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CVP-2002-00004
Rev. 0

Cleanup Verification Package for the 126-F-1, 184-F Powerhouse Ash Pit

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

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EXECUTIVE SUMMARY

This cleanup verification package documents completion of remedial action for the 126-F-1, 184-F Powerhouse Ash Pit. The 126-F-1 site is located within the 100-FR-2 Operable Unit in the 100-F Area of the Hanford Site in southeastern Washington State. This waste site received coal ash from the 100-F Area coal-fired steam plant that operated from 1944 to 1965. Leakage of process effluent (reactor cooling water) from the 116-F-14, 107-F Retention Basins flowed south into the ash pit, contaminating the northern portion of the ash pit. Thus, the northern and southern portions of the ash pit have been addressed separately.

Remedial action of the northern portion of the 126-F-1 site began on October 5, 2001, and was completed on June 17, 2002. Remedial action activities involved removing the contaminated coal ash from the northern portion of the ash pit and the underlying contaminated soil. All contaminated materials were disposed of at the Environmental Restoration Disposal Facility (ERDF). No remedial action was necessary in the southern portion of the 126-F-1 site but the site could not be closed out until radioactive decay occurred from the original sampling date in 2001 to 2007 to meet the radiological dose limit of 15 mrem/yr above natural background. Results of the verification sampling, laboratory analyses, and data evaluations for the 126-F-1 site indicate that all remedial action objectives and goals for direct exposure, protection of groundwater, and protection of the Columbia River have been met (see Table ES-1).

The site meets cleanup standards and has been reclassified as "interim closed out" in accordance with the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1998) and the Waste Site Reclassification Guideline TPA-MP-14, Rev. 1, (RL-TPA-90-0001) (DOE-RL 2007). A copy of the waste site reclassification form is included as Attachment ES-1.

Table ES-1. Summary of Cleanup Verification Results for the 126-F-1, 184-F Powerhouse Ash Pit.

Regulatory Requirement	Remedial Action Goals	Results	Remedial Action Objectives Attained?	Ref.
Direct Exposure – Radionuclides	1. Attain 15 mrem/yr dose rate above background for1,000 years following remediaiton.	1. Maximum dose rate calculated by RESRAD for the northern portion of the site is 4.8 mrem/yr (not accounting for clean backfill).	Yes	a
		2. Maximum dose calculated by RESRAD for the southern portion of the site is calculated to be 14.3 mrem/yr at present (year 2007).	Yes	
Direct Exposure – Nonradionuclides	1. Attain individual COC RAGs.	1. There are no nonradionuclides associated with this site.	N/A	N/A
Meet Nonradionuclide Risk Requirements	1. Hazard quotient of <1 for noncarcinogens.	1. There are no nonradionuclides associated with this site.	N/A	N/A
	2. Cumulative hazard quotient of <1 for noncarcinogens.	2. There are no nonradionuclides associated with this site.		N/A
	3. Excess cancer risk of <1 x 10^{-6} for individual carcinogens.	3. There are no nonradionuclides associated with this site.		N/A
	4. Attain a total excess cancer risk of <1 x 10^{-5} for carcinogens.	4. There are no nonradionuclides associated with this site.		N/A
Groundwater/River Protection – Radionuclides	1. Attain single-COC groundwater and river protection RAGs.	1. All single-COC groundwater and river RAGs have been attained.	Yes	b
	2. Attain National Primary Drinking Water Standards of 4 mrem/yr.	2. All organ-specific dose rates are below the 4 mrem/yr dose rate limit.		b
	3. Meet 15 pCi/L drinking water standard for alpha emitters.	3. There are no alpha-emitting COCs for this site		b
	4. Meet total uranium standard of 21.2 pCi/L.[c]	4. Uranium is not a COC for this site.		
Groundwater/River Protection – Nonradionuclides	1. Attain individual nonradionuclide groundwater and river cleanup requirements.	1. There are no nonradionuclides associated with this site.	N/A	N/A
Other supporting Information	1. 95% UCL calculation (Appendix C).			d
	2. Sample variance calculation (Appendix C).			e
	3. Sample location design (Appendix C).			f

[a] *126-F-1 RESRAD Calculation*, 0100F-CA-V0146 (Northern Portion), Rev. 0, Bechtel Hanford, Inc., Richland, Washington, 0100F-CA-V0102 (Southern Portion), Rev. 1, Washington Closure Hanford, Richland, Washington.

[b] *126-F-1 Comparison to Drinking Water Standards*, 0100F-CA-V0145 (Northern Portion), Rev. 0, Bechtel Hanford, Inc., Richland, Washington, 0100F-CA-V0101 (Southern Portion), Rev. 1, Washington Closure Hanford, Richland, Washington.

[c] See *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)for concentration-to-activity calculation showing the 30 µg/L uranium MCL (40 *Code of Federal Regulations* 141.66) corresponds to 21.2 pCi/L.

[d] *126-F-1 Cleanup Verification 95% UCL Calculations*, 0100F-CA-V0144 (Northern Portion), Rev. 0, 0100F-CA-V0100 (Southern Portion), Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

[e] *126-F-1 Sample Variance Calculation*, 0100F-CA-V0119, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

[f] *126-F-1 Sample Design*, 0100F-CA-V0061 (Overburden), 0100F-CA-V0118 (Shallow), Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

COC = contaminant of concern
MCL = maximum contaminant level (drinking water standard)
N/A = not applicable
RAG = remedial action goal)
RESRAD = RESidual RADioactivity (dose model);
UCL = upper confidence limit

Date Submitted: 4/23/07 Originator: L. M. Dittmer Phone: 372-9664	**WASTE SITE RECLASSIFICATION FORM** Operable Unit(s): 100-FR-1 Waste Site Code: 126-F-1 Type of Reclassification Action: Closed Out ☐ Interim Closed Out ☒ No Action ☐ RCRA Postclosure ☐ Rejected ☐ Consolidated ☐	Control Number: 2002-058

This form documents agreement among parties listed authorizing classification of the subject unit as Closed Out, Interim Closed Out, No Action, RCRA Postclosure, Rejected, or Consolidated. This form also authorizes backfill of the waste management unit, if appropriate, for Closed Out and Interim Closed Out units. Final removal from the NPL of No Action and Closed Out waste management units will occur at a future date.

Description of current waste site condition:
The 126-F-1 waste site is the former 184-F Powerhouse Ash Pit. The site received coal ash from the 100-F Area coal-fired steam plant that operated from 1944 to 1965. Leakage of process effluent (reactor cooling water) from the 116-F-14, 107-F Retention Basins flowed south into the ash pit, contaminating the northern portion of the ash pit. Thus, the northern and southern portions of the ash pit were addressed separately. The northern portion of the site has been remediated and backfilled with clean soil to adjacent grade elevations. No remedial action was necessary in the southern portion of the 126-F-1 site, but this portion of the site could not be closed out until radioactive decay occurred from the original sampling date in 2001 to 2007 to meet the radiological dose limit of 15 mrem/yr above natural background. Remediation and verification sampling of this site have been performed in accordance with remedial action objectives and goals established by 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 Amendment), U.S. Environmental Protection Agency, Region 10, Seattle, Washington. The selected action involved: (1) remediating the site, (2) demonstrating through verification sampling that cleanup goals have been achieved, and (3) proposing the site for reclassification as Interim Closed Out.

Basis for reclassification:
In accordance with this evaluation, the verification sampling results support a reclassification of this site to Interim Closed Out. The current site conditions achieve the remedial action objectives and the corresponding remedial action goals established in the ROD Amendment. The results of verification sampling show that residual contaminant concentrations do not preclude any future uses (as bounded by the rural-residential scenario) and allow for unrestricted use of shallow zone soils (i.e., surface to 4.6 m [15 ft] deep). The results also demonstrate that residual contaminant concentrations are protective of groundwater and the Columbia River. Remedial actions were not required for the northern and southern portion 126-F-1 deep zone soils; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are not required. The basis for reclassification is described in detail in the *Cleanup Verification Package for the 126-F-1, 184-F Powerhouse Ash Pit* (CVP-2002-00004), Washington Closure Hanford, Richland, Washington.

Waste Site Controls:
Engineered Controls: Yes ☐ No ☒ Institutional Controls: Yes ☐ No ☒ O&M requirements: Yes ☐ No ☒
If any of the Waste Site Controls are checked Yes specify control requirements including reference to the Record of Decision, TSD Closure Letter, or other relevant documents.

K. D. Bazzell DOE Federal Project Director (printed)	Signature	5/10/2007 Date
N/A Ecology Project Manager (printed)	Signature	Date
R. A. Lobos EPA Project Manager (printed)	Signature	9-20-07 Date

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ACRONYMS AND ABBREVIATIONS

CFR	Code of Federal Regulations
COC	contaminant of concern
COPC	contaminant of potential concern
CSM	conceptual site model
CVP	cleanup verification package
DCG	derived concentration guide
DOE-RL	U.S. Department of Energy, Richland Operations Office
DQA	data quality assessment
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
LCS	laboratory control spike
MCL	maximum contaminant level
MDA	minimum detectable activity
MS	matrix spike
NaI	sodium iodide
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
PARCC	Precision, Accuracy, Representativeness, Comparability, and Completeness
PQL	practical quantitation limit
QA/QC	quality assurance/quality control
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
RPD	relative percent difference
SAP	sampling and analysis plan
SCA	surface contamination area
SDG	sample delivery group
TDL	target detection limit
UCL	upper confidence limit
URMA	underground radioactive material area
WAC	Washington Administrative Code

1.0 INTRODUCTION

This cleanup verification package (CVP) documents that remediation goals for the 126-F-1, 184-F Powerhouse Ash Pit site have been attained 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* (ROD) (EPA 1997). Remedial action objectives and goals for the 126-F-1 site are documented in the ROD (EPA 1997) and the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP) (DOE-RL 2005). The ROD (EPA 1997) provides the U.S. Department of Energy, Richland Operations Office the authority, guidance, and objectives to conduct this remedial action.

Portions of the 126-F-1 Ash Pit were contaminated by unplanned releases of 105-F Reactor cooling water effluent. The northern portion of the ash pit was remediated in 2001 in accordance with the ROD (EPA 1997). The southern portion of the ash pit was sampled in 2001 and determined to meet cleanup standards through radioactive decay in 2007.

Soil cleanup levels were established in the ROD (EPA 1997) including a limited ecological risk assessment. A baseline risk assessment for the river corridor portion of the Hanford Site began in 2004, which includes a more complete quantitative ecological risk assessment. That baseline risk assessment will be used as part of a final ROD for this site.

The preferred remedy specified in the ROD (EPA 1997) and conducted for the 126-F-1 site included: (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 (ERDF) at the 200 Area of the Hanford Site, and (3) backfilling the site with overburden and clean soil to average adjacent grade elevation. Excavation was driven by remedial action objectives for direct exposure, protection of groundwater, and protection of the Columbia River.
The contaminants of concern (COCs) for the 126-F-1 Ash Pit evolved from the time the site first appeared in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (1998 RDR/RAWP) (DOE-RL 1998b) until the approval of the *Sampling and Analysis Instruction for Confirmatory Sampling of the Southern Portion of the 126-F-1 Ash Pit* (BHI 2001b).

The original COCs for 126-F-1 listed in the 1998 RDR include cesium-137, cobalt-60, europium-152, europium-154, europium-155, nickel-63, plutonium-239/240, strontium-90, chromium, and hexavalent chromium. The site was added to the *100 Area Remedial Action Sampling and Analysis Plan* in 1998 (DOE-RL 1998a) (1998 SAP) with COCs of cesium-137 and europium-152. The list of COCs was decreased in the 1998 SAP due to findings in the *Data Quality Objectives Summary Report for the 100-FR-I, 100-FR-2, 100-HR-1, 100-KR-1, and 100-KR-2 Group 4 Waste Sites* (DOE-RL 1997) (DQO Summary) which found the other contaminants to be waste characterization concerns but not COCs. The COC list was not expanded to include nonradioactive metals because process knowledge of the site showed that

contamination was caused by unplanned releases that were small in comparison to the total amount of 105-F Reactor cooling water effluent disposed to the 116-F-14 Retention Basins. Sampling results from related sites, as described below, also were evaluated to refine the COC list.

The 116-F-14 Retention Basins, which received the 105-F Reactor cooling water effluent, were remediated in 2001. The COCs identified through process knowledge for 116-F-14 listed in the *100 Area Remedial Action Sampling and Analysis Plan* (SAP) (DOE-RL 2001a) were carbon-14, cesium-137, cobalt-60, europium-152, europium-154, europium-155, nickel-63, strontium-90, chromium (total), hexavalent chromium, and cobalt. Shallow zone cleanup verification data is presented in Table 1 showing that residual concentrations of all contaminants are below lookup values from the 100 Area RDR/RAWP (DOE-RL 2005). The lookup values provided on Table 1 represent the lowest value for each COC that the data is compared to (lookup values for direct exposure, groundwater protection, or protection of the Columbia River). The only exceedance is the value for total chromium, which exceeds the groundwater protection lookup value. However, fate and transport modeling results demonstrate that total chromium will not reach groundwater within 1,000 years.

These analyses demonstrate that residual concentrations of nonradionuclides in areas contaminated by reactor cooling water effluent will also be protective of human health and the environment if residual concentrations of radionuclides are below lookup values. The correlation of the levels of nonradionuclide assays to the levels of radionuclide assays at the liquid waste sites is also discussed in the SAP (DOE-RL 2001a). Based on these evaluations, the nonradionuclides (hexavalent chromium, total chromium, and cobalt) were not included as COCs. In particular, it is known that hexavalent chromium with a distribution coefficient of 0 mL/g would have drained through the 126-F-1 coal ash and soil with the reactor cooling water while the radionuclides, which have higher distribution coefficients, would have been adsorbed by the coal ash and soil. Additionally, there is no hexavalent chromium groundwater contamination plume underlying this source unit that would indicate potential contribution from vadose zone soils.

