmaster	7/26/05

SUMMARY OF REVISIONS

*Obtain Calc. No. from DIS

Bechtel Hanford, Inc.

CALCULATION SHEET

Originator	S. W. Clark		**Date**	7/22/05	**Calc. No.** 0100K-CA-V0051	**Rev. No.**	0
Project	100-K Remedial Action		**Job No.**	22192	**Checked** S. W. Callison	**Date**	7-20-05
Subject	100-K-56:1 Comparison to Drinking Water Standards (MCL) Calculation					**Sheet No.**	1 of 3

Purpose:
Compare RESRAD derived groundwater radionuclide concentrations to remedial action goals and maximum contaminant levels (MCLs) for groundwater. Compare beta/gamma emitter dose contributions to the maximum allowable dose of 4 mrem/yr. Compare alpha emitter dose contributions to the maximum allowable gross particle activity of 15 pCi/L or 1/25th of the derived concentration guide (DCG). Alph-emitting COCs were undetected so no comparison was performed

Table of Contents:

Given/References:
1) RESRAD derived groundwater radionuclide concentrations from Calculation 0100K-CA-V0050, *100-K-56:1 Pipeline RESRAD Calculation Brief.*

2) Remedial action goals for groundwater and MCLs summarized in Table 2-3 of the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP), DOE/RL-96-17, Rev. 5, U.S. Department of Energy, Richland Operations office, Richland, WA.

3) Maximum allowable dose of 4 mrem/yr for beta/gamma emitters and maximum allowable gross particle activity of 15 pCi/L for alpha emitters from: 40 CFR 141, "National Primary Drinking Water Regulation," *Code of Federal Regulations*, as amended (40 CFR Part 141, Subpart G, 141.66).

4) 1/25th of the derived concentration guide values from *Radiation Protection of the Public and Environment,* DOE Order 5400.5, U.S. Department of Energy, Washington D.C.

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

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

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

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

4. The cumulative dose for each organ for all beta and gamma emitting COCs (Cs-137, Eu-152, Eu-154) at time t is calculated separately using the concentration corresponding to 4 mrem/year dose (C4) and the sum of fractions equation shown below (from EPA-570/9-76-003). The organs for which doses need to be computed are total body, bone, liver and gastrointestinal tract [lower large intestine] (GI(LLI)). The individual organ doses are compared to 4 mrem/yr.

$$Dose_{organ\ x}(t) = [ConcA(t)/C4A(x) + ConcB(t)/C4B(x) + ...] \times (4\ mrem/yr)$$

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

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

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

3. The alpha emitting COCs (Pu-239/240) were undetected in cleanup verification samples from the site. Therefore, concentrations for the alpha emitting COCs are less than the maximum allowable gross particle activity of 15 pCi/L and the 1/25th of the DCG.

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

Radionuclide	Time (years) 0	1	3	13	43	100	300	1000	MCL	Exceeds MCL?	Peak Conc.	Year of Peak
Cs-137	0	3.30E-02	9.49E-02	3.27E-01	5.41E-01	3.37E-01	9.91E-03	3.09E-09	60	No	5.41E-01	43
Eu-152	0	0	0	0	0	0	0	0	200	No	0.00E+00	0
Eu-154	0	0	0	0	0	0	0	0	60	No	0.00E+00	0

Bechtel Hanford, Inc.

CALCULATION SHEET

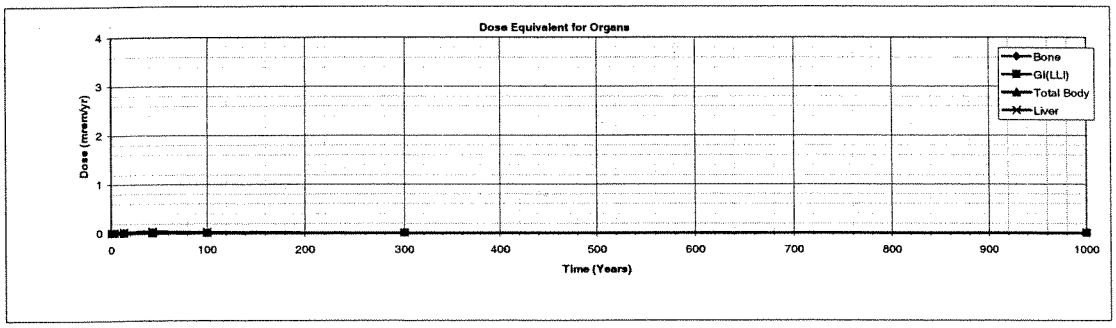
Originator	S. W. Clark SWC	Date 7/22/05	Calc. No. 0100K-CA-V0051	Rev. No.	0
Project	100-K Remedial Action	Job 22192	Checked S. W. Callison SWC	Date	7-26-05
Subject	100-K-56:1 Comparison to Drinking Water Standards (MCL) Calculation			Sheet No.	3 of 3