Table 1. 116-F-14 Cleanup Verification Data Set.

Radionuclide COCs	Radionuclide Activity (pCi/g)	
	Shallow Zone	Lookup Values [a]
Carbon-14	2.0	5.16
Cesium-137	0.63	6.2
Cobalt-60	0.075	1.4
Europium-152	1.8	3.3
Europium-154	0.19	3.0
Europium-155	0.091	125
Strontium-90	0.15	4.5
Nickel-63[c]	6.0	4,026
Nonradionuclide COCs	**Nonradionuclide Concentration(mg/kg)**	
	Shallow Zone	**Lookup Values [a]**
Chromium (total)	24 [b]	18.5
Chromium (hexavalent)	1.2	2.0
Cobalt	7.7	32

[a] Per the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE-RL 2005), Table 2-7.

[b] RESidual RADioactivity (RESRAD) modeling using surrogate radionuclides determined that total chromium (with a distribution coefficient of 200 mL/g) would not reach groundwater within the period of evaluation of 1,000 years.

Additional information related to the 126-F-1 site is available from the *Cleanup Verification Package for the 1607-F-2 Septic System* (BHI 2002). A portion of 1607-F2, specifically the drain field, was located in the northern area of 126-F-1. Waste site COPCs listed in the SAP (DOE-RL 2001a) consist of cobalt-60, cesium-137, europium-154, europium-155, strontium-90, uranium-234, uranium-235, uranium-238, and arsenic. Mercury was added to the COPC list based on waste characterization sampling during remediation. However, in-process sampling and analysis of the sludge in the septic tank, septic system, and tile field determined that strontium-90, the uranium isotopes, mercury, and arsenic were not COCs for the 1607-F2 site. This sampling found that residual concentrations of strontium-90, the uranium isotopes, and mercury were at levels below Hanford Site background (DOE-RL 1996). Because a large portion of the 1607-F2 drain field is within the footprint of the 126-F-1 Ash Pit, and based on agreement between the EPA and DOE, strontium-90 and nonradionuclides were not included in the final list CVP COC list for 126-F-1. Europium-152 was included in the final COC list for 1607-F2, making this list identical to the final COC list identified in the *Sampling and Analysis Instruction for Confirmatory Sampling of the Southern Portion of the 126-F-1 Ash Pit* (BHI 2001b)

While the SAP (DOE-RL 2001a) identified only cesium-137 and europium-152 as radionuclide COCs for 126-F-1, additional COCs were added due to process knowledge and previous data collection activities. These additional COCs were added during preparation of the *Sampling and Analysis Instruction for Confirmatory Sampling of the Southern Portion of the 126-F-1 Ash Pit* (BHI 2001b) which was approved by the EPA and DOE. Given the process knowledge of the minimal volume of unplanned reactor

effluent leaks into the site, combined with the information from concurrent sampling of the 1607-F2 and 116-F-14 sites, the EPA and DOE determined that there was not a need to add additional, nonradioactive COCs for the 126-F-1 site.

The COCs for the 126-F-1 Ash Pit waste site consist of the following:

- Cesium-137
- Cobalt-137
- Europium-152
- Europium-154
- Europium-155.

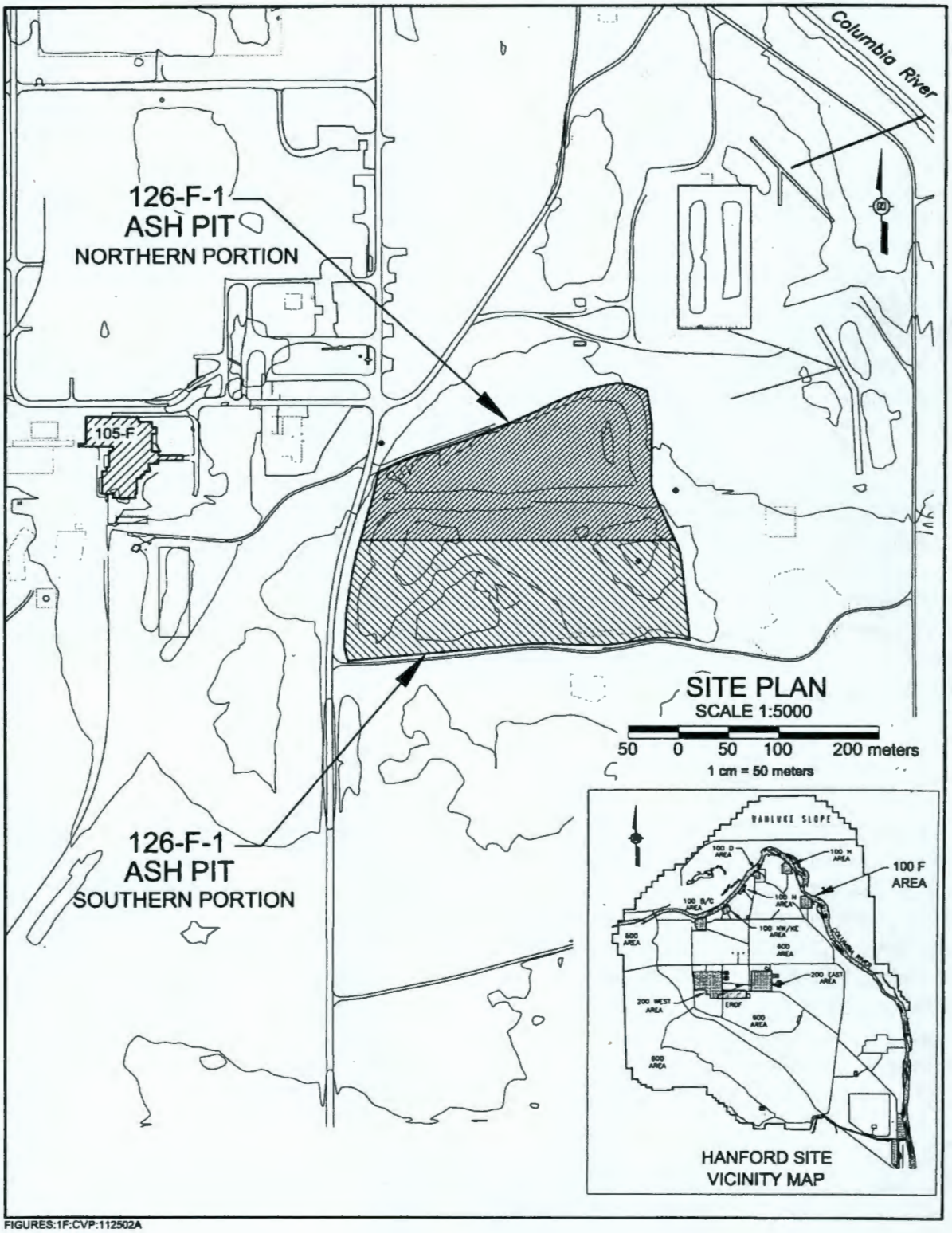
2.0 SITE DESCRIPTION AND SUPPORTING INFORMATION

The 126-F-1 site is part of the 100-FR-2 Operable Unit in the 100-F Area. The 126-F-1 site is approximately 220 m (720 ft) east of the 105-F Reactor Building and 315 m (1,033 ft) from the Columbia River (Figure 1). The 126-F-1 site was created as a result of disposal of ash from the 184-F coal-fired steam plant that operated between 1944 and 1965. Large but unquantified amounts of coal ash were sluiced to the ash pit with raw river water through a 20 cm (8 in.) pipe. Leakage of reactor cooling water from the 116-F-14, 107-F Retention Basins flowed into the northern portion of the ash pit, and was contained with an earthen dike. The coal ash sluice pipe was extended through the dike in the late 1940s to a point farther south, establishing coal ash discharge to the southern portion of the coal ash pit area.

After the 105-F Reactor was shut down in 1965, the entire ash pit was posted as a "surface contamination area" and then, later, as a "contamination area." As noted in the *126-F-1 Radiological Investigation and Downposting Final Report* (BHI 1996), routine surveillance conducted at the site as part of the Radiation Area Action project, revealed that the southern portion was improperly posted as a "contamination area." Posting of the entire ash pit as a "contamination area" had occurred out of concern that heavy equipment used to level the ash may have spread contamination throughout the entire site. In 1996, test pits were dug (BHI 1996) and radiological surveys of the entire ash pit were performed, which resulted in downposting the northern section of the pit from a "surface contamination area" to an "underground radioactive material area" and the southern section from a "surface contamination area" to no posting at all (BHI 2001b).

The area of the 1607-F2 Septic System site was contained within the boundary of the 126-F-1 Ash Pit and was excavated with the northern portion, but sampled separately. Cleanup verification of the 1607-F2 waste site is addressed in a separate CVP document (BHI 2002).

Figure 1. Hanford Site Map and 126-F-1 Site Plan.



FIGURES:1F:CVP:112502A

3.0 REMEDIAL ACTION FIELD ACTIVITIES

3.1 EXCAVATION AND DISPOSAL

Remedial action at the 126-F-1 site began on October 5, 2001. Excavation of the site involved removing the overburden materials and underlying contaminated soil in the northern portion of the site only. Based on field screening (discussed in Section 3.2), overburden materials identified as potentially clean were placed in a stockpile for potential use as backfill. Contaminated materials were disposed of at ERDF.

On June 17, 2002, the excavation of the northern portion of the site was completed. Pre- and post-remediation topographic maps are shown in Figures 2 and 3, respectively. The average elevation of the bottom of the excavation was at 119.8 m (393.0 ft) upon completion. The excavation was approximately 10,689 m^2 (115,052 ft^2) in area with a maximum depth of approximately 4 m (13 ft). Approximately 100,964 metric tons (111,313 tons) of material from the site were disposed of at ERDF.

The *Data Quality Objectives Summary Report for the 100-FR-I, 100-FR-2, 100-HR-1, 100-KR-1, and 100-KR-2 Group 4 Waste Sites* (DOE-RL 1997) identified the 126-F-1 southern portion of the site as a "Type III" site for which sampling is required to identify the nature/extent of contamination or to verify the need for remediation. Discussion with the regulators supported the use of the *Sampling and Analysis Plan for the 100 Area Remaining Sites* (Remaining Sites SAP) (DOE-RL 2000) confirmatory sampling designs to verify that the southern portion of the ash pit met the cleanup standards and that no further remediation was necessary.

3.2 FIELD SCREENING

In the northern portion of the 126-F-1 site, field screening was conducted during the site remedial action as specified in the SAP (DOE-RL 2001). Field screening was used to guide the excavation to quickly assess for the presence and level of contamination. Field screening for the 126-F-1 site included using a radiological data mapping system survey, hand-held sodium iodide (NaI) detectors, and gamma energy analyses. The radiological mapping survey is performed over more than 50% of the site excavation surface area. The hand-held NaI detector is 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.

The *Sampling and Analysis Instruction for Confirmatory Sampling of the Southern Portion of the 126-F-1 Ash Pit* (BHI 2001b) summarizes field screening activities and data for the southern portion of the site. The document describes the following activities for the southern portion:

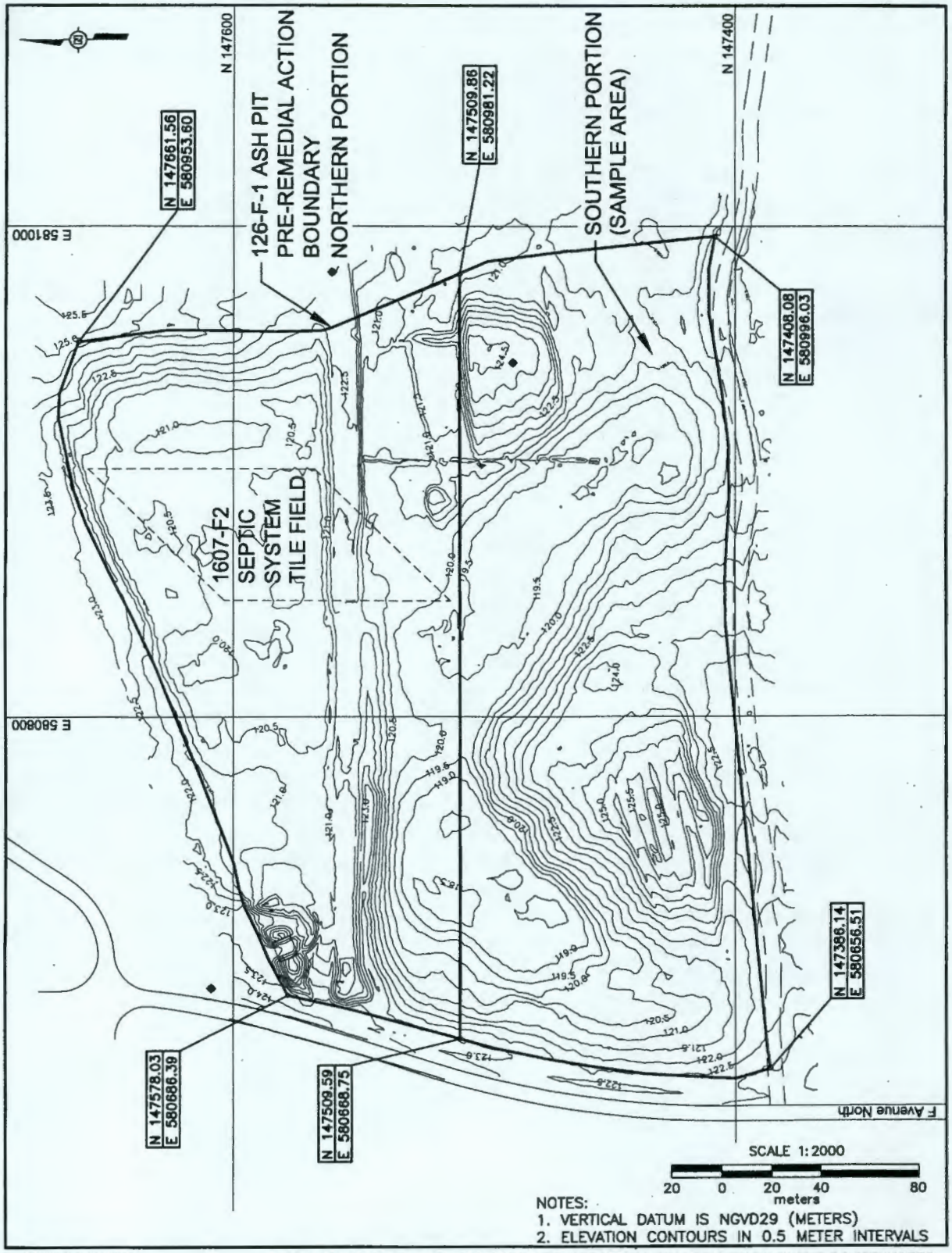
Radiological surveys of the southern portion were conducted in 1995 to support selection of remedial action alternatives for the site (BHI 1995), and identified mostly low-level contamination throughout the site. Radiological surveys, using sodium iodide (NaI) detectors and alpha energy and gamma energy analyses, were performed in March 1996 to support downposting of the southern portion of the site. Six test pits were excavated, and samples of ash were analyzed onsite using high-purity germanium and gamma spectroscopy during the March 1996 data collection activities. Results of this effort indicated that slightly elevated levels of cobalt-60, cesium-137, europium-152, and europium-154 were present at the ash pit above 1.2 m (4 ft) and concentrations decreased with depth (BHI 2001b).

In 1997, Group 4 Remedial Action performed a field investigation to evaluate if sufficient information existed to support remedial design and to fill in data gaps for some of the 100 Area waste sites (Blumenkranz 1997). As part of this activity, a test pit was excavated on the south side of the ash pit to evaluate the density of the ash for development of remedial action contract specifications. This investigation identified a coal ash layer of varying depth with a density of 999 kg/m^3 and the underlying soil (i.e., sand and gravel) with a density of 2,093 kg/m^3 (BHI 2001b).

In 1999, spectral-gamma logging using a small-diameter geophysical logging system was performed to collect data on the distribution of subsurface gamma-emitting radionuclides in the vadose zone. The gross gamma-logging data indicated elevated gamma activity in the upper few feet of each hole, generally with a peak in activity at approximately 0.5 m (1.5 ft). It was initially thought that the elevated total gamma readings (although low) represented widespread low-level contamination from the reactor effluent leakage that had mixed with powerhouse coal ash. However, after spectral gamma analysis of the data, it was determined that the increase was primarily from the naturally occurring radionuclides of potassium, uranium, and thorium. Minor concentrations of cesium-137 and cobalt-60 were determined from the spectral gamma logs for a few of the probe holes. The concentrations above minimal detectable activity levels were located within the top 1.5 m (5 ft) of the surface material. The majority of analyses from the southern portion of the site were below detection limits (BHI 2001b).

A review of the combined historical radiological field survey data, GeoProbe gamma survey data, and high-purity germanium data for test pit samples indicated that confirmatory sampling should be performed to provide evidence that the southern portion of the ash pit could be closed without remediation (BHI 2001b).

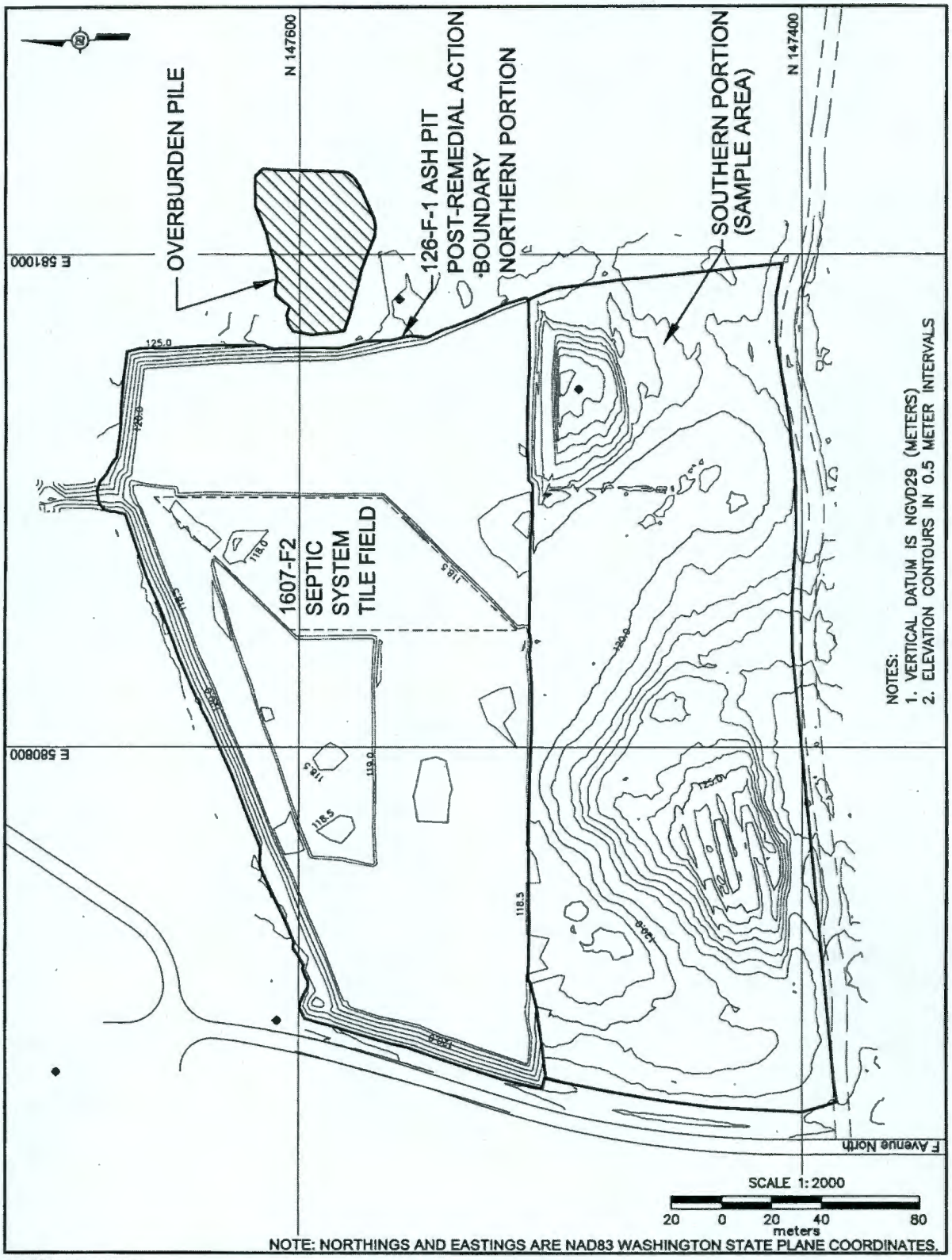
Figure 2. Pre-Remediation Topographic Plan.



FIGURES\1F\CVP\112502B

NOTE: NORTHINGS AND EASTINGS ARE NAD83 WASHINGTON STATE PLANE COORDINATES.

Figure 3. Post-Remediation Topographic Plan.



FIGURES\1F\CVP\112502C

3.3 VARIANCE SAMPLING AND ANALYSIS

Variance analysis was performed in the northern portion of the site following field screening. The variance analysis quantifies the variability of residual contamination. This information was used to determine the site-specific number of final cleanup verification samples to be collected in the northern portion of the site. Variance sampling and testing was performed on March 6, 2002. As specified in the SAP and the instruction guide (DOE-RL 2001, BHI 2001a), variance analysis was performed for the shallow zone and overburden decision units. A total of 216 variance samples were collected from the northern portion of the 126-F-1 site. Variance samples were collected in the locations shown on the 126-F-1 Ash Pit Shallow Zone Sampling Design and 126-F-1 Overburden Sampling Design calculation briefs (Appendix C).

The results of the variance analysis indicated that the number of verification samples to be taken from each decision subunit in the northern half of the site was less than the default number of four; therefore, four final verification samples were collected from each northern shallow zone decision subunit.

Using the field investigation data and the history of the site, the surface spill conceptual site model (CSM) was selected to most likely approximate the distribution of contamination in the southern portion of the 126-F-1 site. Therefore, the confirmatory sampling design, and number of confirmatory samples required, was based on the requirements specified in the Remaining Sites SAP, Appendix B, "Sampling Design for the Surface Spills Conceptual Site Model" (DOE-RL 2000). In addition, historical data were available to evaluate site and sampling variability in the southern portion of the 126-F-1 site. Specifically, test pit data obtained during sampling activities in March of 1996 for cobalt-60 and cesium-137 were used (BHI 2001b).

The first step of the surface spill CSM sample design (DOE-RL 2000) establishes the number of lateral sampling locations in the X-Y plane. Because mechanical mixing of the spill-contaminated ash occurred, a systematic grid sampling design was recommended (rather than a random sample design) to ensure that there were no significant areas of elevated concentrations above cleanup levels existing within the site. Therefore, the sample design selected was a random-start, systematic grid sample design that ensured a 95% probability of detecting a hot spot and would also support statistical treatment of the sample results. The size of a significant hot spot was set at a circle with a 22 m (72.2 ft) radius, which is smaller than the 0.2 hectare (0.5 acre) area considered by the EPA to be of a sufficient size to pose a potential human health risk in a residential setting (EPA 1996). Based upon these considerations, Visual Sample Plan[1] was used to develop the sampling design. A total of 24 samples were systematically collected on a 42 m (137.8 ft) triangular grid, having a 95% probability that a hot spot with a 22 m (72.2 ft) or greater radius would be detected.

[1] Visual Sampling Plan is a site map-based user-interface program that may be downloaded from the Internet at http://dqo.pnl.gov.

3.4 CLEANUP VERIFICATION SAMPLING AND ANALYSIS

Final cleanup verification samples were collected from the northern portion of the site following variance sampling, analysis, and data evaluation. Cleanup verification sampling in the northern portion of the site began on July 16, 2002, and concluded on July 17, 2002. The samples were submitted to offsite laboratories for analysis using approved EPA analytical methods, as required per the SAP (DOE-RL 2001). Each verification sample was a composite formed by combining samples collected at four randomly selected nodes within each sampling area (excluding the quality assurance/quality control samples). The sample design methodology and sample location figures are presented in the calculation briefs for variance analysis and sample design in Appendix C.

The division of the site excavation into decision units, as shown on the sample design figures in 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 (shallow zone and overburden soil). The northern portion of the 126-F-1 site consisted of shallow zone and overburden decision units. The site was excavated to a depth of 4 m (13 ft), with the shallow zone consisting of the excavation sidewalls together with the floor of the excavation.

As described in Section 3.3, the required number of composite samples for each decision subunit in the shallow zone was less than the default number of four composite samples specified in the SAP (DOE-RL 2001). Therefore, the default number of four samples were collected from each shallow zone decision subunit (excluding the quality assurance/quality control samples). The shallow zone decision unit for the northern portion of the site contained nine decision subunits, which were each divided into four sampling areas, giving a total of 36 sampling areas. Each sampling area was further divided into 16 sampling nodes. Four of the 16 nodes were randomly selected and sampled to form a composite sample for each sampling area.

An overburden decision unit was included with this site. The overburden decision unit for the northern portion of the site contained three decision subunits, which were each divided into four sampling areas, giving a total of 12 sampling areas. One composite cleanup verification sample from each sampling area was obtained by compositing the samples collected from four of the 16 sampling nodes for each sample area. The sample design for this site is documented in the sample area and location calculation brief included in Appendix C.

Confirmatory samples were collected from the southern portion of the site after a review of the combined historical radiological field survey data, GeoProbe gamma survey data, and high-purity germanium data for test pit ash samples indicated that confirmatory sampling should be performed to provide evidence that the southern portion of the ash pit can be closed without remediation. The site conditions, site COCs, and the CSM are used to determine the number of confirmatory samples required (as described in Section 3.3), the sampling depths, sample type, and sample locations. A complete description of the confirmatory sampling design basis for the southern half of the

126-F-1 is contained in Appendix A of the *Sampling and Analysis Instruction for Confirmatory Sampling of the Southern Portion of 126-F-1 Ash Pit* (BHI 2001b).

Confirmatory sampling in the southern portion of the site began May 21, 2001, and concluded on June 28, 2001. Samples of the ash were collected as composite samples from 0 to 0.6 m (2 ft) below ground surface at each of 24 grid sample locations, as described in Section 3.3. These samples were analyzed at an offsite laboratory.

4.0 CLEANUP VERIFICATION DATA EVALUATION

This section presents the evaluation and modeling of the 126-F-1 cleanup verification data for comparison with the data quality criteria and RAGs.

4.1 DATA QUALITY ASSESSMENT PROCESS

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

The data quality assessment for the 126-F-1 site determined that the data are of the right type, quality, and quantity to support site verification decisions within specified error tolerances. All verification and confirmatory data were found to be acceptable for decision-making purposes. The evaluation verified that the sample design was sufficient for the purpose of clean site verification. The cleanup verification sample analytical data are stored in the Hanford Environmental Information System and are summarized in Appendix A. The detailed data quality assessment 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% UCL on the arithmetic mean of the data. The 95% UCL values for each COC are computed for each decision unit (for the shallow zone and overburden). Prior to calculating the 95% UCL, the individual sample results are reviewed and, as appropriate, adjusted per the SAP (DOE-RL 2001). This process is summarized below.