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

Radionuclide	Time (years)								Organ	C_4	Exceeds 4 mrem/yr?	Peak Conc.	Year of Peak Conc.
	0	1	3	13	43	100	300	1000					
Cs-137	0	3.30E-02	9.49E-02	3.27E-01	5.41E-01	3.37E-01	9.91E-03	3.09E-09	Bone	80	No	5.41E-01	43
									GI(LLI)	2,000	No		
									Total Body	200	No		
									Liver	60	No		
Eu-152	0	0	0	0	0	0	0	0	Bone	30,000	No	0	NA
									GI(LLI)	200	No		
									Total Body	200,000	No		
									Liver	100,000	No		
Eu-154	0	0	0	0	0	0	0	0	Bone	5,000	No	0	NA
									GI(LLI)	60	No		
									Total Body	70,000	No		
									Liver	60,000	No		

Cumulative dose for each organ (with time)

Organ	Time (years)								Exceeds 4	Peak Conc.	Year of Peak Conc.
	0	1	3	13	43	100	300	1000			
Bone	0.00E+00	1.65E-03	4.75E-03	1.64E-02	2.71E-02	1.69E-02	4.96E-04	1.55E-10	No	2.71E-02	43
GI(LLI)	0.00E+00	6.60E-05	1.90E-04	6.54E-04	1.08E-03	6.74E-04	1.98E-05	6.18E-12	No	1.08E-03	43
Total Body	0.00E+00	6.60E-04	1.90E-03	6.54E-03	1.08E-02	6.74E-03	1.98E-04	6.18E-11	No	1.08E-02	43
Liver	0.00E+00	2.20E-03	6.33E-03	2.18E-02	3.61E-02	2.25E-02	6.61E-04	2.06E-10	No	3.61E-02	43



CALCULATION COVER SHEET

Project Title 100-K Area Remedial Action **Job No.** 22192

Area 100-K

Discipline Environmental ***Calc. No.** 0100K-CA-V0054

Subject 116-KW-4 and 116-KE-5 Heat Recovery Stations 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 Total = 4	J. M. Capron J M Capron 8/23/05	T. M. Blakley 8/23/05 J. M. Blakley	L. M. Dittmer J. M. Blakley for 8/23/05	S. W. Callison S W Callison 8-24-05	8-24-05

SUMMARY OF REVISION

*Obtain Calc. No. from DIS

Bechtel Hanford, Inc. CALCULATION SHEET

Originator:	J. M. Capron	Date:	08/23/05	Calc. No.:	0100K-CA-V0054	Rev.:	0
Project:	100-K Area Remedial Action	Job No:	22192	Checked:	T. M. Blakley	Date:	8/23/05
Subject:	116-KW-4 and 116-KE-5 Heat Recovery Stations 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 116-KW-4 and 116-KE-5 Heat Recovery Stations presented in the *Cleanup Verification Package for the 100-K-55:1 and 100-K-56:1 Pipelines and the 116-KW-4 and 116-KE-5 Heat Recovery Stations* (BHI 2005). 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 $<1 \times 10^{-6}$ for individual carcinogens
4) A cumulative excess cancer risk of $<1 \times 10^{-5}$ for carcinogens.

GIVEN/REFERENCES:

1) BHI, 2005, *Cleanup Verification Package for the 100-K-55:1 and 100-K-56:1 Pipelines and the 116-KW-4 and 116-KE-5 Heat Recovery Stations*, CVP-2005-00006, Bechtel Hanford, Inc., Richland, Washington.

2) 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.

3) 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.

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

SOLUTION:

1) Generate an HQ for each noncarcinogenic constituent detected above background or required detection limit/practical quantitation limit and compare it to the individual HQ criterion of <1.0 (DOE-RL 2005).

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

3) Generate an excess cancer risk value for each carcinogenic constituent detected above background or required detection limit/practical quantitation limit and compare it to the excess cancer risk criterion of $<1 \times 10^{-6}$ (DOE-RL 2005).