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

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

- **Nonradionuclides:**

There are no nonradionuclide COCs associated with this site.

Table 2. Cleanup Verification Data.

COCs	95% UCL Statistical Values		Hanford Site Background[a]	Cleanup Verification Data Set	
	Shallow Zone	Overburden		Shallow Zone	Overburden
Northern Portion Radionuclides (pCi/g)[c]					
Cesium-137	0.39	0.097	1.1	0.39	0 (< BG)[b]
Cobalt-60	0.041	0.035	0.008	0.041	0.027[b]
Europium-152	0.66	0.29	NA[d]	0.66	0.29[b]
Europium-154	0.091	0.077	0.033	0.091	0.044[b]
Europium-155	0.12	0.054	0.054	0.12	0.00028[b]
Southern Portion Radionuclides (pCi/g)[c]					
Cesium-137	0.39	N/A	1.1	0 (< BG)[b]	N/A
Cobalt-60	0.27		0.008	0.26[b]	
Europium-152	3.5		NA[d]	3.5[b]	
Europium-154	0.45		0.033	0.42[b]	
Europium-155	0.11		0.054	0.061[b]	

[a] Represents the 90th percentile of the lognormal distribution (DOE-RL 1996).
[b] For overburden and unexcavated soil in the southern portion of the waste site, anthropogenic background (global fallout from nuclear weapons testing) and naturally occurring background is subtracted from all radionuclides. Refer to Appendix C for additional details on determination of statistical values.
[c] Laboratory data including the minimum detectable activity or practical quantitation limit for the individual cleanup verification samples are included in Appendix A and the 95% UCL calculation brief.
[d] A background value for this analyte has not been established.
BG = background
COC = contaminant of concern
N/A = not applicable. *The southern portion of the site had no associated overburden decision unit.
UCL = upper confidence limit

Statistical calculations are presented in the 126-F-1 cleanup verification 95% UCL calculation brief (Appendix C). The columns on the left side of Table 2 are the 95% statistical values before subtraction of background. The columns on the right side of the table present statistical values adjusted for background. For overburden soil, anthropogenic background (global fallout from nuclear weapons testing, DOE-RL 1996) and naturally occurring background is normally subtracted from all radionuclides, as was done for the northern portion of the site. In the southern portion, Hanford Site background values were also subtracted, since the soil was not excavated and would be impacted by anthropogenic and naturally occurring background concentrations as well. Refer to Appendix C for additional details on determination of statistical values. It is these values that constitute the cleanup verification data set and are used for RESidual RADioactivity (RESRAD) modeling.

4.3 SITE-SPECIFIC CLEANUP VERIFICATION MODEL

The site-specific cleanup verification models used for both the northern and southern portions of the site were developed using the statistical values summarized above (Table 2). The models used assume the worst case described in the RDR/RAWP (DOE-RL 2005), where the excavation statistical concentrations for the shallow zone decision units continue at the same concentrations to groundwater. Schematic cross sections of the site-specific cleanup verification models are included in the RESRAD calculations in Appendix C.

4.4 RESRAD MODELING

The individual radionuclide cleanup verification statistical values for each portion of the site (Table 2) were entered into the RESRAD computer code, Version 6.2 (ANL 2002) for the northern portion or Version 6.3 (ANL 2005) for the southern portion, to predict the dose rate and to predict the impact on groundwater and the river from residual COC concentrations. Soil concentration values for the southern portion from the 126-F-1 cleanup verification 95% UCL calculation brief (Appendix C) are reduced by radioactive decay calculations in the RESRAD calculation brief for the southern portion (Appendix C) from original sample values on 5/21/2001 to present decayed values (2/8/2007).

The RESRAD modeling methodologies, results, input values, and the site-specific cleanup verification models for the northern and southern portions of the site are included in the RESRAD calculation briefs (Appendix C). The drinking water dose rate calculations based on the RESRAD-predicted groundwater radionuclide concentrations are shown in the comparison to drinking water standards calculation briefs for each portion of the site as well (Appendix C). Specific results from the calculations are discussed in the RAG evaluation section (Section 6.0).

5.0 EVALUATION OF REMEDIAL ACTION GOAL ATTAINMENT

This section demonstrates that remedial actions at the 126-F-1 site have achieved the applicable RAGs. Sections 5.1, 5.2, and 5.3 address attainment of direct exposure, groundwater protection, and Columbia River protection RAGs, respectively.

5.1 DIRECT EXPOSURE SOIL REMEDIAL ACTION GOALS ATTAINED

5.1.1 Radionuclides

The results of the RESRAD all-pathways scenario dose rate estimate for the northern and southern portion of the site are presented in Figures 4, 5, and 6. This dose rate represents the dose contributions from soils at relevant time periods.

The dose rate was largest at year 2002 for the northern portion shallow zone (4.8 mrem/yr) and was calculated to decrease to 9.5×10^{-11} mrem/yr in 1,000 years. The estimated dose rate for the northern portion shallow zone in the year 2018 is 2.1 mrem/yr. The overburden dose rate was largest at year 2002 (1.8 mrem/yr) and was calculated to decrease to 5.0×10^{-16} mrem/yr in 1,000 years. The estimated dose rate for the northern portion overburden in the year 2018 is 0.65 mrem/yr. The 2018 date corresponds to the 30-year site cleanup schedule of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1998). The dose rate estimates for the northern portion of the site are less than the 15 mrem/yr RAG.

The confirmatory sampling data from the southern portion of the site was assessed using cleanup verification methodology. After radioactive decay from 2001 to 2007, all RAGs were met for the southern portion of the ash pit, as documented in the calculation briefs for the southern portion (Appendix C). The dose rate calculation for the southern portion of the ash pit after radioactive decay from 2001 to 2007 was 14.3 mrem/yr (Figure 6). As documented in the RESRAD calculation brief for the southern portion of the site, the dose rate is now calculated to be below the 15 mrem/yr RAG.

Figure 4. RESRAD Analysis for the Ash Pit Northern Portion Shallow Zone – All Radionuclides, All-Pathways Dose Rate Estimate.

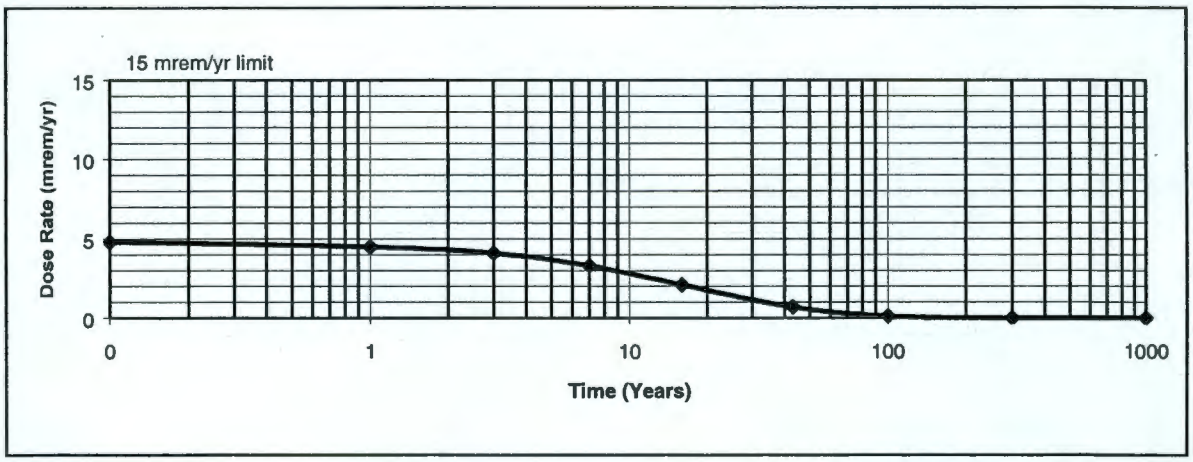


Figure 5. RESRAD Analysis for the Ash Pit Northern Portion Overburden – All Radionuclides, All-Pathways Dose Rate Estimate.

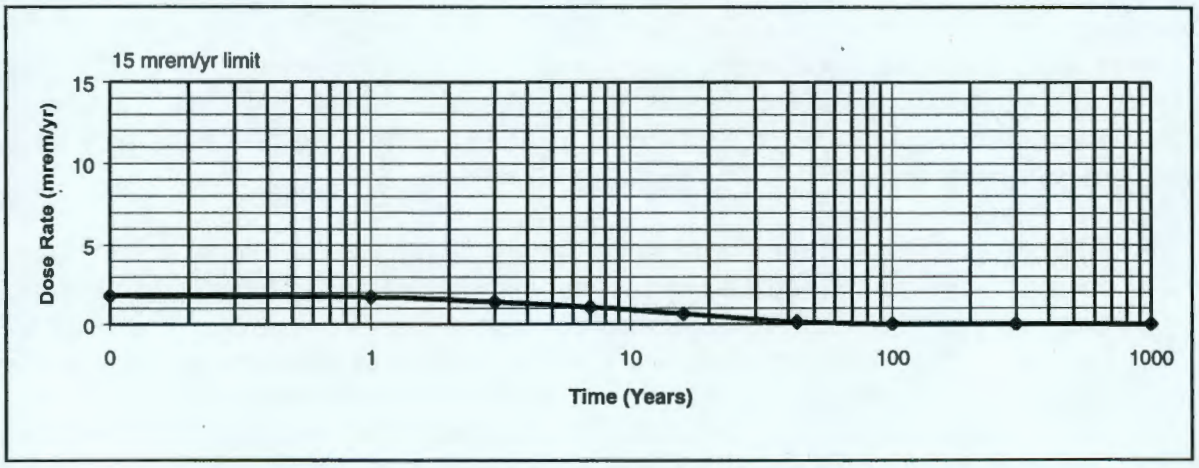
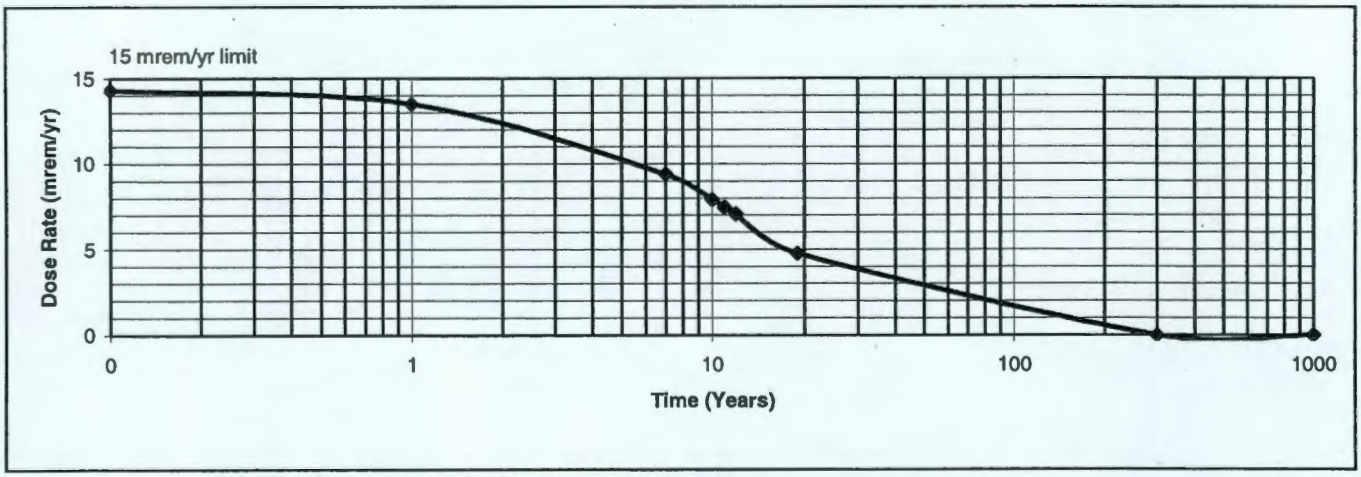


Figure 6. RESRAD Analysis for the Ash Pit Southern Portion Shallow Zone – All Radionuclides, All-Pathways Dose Rate Estimate.



The RESRAD computations for both portions of the site are presented in detail in the referenced calculation briefs summarized in Appendix C.

5.1.2 Nonradionuclides

There are no nonradionuclide COCs associated with this site.

5.2 GROUNDWATER REMEDIAL ACTION GOALS ATTAINED

5.2.1 Radionuclides

The estimated groundwater concentrations for all of the radionuclide COCs contributed by the site soils are shown in the RESRAD calculation brief (Appendix C). Table 3 shows the total peak 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 for both the northern and southern portions of the site.

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

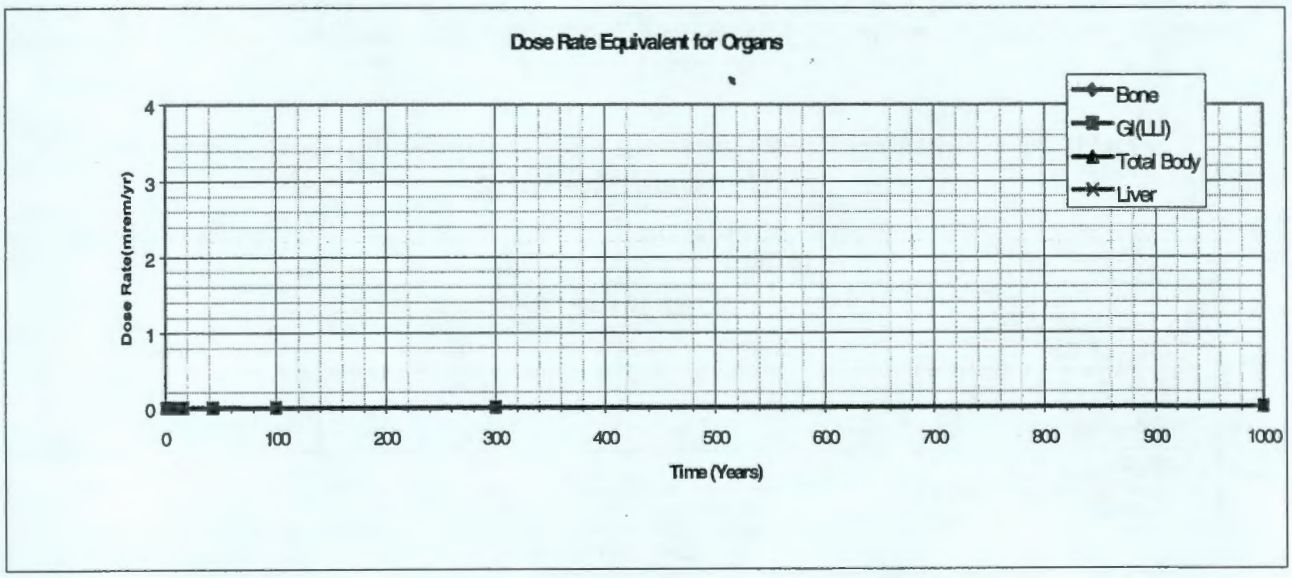
Radionuclide	Peak Concentration (pCi/L)	RAG (pCi/L)	RAGS Attained? (Yes/No)
Northern Portion			
Cesium-137	0.00029	60[b]	Yes
Cobalt-60	0.016	100[b]	Yes
Europium-152	[a]	200[b]	Yes
Europium-154	[a]	60[b]	Yes
Europium-155	[a]	600[b]	Yes
Overburden			
Cesium-137	[a]	60[b]	Yes
Cobalt-60	[a]	100[b]	Yes
Europium-152	[a]	200[b]	Yes
Europium-154	[a]	60[b]	Yes
Europium-155	[a]	600[b]	Yes
Southern Portion			
Cesium-137	[c]	60[b]	Yes
Cobalt-60	2.31E-03	100[b]	Yes
Europium-152	5.48E-03	200[b]	Yes
Europium-154	4.72E-04	60[b]	Yes
Europium-155	3.08E-05	600[b]	Yes

[a]These radionuclides do not reach groundwater in 1,000 years.
[b]Lookup value corresponding to a dose rate of 4 mrem/yr.
[c]Soil concentrations for these radionuclides are below Hanford Site background and, therefore, were not assessed using RESRAD.
RAG = remedial action goal
RESRAD = RESidual RADioactivity dose assessment model

Individual organ dose rates for beta- and gamma-emitting radionuclides predicted over 1,000 years for the northern and southern portions of the site are shown in Figure 7, as shown in the comparison to drinking water standards calculation briefs (Appendix C). None of the organ dose rates are predicted to exceed the 4 mrem/yr standard for 1,000 years following remediation.

There are no alpha emitters identified at this site; therefore, the drinking water standard for nonuranium alpha emitters and the uranium standard of 30 µg/L have been met. Results of the RESRAD calculations are shown in Appendix C.

Figure 7. Dose Rates to Organs from Groundwater.



5.2.2 Nonradionuclides

There are no nonradionuclide COCs associated with this site.

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

5.3.2 Nonradionuclides

There are no nonradionuclide COCs associated with this site.

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 (updated 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 (NCP)(40 CFR 300) presents a target range for residual risk of 10^{-4} to 10^{-6}.

Figures 8 and 10 illustrate the excess lifetime cancer risk as estimated using the RESRAD model for the northern portion shallow zone and overburden, respectively. Figure 12 illustrates excess lifetime cancer risk as estimated using the RESRAD model for the shallow zone of the southern portion of the site. Because of radioactive decay, the risk decreases over time.

For the northern portion shallow zone, the estimated risk was largest, 5.8×10^{-5}, at the time of the original RESRAD evaluation (year 2002), and decreased to 1.5×10^{-15} in 1,000 years. The estimated risk in the year 2018 is 6.8×10^{-5}. Figure 9 plots the radiation dose rate above background for the northern portion shallow zone, similar to Figure 5, and shows the corresponding radionuclide risk at the time of the original RESRAD evaluation and in the year 2018. For the overburden, the estimated risk is largest, 1.9×10^{-5}, at the time of the original RESRAD evaluation (year 2002), and decreases to 3.4×10^{-21} in 1,000 years. The estimated risk posed by overburden soil in the year 2018 is 7.3×10^{-6}. Figure 11 plots the radiation dose rate above background for the overburden soil, and shows the corresponding radionuclide risk at present and in the year 2018.

For the southern portion shallow zone, the estimated risk is largest, 2.2×10^{-4}, at present (year 2007), and decreases to 4.8×10^{-20} in 1,000 years. The estimated risk in the year 2018 is 8.4×10^{-4}. Figure 13 plots the radiation dose rate above background for the southern portion shallow zone, and shows the corresponding radionuclide risk at present and in the year 2018.

Figure 8. RESRAD Analysis for the Northern Portion Shallow Zone – Radionuclide Risk, All Pathways.

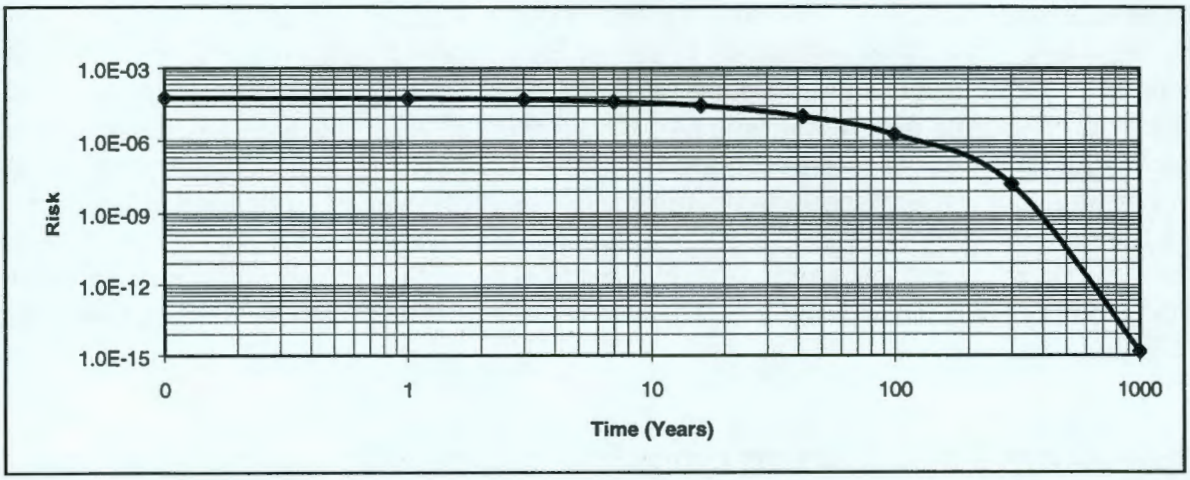


Figure 9. RESRAD Analysis for the Northern Portion Shallow Zone – Radionuclide Dose Rate, All Pathways, With Corresponding Risk Values.

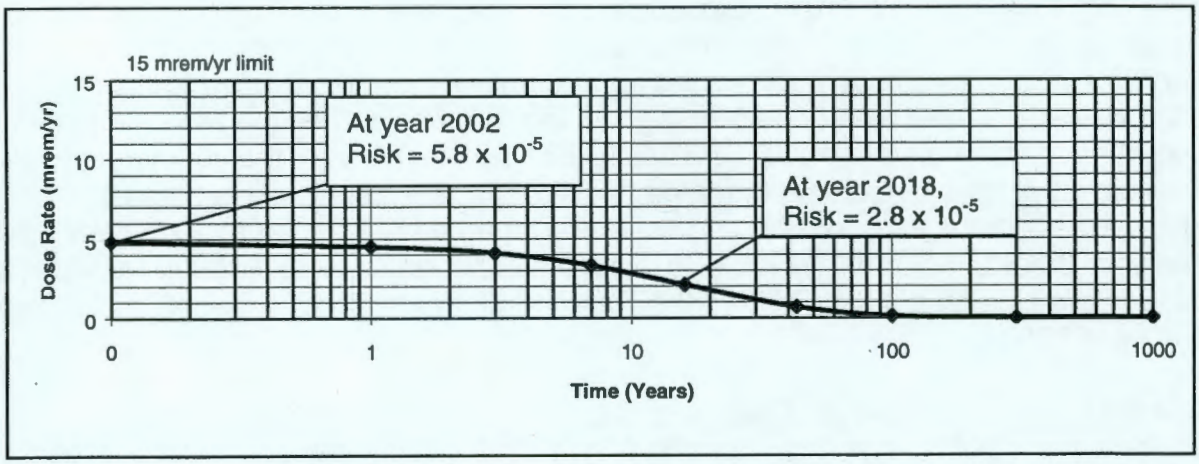


Figure 10. RESRAD Analysis for the Northern Portion Overburden – Radionuclide Risk, All Pathways.

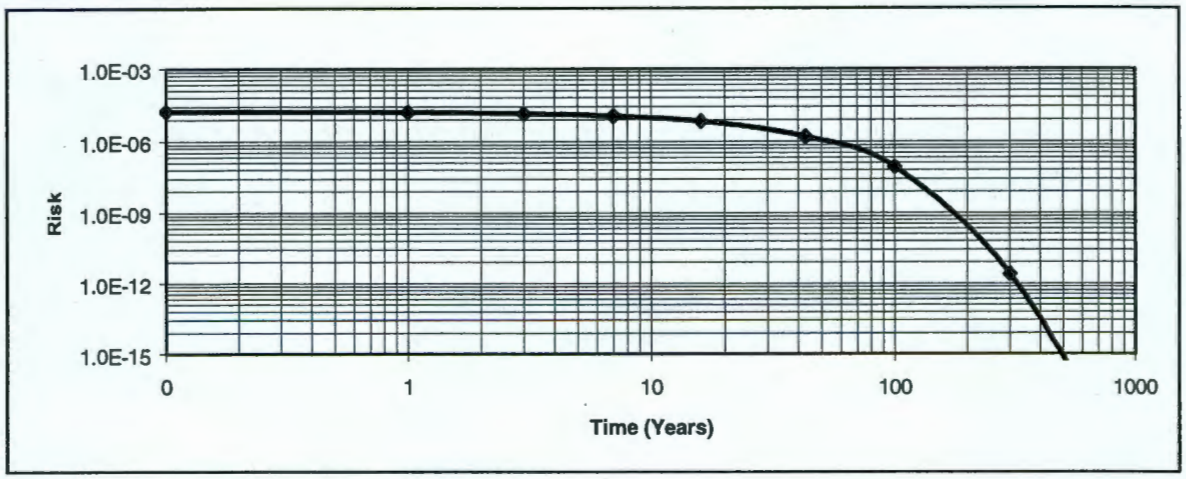


Figure 11. RESRAD Analysis for the Northern Portion Overburden– Radionuclide Dose Rate, All Pathways, With Corresponding Risk Values.

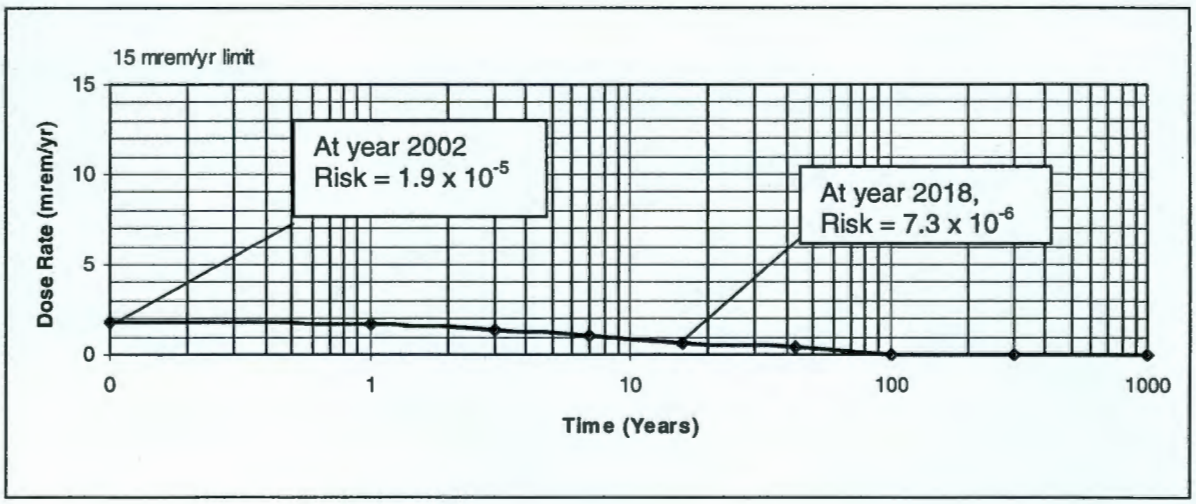


Figure 12. RESRAD Analysis for the Southern Portion Shallow Zone – Radionuclide Risk, All Pathways.