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

Bechtel Hanford, Inc. CALCULATION SHEET

Originator:	J. M. Capron		Date:	08/23/05	Calc. No.:	0100K-CA-V0054	Rev.: 0
Project:	100-K Area Remedial Action		Job No:	22192	Checked:	T. M. Blakley	Date: 8/23/05
Subject:	116-KW-4 and 116-KE-5 Heat Recovery Stations Hazard Quotient and Carcinogenic Risk Calculations						Sheet No. 2 of 3

METHODOLOGY:

Hazard quotient and carcinogenic risk calculations were computed separately for the 116-KW-4 and 116-KE-5 sites using the discrete sample data from BHI (2005). Of the contaminants of potential concern for the 116-KE-5 site, chromium (total and hexavalent) and lead require the HQ and risk calculations because these analytes were detected above their Hanford Site background values. Ethylene glycol requires calculations because it was detected by laboratory analysis and cannot be attributed to natural occurrence. For the 116-KW-4 site, calculations are only required for hexavalent chromium, as no other contaminants of potential concern were detected above background levels or laboratory detection limits. An example of the HQ and risk calculations is presented below:

1) For example, the maximum value for total chromium at the 116-KE-5 site is 30 mg/kg, divided by the noncarcinogenic RAG value of 120,000 mg/kg (chromium is identified as a noncarcinogen in WAC 173-340-740[3]), is 2.5×10^{-4}. Comparing this value, and all other individual values, to the requirement of <1.0, this criteria is met.

2) After the HQ calculation is completed for the appropriate analytes, the cumulative HQs can be obtained by summing the individual values for each site. The sums of the HQ values for the 116-KW-4 and 116-KE-5 sites are 1.0×10^{-3} and 3.4×10^{-2}, respectively. Comparing these values to the requirement of <1.0, this criterion is met.

3) To calculate the excess cancer risk, the statistical value is divided by the carcinogenic RAG value, then multiplied by 1×10^{-6}. For example, the maximum value for hexavalent chromium at the 116-KW-4 site is 0.24 mg/kg; divided by 2.1 mg/kg and multiplied as indicated is 1.1×10^{-7}. 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 cancer risk can be obtained by summing the individual values. The sums of the excess cancer risk values for the 116-KW-4 and 116-KE-5 sites are 1.1×10^{-7} and 1.6×10^{-7}, respectively. Comparing these values 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.

Tables 1 and 2 show the results of the calculations for the 116-KW-4 and 116-KE-5 sites, respectively.

Bechtel Hanford, Inc. CALCULATION SHEET

Originator:	J. M. Capron	Date:	08/23/05	Calc. No.:	0100K-CA-V0054	Rev.:	0
Project:	100-K Area Remedial Action	Job No:	22192	Checked:	T. M. Blakley	Date:	8/23/05
Subject:	116-KW-4 and 116-KE-5 Heat Recovery Stations Hazard Quotient and Carcinogenic Risk Calculations					Sheet No.	3 of 3

Table 1. Hazard Quotient and Excess Cancer Risk Results for the 116-KW-4 Site.

Contaminants of Potential Concern[a]	Maximum Value[a] (mg/kg)	Noncarcinogen RAG[b] (mg/kg)	Hazard Quotient	Carcinogen RAG (mg/kg)	Carcinogen Risk
Metals					
Chromium, hexavalent[c]	0.24	240	1.0E-03	2.1	1.1E-07
Totals					
Cumulative Hazard Quotient:			**1.0E-03**		
Cumulative Excess Cancer Risk:					**1.1E-07**

Notes:
RAG = remedial action goal
-- = not applicable
[a] = From Table 4 (BHI 2005).
[b] = Value obtained from *Washington Administrative Code* (WAC) 173-340-740(3), Method B, 1996, unless otherwise noted.
[c] = Value for the carcinogen RAG calculated based on the inhalation exposure pathway (WAC) 173-340-750(3), 1996.

Table 2. Hazard Quotient and Excess Cancer Risk Results for the 116-KE-5 Site.

Contaminants of Potential Concern[a]	Maximum Value[a] (mg/kg)	Noncarcinogen RAG[b] (mg/kg)	Hazard Quotient	Carcinogen RAG (mg/kg)	Carcinogen Risk
Metals					
Chromium, total	30	120,000	2.5E-04		
Chromium, hexavalent[c]	0.33	240	1.4E-03	2.1	1.6E-07
Lead[d]	11.3	353	3.2E-02	--	--
Semivolatiles					
Ethylene glycol	59	160,000	3.7E-04		
Totals					
Cumulative Hazard Quotient:			**3.4E-02**		
Cumulative Excess Cancer Risk:					**1.6E-07**

Notes:
RAG = remedial action goal
-- = not applicable
[a] = From Table 4 (BHI 2005).
[b] = Value obtained from *Washington Administrative Code* (WAC) 173-340-740(3), Method B, 1996, unless otherwise noted.
[c] = Value for the carcinogen RAG calculated based on the inhalation exposure pathway (WAC) 173-340-750(3), 1996.
[d] = Value for the noncarcinogen RAG obtained from EPA (1994).

CONCLUSION:

This calculation demonstrates that the 116-KW-4 and 116-KE-5 sites meet the requirements for the hazard quotients and carcinogenic (excess cancer) risk as identified in the RDR/RAWP (DOE-RL 2005).

DISTRIBUTION

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