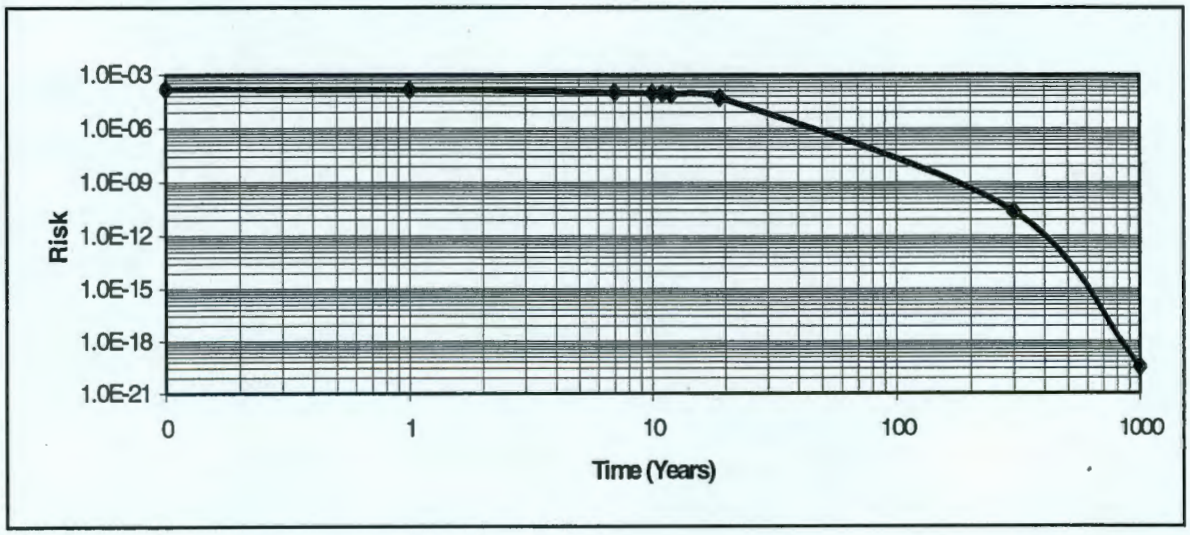
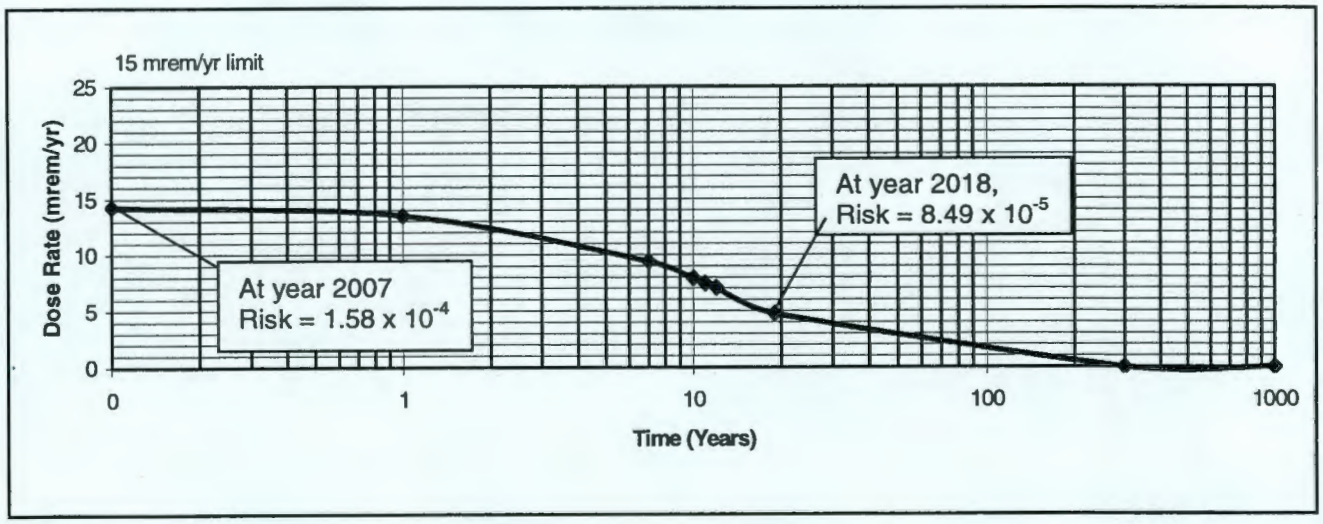


Figure 13. RESRAD Analysis for the Southern Portion Shallow Zone – Radionuclide Dose Rate, All Pathways, With Corresponding Risk Values.



7.0 STATEMENT OF PROTECTIVENESS

This CVP demonstrates that remedial action in the northern portion of the 126-F-1 site has achieved the RAOs and corresponding RAGs established in the approved Amendment to the Interim Action ROD (EPA 1997) and RDR/RAWP (DOE-RL 2005). The remaining soils in the northern portion of the 126-F-1 site have been sampled, analyzed, and modeled. The results of this effort indicate that the materials from the 126-F-1 site containing COCs at concentrations exceeding RAGs have been excavated and disposed of at ERDF. The northern portion of the 126-F-1 site is verified as remediated in accordance with the ROD (EPA 1997) and has been backfilled.

The confirmatory sampling effort in the southern portion of the 126-F-1 site determined that due to radioactive decay the dose rate would fall below the 15 mrem/yr RAG in 2007. A current dose evaluation using decayed data determines that the radionuclide dose is 14.3 mrem/yr above background. These results also indicate that residual concentrations in the shallow zone will support future land uses that can be represented (or bounded) by a rural-residential scenario, and that residual concentrations throughout the site pose no threat to groundwater or the Columbia River.

Remedial actions were not required for the northern and southern portion 126-F-1 site deep zone soils; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are not required.

8.0 REFERENCES

40 CFR 141, "National Primary Drinking Water Regulations," *Code of Federal Regulations*, as amended.

40 CFR 141.66, "National Primary Drinking Water Regulations, Maximum Contaminant Levels for Radionuclides," *Code of Federal Regulations*, as amended.

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

ANL, 2005, *RESRAD for Windows*, Version 6.3, Argonne National Laboratory, Environmental Assessment Division, Argonne, Illinois.

BHI, 1995, *100-FR-2 Operable Unit Man-Carried Radiological Detection System (MRDS) Radiological Surveys*, BHI-00339, Rev. 00, Bechtel Hanford, Inc., Richland, Washington.

BHI, 1996, *126-F-1 Radiological Investigation and Downposting Final Report*, BHI-00806, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

BHI, 2001a, *Instruction Guide for Remediation of the 100 Areas Waste Sites*, 0100X-IG-G0001, Rev. 3, Bechtel Hanford, Inc., Richland, Washington.

BHI, 2001b, *Sampling and Analysis Instruction for Confirmatory Sampling of the Southern Portion of the 126-F-1 Ash Pit*, BHI-01522, Rev. 1, Bechtel Hanford, Inc., Richland, Washington.

BHI, 2002, *Cleanup Verification for the 1607-F2 Septic System*, CVP-2002-00005, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

Blumenkranz, D. B., 1997, *Group 4 Field Investigation Results and Remedial Design Recommendations*, CCN 051553, interoffice memorandum to K. E. Cook, dated October 8, 1997, 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, 1997, *Data Quality Objectives Summary Report for the 100-FR-I, 100-FR-2, 100-HR-1, 100-KR-1, and 100-KR-2 Group 4 Waste Sites*, DOE/RL-97-61, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 2000, *Sampling and Analysis Plan for the 100 Area Remaining Sites*, DOE/RL-99-58, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 2001, *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, 2005, *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.

DOE-RL, 2007, *Tri-Party Agreement Handbook Management Procedures, RL-TPA-90-0001, Guideline Number TPA-MP-14, Rev. 1, "Maintenance of the Waste Information Data System (WIDS),"* U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Ecology, EPA, and DOE, 1998, *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.

EPA, 1996, *Guidance for Data Quality Assessment*, EPA QA/G-9, U.S. Environmental Protection Agency, Office of Research and Development, 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*, U.S. Environmental Protection Agency, Region 10, Seattle, Washington.

EPA, 1999, *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington*, July 1999, U.S. Environmental Protection Agency, Region 10, Seattle, Washington.

WAC 173-340-740(7)(g), "Model Toxics Control Act – Cleanup, Soil Cleanup Standards," *Washington Administrative Code*, as amended, 1996.

APPENDIX A

SUMMARY OF VERIFICATION SOIL SAMPLING AND ANALYTICAL RESULTS

Table A-1. Northern Portion Shallow Zone Cleanup Verification Data (Sample Date 7/16/02 and 7/17/02). (2 pages)

Sampling Area	HEIS Number	Sample Date	Cs-137			Co-60			Eu-152			Eu-154			Eu-155		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
A1	J000C2	07/16/2002	9.30E-02	a	3.50E-02	1.10E-01	U	1.10E-01	1.80E-01	U	1.80E-01	1.20E-01	U	1.20E-01	1.10E-01	U	1.10E-01
Duplicate of J000C2	J000F0	07/16/2002	7.00E-02	a	4.50E-02	4.20E-02	U	4.20E-02	1.10E-01	U	1.10E-01	1.40E-01	U	1.40E-01	1.00E-01	U	1.00E-01
Split of J000C2	J000J0	7/16/2002	5.91E-02		1.79E-02	6.25E-03	U	2.18E-02	7.38E-02	U	5.48E-02	1.57E-02	U	6.86E-02	4.99E-02	U	4.88E-02
E9	J000F1	07/16/2002	2.88E-01		5.20E-02	6.80E-02	U	6.80E-02	9.54E-01		1.30E-01	2.10E-01	U	2.10E-01	1.60E-01	U	1.60E-01
Duplicate of J000F1	J000H9	07/16/2002	3.73E-01		6.10E-02	5.70E-02		4.10E-02	9.97E-01		1.10E-01	1.70E-01	U	1.70E-01	1.30E-01	U	1.30E-01
Split of J000F1	J000J1	07/16/2002	4.56E-01		2.91E-02	3.58E-02	U	3.13E-02	1.06E+00		6.90E-02	1.48E-01	U	1.01E-01	9.10E-02	U	7.51E-02
A2	J000C3	07/16/2002	5.33E-01		3.60E-02	3.50E-02	a	3.10E-02	4.88E-01		6.70E-02	1.00E-01	U	1.00E-01	6.30E-02	U	6.30E-02
A3	J000C4	07/16/2002	1.12E+00		4.00E-02	7.60E-02		3.00E-02	4.66E-01		7.30E-02	1.20E-01	U	1.20E-01	6.70E-02	U	6.70E-02
A4	J000C5	07/16/2002	5.13E-01		4.70E-02	9.50E-02	U	9.50E-02	4.35E-01		1.20E-01	1.20E-01	U	1.20E-01	1.80E-01	U	1.80E-01
B5	J000C6	07/16/2002	2.09E-01		4.40E-02	4.10E-02	U	4.10E-02	1.60E-01	U	1.60E-01	1.20E-01	U	1.20E-01	1.10E-01	U	1.10E-01
B6	J000C7	07/16/2002	1.50E-01		3.10E-02	5.90E-02	U	5.90E-02	2.14E-01		5.90E-02	1.00E-01	U	1.00E-01	1.00E-01	U	1.00E-01
B7	J000C8	07/16/2002	3.09E-01		6.60E-02	7.00E-02	U	7.00E-02	4.46E-01		1.10E-01	1.90E-01	U	1.90E-01	9.80E-02	U	9.80E-02
B8	J000C9	07/16/2002	1.94E-01		5.30E-02	6.20E-02	U	6.20E-02	6.30E-01		9.20E-02	1.60E-01	U	1.60E-01	1.10E-01	U	1.10E-01
C9	J000D0	07/16/2002	2.56E-01		3.60E-02	5.00E-02		2.80E-02	7.78E-01		5.80E-02	1.10E-01	U	1.10E-01	9.10E-02	U	9.10E-02
C10	J000D1	07/16/2002	6.15E-01		7.10E-02	4.80E-02	U	4.80E-02	7.70E-01		1.70E-01	1.30E-01	U	1.30E-01	2.40E-01	U	2.40E-01
C1	J000D2	07/16/2002	2.10E-01		9.00E-02	7.60E-02	U	7.60E-02	4.34E-01		1.60E-01	2.00E-01	U	2.00E-01	1.70E-01	U	1.70E-01
C2	J000D3	07/16/2002	1.36E-01		4.70E-02	4.40E-02	U	4.40E-02	2.40E-01	U	2.40E-01	1.20E-01	U	1.20E-01	1.00E-01	U	1.00E-01
D3	J000D4	07/16/2002	1.96E-01		5.10E-02	4.10E-02	U	4.10E-02	4.30E-01	U	4.30E-01	1.30E-01	U	1.30E-01	8.90E-02	U	8.90E-02
D4	J000D5	07/16/2002	3.42E-01		6.00E-02	5.10E-02	U	5.10E-02	4.00E-01	U	4.00E-01	1.60E-01	U	1.60E-01	1.80E-01	U	1.80E-01
D5	J000D6	07/16/2002	4.30E-02	a	3.50E-02	3.50E-02	U	3.50E-02	1.50E-01	U	1.50E-01	1.10E-01	U	1.10E-01	9.30E-02	U	9.30E-02
D6	J000D7	07/16/2002	1.75E-01		4.30E-02	4.20E-02	U	4.20E-02	2.75E-01		8.30E-02	1.30E-01	U	1.30E-01	1.00E-01	U	1.00E-01
E7	J000D8	07/16/2002	8.31E-01		6.20E-02	1.10E-01	U	1.10E-01	1.67E+00		1.00E-01	3.00E-01	U	3.00E-01	1.70E-01	U	1.70E-01
E8	J000D9	07/16/2002	4.42E-01		6.80E-02	6.60E-02	U	6.60E-02	6.77E-01		1.20E-01	2.00E-01	U	2.00E-01	1.90E-01	U	1.90E-01
E10	J000F2	07/17/2002	1.09E+00		2.40E-02	7.10E-02		1.70E-02	1.93E+00		5.80E-02	1.60E-01		5.50E-02	9.40E-02	U	9.40E-02
F1	J000F3	07/17/2002	7.13E-01		3.60E-02	1.00E-01		2.70E-02	2.70E+00		6.00E-02	2.47E-01		8.60E-02	9.40E-02	U	9.40E-02
F2	J000F4	07/17/2002	3.96E-01		1.10E-02	2.70E-02	a	1.40E-02	4.42E-01		3.00E-02	6.00E-02	U	6.00E-02	3.20E-02	a	3.20E-02
F3	J000F5	07/17/2002	9.30E-02	a	5.20E-02	5.40E-02	U	5.40E-02	3.07E-01		9.20E-02	1.80E-01	U	1.80E-01	1.20E-01	U	1.20E-01
F4	J000F6	07/17/2002	1.10E-01	U	1.10E-01	4.80E-02	U	4.80E-02	1.60E-01	U	1.60E-01	1.50E-01	U	1.50E-01	1.10E-01	U	1.10E-01
G5	J000F7	07/17/2002	1.22E-01		1.70E-02	2.30E-02	U	2.30E-02	2.20E-01		3.40E-02	4.90E-02	U	4.90E-02	3.50E-02	U	3.50E-02

Table A-1. Northern Portion Shallow Zone Cleanup Verification Data (Sample Date 7/16/02 and 7/17/02). (2 pages)

Sampling Area	HEIS Number	Sample Date	Cs-137			Co-60			Eu-152			Eu-154			Eu-155		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
G6	J000F8	07/17/2002	7.30E-02		3.00E-02	2.80E-02	U	2.80E-02	1.40E-01	U	1.40E-01	9.40E-02	U	9.40E-02	5.50E-02	U	5.50E-02
G7	J000F9	07/17/2002	9.30E-02	a	4.70E-02	4.60E-02	U	4.60E-02	1.60E-01	U	1.60E-01	1.60E-01	U	1.60E-01	1.00E-01	U	1.00E-01
G8	J000H0	07/17/2002	9.20E-02	U	9.20E-02	4.90E-02	U	4.90E-02	1.10E-01	U	1.10E-01	1.60E-01	U	1.60E-01	7.50E-02	U	7.50E-02
H9	J000H1	07/17/2002	2.08E-01		4.10E-02	6.70E-02	U	6.70E-02	6.14E-01		8.10E-02	1.20E-01	U	1.20E-01	1.20E-01	U	1.20E-01
H10	J000H2	07/17/2002	2.86E-01		4.50E-02	6.50E-02		3.70E-02	6.23E-01		7.70E-02	1.40E-01	U	1.40E-01	1.30E-01	U	1.30E-01
H1	J000H3	07/17/2002	5.44E-01		3.70E-02	6.80E-02	U	6.80E-02	5.84E-01		7.40E-02	1.20E-01	U	1.20E-01	8.70E-02	U	8.70E-02
H2	J000H4	07/17/2002	5.90E-02	U	5.90E-02	5.60E-02	U	5.60E-02	1.30E-01	U	1.30E-01	2.20E-01	U	2.20E-01	1.00E-01	U	1.00E-01
I3	J000H5	07/17/2002	1.00E-01		4.30E-01	6.20E-02	U	6.20E-02	3.91E-01		8.50E-02	1.40E-01	U	1.40E-01	1.30E-01	U	1.30E-01
I4	J000H6	07/17/2002	1.09E-01		4.10E-02	3.70E-02		3.70E-02	1.10E-01	U	1.10E-01	1.30E-01	U	1.30E-01	7.30E-02	U	7.30E-02
I5	J000H7	07/17/2002	3.11E-01		5.90E-02	6.70E-02	U	6.70E-02	2.00E-01	U	2.00E-01	1.90E-01	U	1.90E-01	9.40E-02	U	9.40E-02
I6	J000H8	07/17/2002	3.14E-01		3.10E-02	1.10E-01	U	1.10E-01	7.84E-01		8.80E-02	1.70E-01	U	1.70E-01	1.30E-01	U	1.30E-01

[a]Because of laboratory reporting conditions, these data were given a non-relevant "J" qualifier that appears in the Hanford Environmental Information System (HEIS) database and in analytical data. The data quality assessment (Appendix B) further discusses the "J" qualifiers applied during validation.
U = Below laboratory detection limits

Table A-2. Northern Portion Overburden Cleanup Verification Data (Sample Date 7/15/02).

Sampling Area	HEIS Number	Sample Date	Cs-137			Co-60			Eu-152			Eu-154			Eu-155		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
A1	J00097	07/15/2002	4.90E-02	U	4.90E-02	5.50E-02	U	5.50E-02	1.00E-01	U	1.00E-01	1.80E-01	U	1.80E-01	8.10E-02	U	8.10E-02
Duplicate of J00097	J000B9	07/15/2002	1.10E-01	U	1.10E-01	3.10E-02	U	3.10E-02	9.10E-02	U	9.10E-02	1.00E-01	U	1.00E-01	1.40E-01	U	1.40E-01
Split of J00097	J000C1	07/15/2002	1.4E-02	U	2.2E-02	6.5E-03	U	2.1E-02	-3.7E-03	U	4.7E-02	-5.7E-02	U	6.3E-02	3.1E-02	U	4.7E-02
A2	J00098	07/15/2002	6.60E-02	a	3.60E-02	3.20E-02	U	3.20E-02	7.00E-02	U	7.00E-02	1.10E-01	U	1.10E-01	6.30E-02	U	6.30E-02
A3	J00099	07/15/2002	4.80E-02	U	4.80E-02	5.10E-02	U	5.10E-02	1.20E-01	U	1.20E-01	1.80E-01	U	1.80E-01	1.10E-01	U	1.10E-01
A4	J000B0	07/15/2002	1.07E-01		4.00E-02	3.80E-02	U	3.80E-02	2.10E-01	U	2.10E-01	1.30E-01	U	1.30E-01	1.20E-01	U	1.20E-01
B5	J000B1	07/15/2002	5.00E-02	a	2.90E-02	3.60E-02	U	3.60E-02	1.10E-01	U	1.10E-01	1.20E-01	U	1.20E-01	1.10E-01	U	1.10E-01
B6	J000B2	07/15/2002	8.70E-02	a	4.30E-02	5.30E-02	U	5.30E-02	2.00E-01	U	2.00E-01	1.70E-01	U	1.70E-01	7.80E-02	U	7.80E-02
B7	J000B3	07/15/2002	1.11E-01		3.50E-02	3.40E-02	U	3.40E-02	1.73E-01		6.30E-02	1.10E-01	U	1.10E-01	5.90E-02	U	5.90E-02
B8	J000B4	07/15/2002	7.30E-02	a	4.20E-02	5.00E-02	U	5.00E-02	2.56E-01		1.00E-01	1.60E-01	U	1.60E-01	1.10E-01	U	1.10E-01
C9	J000B5	07/15/2002	4.50E-02	U	4.50E-02	4.50E-02	U	4.50E-02	1.20E-01	U	1.20E-01	1.60E-01	U	1.60E-01	1.10E-01	U	1.10E-01
C10	J000B6	07/15/2002	1.97E-01		4.70E-02	8.10E-02		4.00E-01	9.56E-01		9.40E-02	1.50E-01	U	1.50E-01	1.40E-01	U	1.40E-01
C1	J000B7	07/15/2002	6.70E-02	U	6.70E-02	5.30E-02	U	5.30E-02	1.10E-01	U	1.10E-01	1.70E-01	U	1.70E-01	8.00E-02	U	8.00E-02
C2	J000B8	07/15/2002	6.80E-02	a	3.30E-02	3.30E-02	U	3.30E-02	1.02E-01		6.00E-02	1.10E-01	U	1.10E-01	6.00E-02	U	6.00E-02

[a]Because of laboratory reporting conditions, these data were given a nonrelevant "J" qualifier that appears in the Hanford Environmental Information System (HEIS) database and in analytical data. The data quality assessment (Appendix B) further discusses the "J" qualifiers applied during validation.
U = Below laboratory detection limits

Table A-3. Southern Portion Shallow Zone Cleanup Verification Data (Sample Date 5/21/01, 6/18/01). (2 pages)

Sample Area	HEIS Number	Sample Date	Cs-137			Co-60			Eu-152			Eu-154			Eu-155		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
2	B121M4	5/21/2001	1.50E-01		7.20E-02	1.36E-01		7.40E-02	9.57E-01		1.80E-01	2.50E-01	U	2.50E-01	1.80E-01	U	1.80E-01
Duplicate of B121M4	B121P8	5/21/2001	1.44E-01		5.80E-02	5.40E-02	U	5.40E-02	1.50E-01	U	1.50E-01	1.50E-01	U	1.50E-01	1.80E-01	U	1.80E-01
17	B121N9	5/21/2001	8.70E-02	a	4.20E-02	3.50E-02	U	3.50E-02	1.02E-01		7.50E-02	1.00E-01	U	1.00E-01	1.10E-01	U	1.10E-01
Duplicate of B121N9	B121P7	5/21/2001	4.90E-02	U	4.90E-02	4.90E-02	U	4.90E-02	2.00E-01	U	2.00E-01	1.20E-01	U	1.20E-01	1.40E-01	U	1.40E-01
13	B121N5	5/21/2001	1.10E+00		1.60E-01	1.63E+00		1.00E-01	1.46E+01		2.20E-01	1.73E+00		3.40E-01	2.40E-01	U	2.40E-01
	B12688	6/18/2001	5.83E-01		3.00E-01	7.34E-01		2.30E-01	6.84E+00		3.70E-01	6.50E-01		6.90E-01	3.30E-01	U	3.30E-01
Duplicate of B12688	B12692	6/18/2001	9.68E-01		1.60E-01	6.24E-01		1.50E-01	6.46E+00		3.60E-01	1.01E+00		4.60E-01	5.70E-01	U	5.70E-01
19	B121P1	5/21/2001	7.10E-02	a	2.80E-02	5.80E-02	U	5.80E-02	2.07E-01		1.00E-01	1.20E-01	U	1.20E-01	1.10E-01	U	1.10E-01
20	B121P2	5/21/2001	1.02E-01		2.30E-02	1.80E-02	U	1.80E-02	7.10E-02	U	7.10E-02	5.50E-02	U	5.50E-02	5.60E-02	U	5.60E-02
21	B121P3	5/21/2001	1.16E-01		3.30E-02	2.50E-02	U	2.50E-02	1.10E-01	U	1.10E-01	7.80E-02	U	7.80E-02	8.80E-02	U	8.80E-02
22	B121P4	5/21/2001	1.41E+00		1.70E-01	1.06E+00		9.20E-02	1.53E+01		2.40E-01	1.90E+00		3.30E-01	4.60E-01	U	4.60E-01
23	B121P5	5/21/2001	2.60E-01		7.70E-02	9.50E-02		5.50E-02	2.62E+00		1.40E-01	3.17E-01		2.00E-01	1.80E-01	U	1.80E-01
15	B121N7	5/21/2001	2.37E-01		4.40E-02	6.40E-02		4.10E-02	1.30E+00		7.90E-02	1.20E-01	U	1.20E-01	1.10E-01	U	1.10E-01
14	B121N6	5/21/2001	9.50E-02	a	6.00E-02	4.60E-02	U	4.60E-02	1.30E-01	U	1.30E-01	1.60E-01	U	1.60E-01	1.50E-01	U	1.50E-01
7	B121M9	5/21/2001	7.70E-02	U	7.70E-02	8.30E-02	U	8.30E-02	2.10E-01	U	2.10E-01	2.20E-01	U	2.20E-01	1.90E-01	U	1.90E-01
12	B121N4	5/21/2001	8.30E-02	U	8.30E-02	7.50E-02	U	7.50E-02	1.80E-01	U	1.80E-01	2.10E-01	U	2.10E-01	2.40E-01	U	2.40E-01
11	B121N3	5/21/2001	1.01E-01		4.50E-02	5.20E-02	U	5.20E-02	1.90E-01	U	1.90E-01	1.40E-01	U	1.40E-01	1.90E-01	U	1.90E-01
6	B121M8	5/21/2001	6.20E-02	a	2.90E-02	3.50E-02	U	3.50E-02	9.40E-02	U	9.40E-02	1.00E-01	U	1.00E-01	1.10E-01	U	1.10E-01
5	B121M7	5/21/2001	7.84E-01		9.70E-02	4.94E-01		7.40E-02	7.22E+00		1.70E-01	7.91E-01		2.00E-01	2.10E-01	U	2.10E-01
	B12689	6/18/2001	2.50E-01		1.10E-01	2.33E-01		9.30E-02	2.71E+00		2.00E-01	3.93E-01		3.40E-01	3.30E-01	U	3.30E-01
10	B121N2	5/21/2001	1.42E-01		7.40E-02	9.70E-02		5.90E-02	8.27E-01		1.20E-01	1.90E-01	U	1.90E-01	2.00E-01	U	2.00E-01
4	B121M6	5/21/2001	4.04E-01		4.80E-02	2.92E-01		3.30E-02	3.88E+00		8.20E-02	6.01E-01		1.20E-01	1.10E-01	U	1.10E-01
	B12690	6/18/2001	3.19E-01		1.70E-01	2.40E-01	U	2.40E-01	1.92E+00		3.60E-01	5.80E-01	U	5.80E-01	2.60E-01	U	2.60E-01
3	B121M5	5/21/2001	1.92E-01		4.80E-02	4.90E-02	a	3.90E-02	8.94E-01		1.10E-01	1.40E-01	U	1.40E-01	1.30E-01	U	1.30E-01
24	B121P6	5/21/2001	2.20E-01		4.80E-02	4.80E-02	U	4.80E-02	1.10E-01	U	1.10E-01	1.50E-01	U	1.50E-01	1.70E-01	U	1.70E-01
9	B121N1	5/21/2001	3.76E-01		6.80E-02	2.14E-01		4.00E-02	3.15E+00		1.10E-01	3.30E-01		1.80E-01	1.50E-01	U	1.50E-01

Table A-3. Southern Portion Shallow Zone Cleanup Verification Data (Sample Date 5/21/01, 6/18/01). (2 pages)

Sample Area	HEIS Number	Sample Date	Cs-137			Co-60			Eu-152			Eu-154			Eu-155		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
1	B121M3	5/21/2001	3.32E-01		8.40E-02	1.41E-01		6.70E-02	1.79E+00		1.40E-01	2.80E-01	U	2.80E-01	1.10E-01	U	1.10E-01
8	B121N0	5/21/2001	8.52E-01		1.00E-01	4.43E-01		4.80E-02	9.08E+00		1.70E-01	9.36E-01		2.00E-01	2.40E-01	U	2.40E-01
	B12691	6/18/2001	6.34E-01		2.50E-01	4.88E-01		1.10E-01	9.12E+00		4.70E-01	1.24E+00		4.10E-01	8.00E-01	U	8.00E-01
16	B121N8	5/21/2001	1.71E-01		6.40E-02	5.50E-02	U	5.50E-02	1.40E-01	U	1.40E-01	1.70E-01	U	1.70E-01	1.30E-01	U	1.30E-01
18	B121P0	5/21/2001	8.80E-02	a	5.70E-02	4.80E-02	U	4.80E-02	2.50E-01	U	2.50E-01	1.50E-01	U	1.50E-01	1.70E-01	U	1.70E-01

[a]Because of laboratory reporting conditions, these data were given a nonrelevant "J" qualifier that appears in the Hanford Environmental Information System (HEIS) database and in analytical data. The data quality assessment (Appendix B) further discusses the "J" qualifiers applied during validation.
U = Below laboratory detection limits

APPENDIX B

DATA QUALITY ASSESSMENT

B1.0 DATA QUALITY ASSESSMENT FOR THE 126-F-1 SITE

B1.1 OVERVIEW

This data quality assessment (DQA) was performed to compare the verification sampling approach and resulting analytical data with the sampling and data quality requirements specified by the project objectives and performance specifications. The DQA involves the scientific and statistical evaluation of the data to determine if they are of the right type, quality, and quantity to support their intended use (i.e., closeout decisions [EPA 1996]). The DQA completes the data life cycle (i.e., planning, implementation, and assessment) that was initiated by the data quality objectives process.

This DQA was performed in accordance with BHI-EE-01, *Environmental Investigations Procedures.* Specific data quality objectives for the site are found in the *100 Area Remedial Action Sampling and Analysis Plan* (SAP) (DOE-RL 2001). The DQA is based on the guidelines presented in *Guidance for Data Quality Assessment* (EPA 2000). Statistical tests used in this DQA were performed as specified in the SAP (DOE-RL 2001) and the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP) (DOE-RL 2005).

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

The DQA for the 126-F-1 site determined that the data are of the right type, quality, and quantity to support site cleanup verification decisions within specified error tolerances. All analytical data were found to be acceptable for decision-making purposes. The evaluation verified that the sample design was sufficient for the purpose of clean site verification. Additional quality requirements of the quality assurance project plan included data acquisition requirements. The cleanup verification sample analytical data are stored in the Hanford Environmental Information System and are summarized in Appendix A.

The following subsections describe the DQA results for the 126-F-1 site, including formal data validation, supplementary data evaluation, and field quality assurance

(QA)/quality control (QC) program results. The statistical evaluation of the data is provided in the calculation brief excerpts included in Appendix C.

B1.2 DATA VALIDATION

B1.2.1 Laboratory QA/QC Analysis

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

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

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

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

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

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

B1.2.2 Data Validation Results

After sampling was completed, all of the fixed-base laboratory data from one SDG, H1868, were validated to Level C per BHI-EE-01, Procedure 2.5, "Data Package Validation Process." Level C validation procedures are specified in *Data Validation Procedure for Radiochemical Analysis* (BHI 2000a) and *Data Validation Procedure for Chemical Analysis* (BHI 2000b). Validation was performed by Tech Law, Inc. (Tech Law 2002).

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

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

Data flagged 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 that 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 target detection limits pursuant to the SAP (DOE-RL 2001). The organization performing the data validation reported that, of the data given formal validation, the laboratory met the standards for performance for precision (±30%), accuracy (±30%), and completeness (>90%). Comparison of the TDL with the respective MDA or PQL is discussed in Section B1.3.

A summary of deficiencies noted during validation of SDG H1868 follows:

Radionuclides. The DQA noted no major deficiencies. Minor deficiencies noted during validation include the following:

- Of the 47 missed TDL nondetects, only 5 exceeded the TDL by more than a factor of 2. All missed TDL nondetects in shallow zone samples were less than one-tenth of their associated RAGs. Additional discussion on analyses with missed MDAs is provided in Section B1.3.

B1.3 DATA EVALUATION

The formal data validation described in the previous section included evaluation of only one SDG; however, a DQA is required for all SDGs. Therefore, a supplementary data evaluation was performed on the remaining SDGs. The following paragraphs include the results of the data evaluation of all SDGs.

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

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

The reported MDA was above the TDL for the following COCs:

- Cesium-137: 2 of 6 nondetect results
- Cobalt-60: 34 of 61 nondetect results
- Europium-152: 31 of 32 nondetect results
- Europium-154: 63 of 76 nondetect results
- Europium-155: 56 of 92 nondetect results.

Of the 186 missed TDL nondetects, only 8 exceeded the TDL by more than a factor of 3. All missed TDL nondetects in shallow zone samples were less than one-tenth of their associated RAGs with three exceptions (europium-152 in sample B12690 with a result of 0.58 pCi/g [U], europium-152 in sample J000D4 with a result of 0.43 pCi/g [U], and europium-152 in sample J000D5 with a result of 0.40 pCi/g [U]; the direct exposure RAG is 3.0 pCi/g). Because the reported values are sufficiently less than the remedial action goals, the associated data are of sufficient quality for decision-making purposes (DOE-RL 2005).

All other nondetected analyses had detection limits below the TDL.

All other parameters meet acceptance criteria.

B1.4 FIELD QA/QC

Field QA/QC measures were used to assess potential sources of error and cross-contamination of soil samples that could bias results. Field QA/QC samples included two equipment blanks:

- Sample B121P9, associated with shallow zone main sample B121M5
- Sample J000C0, associated with overburden main sample J00097.

Field QA/QC samples also included five field duplicate samples:

- Sample B121P8, duplicate of southern shallow zone main sample B121M4
- Sample B121P7, duplicate of southern shallow zone main sample B121N9
- Sample B12692, duplicate of southern shallow zone main sample B12688
- Sample J000F0, duplicate of northern shallow zone main sample J000C0
- Sample J000H9, duplicate of northern shallow zone main sample J000F1
- Sample J000B9, duplicate of overburden main sample J00097.

Field QA/QC samples included three field split samples:

- Sample J000J0, split of northern shallow zone main sample J000C0
- Sample J000J1, split of northern shallow zone main sample J000F1
- Sample J000C1, split of overburden main sample J00097.

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

B1.4.1 Equipment Blank Samples

Two equipment blank samples (B121P9, associated with southern shallow zone main sample B121M5; J000C0, associated with overburden main sample J00097) were collected as part of the QA/QC measures. The blank sample results for this site were less than detection for all COCs.

B1.4.2 Field Duplicate Samples

Duplicate samples were collected to provide a relative measure of the degree of local heterogeneity in the sampling medium, unlike laboratory duplicates that are used to evaluate precision in the analytical process. The field duplicates are evaluated by computing the RPD of the duplicate samples for each COC. Only analytes with values above five times the detection limits for both the main and duplicate samples are compared.

Based on these criteria, calculation of the RPD was required for results for two cesium-137 pairs, two cobalt-60 pairs, three europium-152 pairs, and one europium-154 pair. All calculated RPDs were within the +/-30% range.

B1.4.3 Field Split Samples

Split samples were collected to provide a relative measure of the degree of variability in the sampling, sample handling, and analytical techniques used by commercial laboratories. The field main and split samples are evaluated by computing the RPD of the split samples for each COC to determine the usability of the verification data. The U.S. Environmental Protection Agency Contract Laboratory Program duplicate sample comparison methodology, *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (EPA 1994), is used as an initial test of the data from the splits. Only analytes that had values above five times the TDLs or contract required detection limit for both the main and split sample were compared.

Based on these criteria, calculation of the RPD was required in one split/main pair for europium-152, the result of which was within the +/-30% range.

B1.5 SUITABILITY OF DATA

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

B2.0 REFERENCES

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

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

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

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

DOE-RL, 2005, *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, 1996, *Guidance for Data Quality Assessment*, EPA QA/G-9, U.S. Environmental Protection Agency, Office of Research and Development, Washington, D.C.

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

Tech Law, 2002, *Radionuclides - Data Package No. H1868-TR (SDG No. H1868)*, Tech Law, Inc., Richland, Washington.

APPENDIX C

RESRAD INPUT PARAMETERS AND CALCULATION BRIEF EXCERPTS

DISCLAIMER FOR CALCULATIONS

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

CALCULATION BRIEFS

The following calculation briefs have been prepared in accordance with ENG-1, *Engineering Services,*, ENG-1-4.5, "Project Calculations," Washington Closure Hanford, Richland, Washington.

126-F-1 Sample Variance Calculation, 0100F-CA-V0119, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

126-F-1 Overburden and Shallow Zone Sample Design, 0100F-CA-V0061 (Overburden), 0100F-CA-V0118 (Shallow), Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

126-F-1 Northern Portion Cleanup Verification 95% UCL Calculations, 0100F-CA-V0144, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

126-F-1 Southern Portion Cleanup Verification 95% UCL Calculations, 0100F-CA-V0100, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

126-F-1 (Northern Portion) RESRAD Calculation, 0100F-CA-V0146, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

126-F-1 (Southern Portion) RESRAD Calculation, 0100F-CA-V0102, Rev. 1, Bechtel Hanford, Inc., Richland, Washington.

126-F-1 (Northern Portion) Comparison to Drinking Water Standards, 0100F-CA-V0145, Rev. 0 , Bechtel Hanford, Inc., Richland, Washington.

126-F-1 (Southern Portion) Comparison to Drinking Water Standards, 0100F-CA-V0101, Rev. 1, 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-F Group 4 Remedial Action	**Job No.**	22192
Area	100-F Remedial Action		
Discipline	Environmental	***Calc. No.**	0100F-CA-V0119
Subject	126-F-1Ash Pit Sample 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 Calculations - 7 Attachment 1 - 3 Attachment 2 - 2 Attachment 3 - 5 Attachment 4 - 2	9-3-02	9/3/02	9/3/02	9/04/02	9/04/02
	Total - 20	M. T. Stankovich	D. W. Shea	J.E. Thomson	M. A. Buckmaster	

SUMMARY OF REVISIONS

Scanned	Rev.	Date	Bar Code No.

* Obtain Calc. No. from DIS.

CALCULATION SHEET

Bechtel Hanford Inc.							
Originator	M. T. Stankovich	Date	7/10/2002	Calc. No.	0100F-CA-V0119	Rev. No.	0
Project	100F Group 4 Remedial Action	Job No.	22192	Checked	DWJ Shea	Date	7/31/02
Subject	126-F-1Ash Pit Sample Variance Calculation					Sheet No.	1 of 7

Conclusion:
The required number of samples calculated (2 samples) for each decision sub-unit is less than the default number (4 samples) specified in the "100 Area Remedial Action Sampling and Analysis Plan" 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 verification samples required for 126-F-1 Ash Pit Shallow Zone and Overburden Zone Decision Unit 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 3).

Given:
1) Sample locations for the 126-F-1 Ash Pit Shallow, and Overburden are identified on the 126-F-1 Ash Pit Shallow Zone and Stockpile Sample Plan, Calculation numbers 0100F-CA-V0118 and 0100F-CA-V0061, respectively
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 3.

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 verification 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
2-5	Shallow Zone	Required Number of Samples Calculation
6-7	Overburden Zone	Required Number of Samples Calculation
Att. 1	Shallow Zone Formulas	Formulas
Att. 2	Overburden Zone Formulas	Formulas
Att. 3	Shallow Zone Data	Raw Data from Sample Management
Att. 4	Overburden Zone Data	Raw Data from Sample Management

CALCULATION SHEET 1

Bechtel Hanford Inc.

Originator M. T. Stankovich — Date 7/10/2002 — Calc. No. 0100F-CA-V0119 — Rev. No. 0
Project 100F Group 4 Remedial Action — Job No. 22192 — Checked DWJ — Date 7/3/02
Subject 126-F-1Ash Pit Sample Variance Calculation — Sheet No. 2 of 7

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 0100F-CA-V0118.
Mean, Standard Deviation, *t*, and Number of Samples formulas are from DOE/RL-96-22, Appendix A.

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

Sample #	Sample Date	Location	Constituent: Cobalt-60 pCi/g	Q	Cesium-137 pCi/g	Q	Europium-152 pCi/g	Q
Look-up Value (HT) ——>			1.4		6.2		3.3	
B14599	21-Jun-02	SD5-5	0.11	U	0.205		0.29	U
B145C4	21-Jun-02	SE7-11	0.11	U	0.607		0.942	
B145C3	21-Jun-02	SE7-8	0.095	U	0.719		1.32	
B145C2	21-Jun-02	SE7-5	0.17	U	1.35		3.25	
B145C1	21-Jun-02	SE7-4	0.11	U	0.542		0.862	
B145C0	21-Jun-02	SE7-3	0.045	U	0.037	U	0.084	U
B145B9	21-Jun-02	SE7-1	0.08	U	0.069	U	0.17	U
B145B5	21-Jun-02	SD6-12	0.053	U	0.332		0.446	
B145B4	21-Jun-02	SD6-10	0.045	U	0.044	U	0.11	U
B145H0	24-Jun-02	SF2-6	0.093	U	0.386		0.344	
B145B0	21-Jun-02	SD5-7	0.12	U	0.16	U	0.31	U
B145C7	21-Jun-02	SE8-4	0.11	U	0.186		0.868	
B14598	21-Jun-02	SD5-2	0.065	U	0.112		0.22	U
B14597	21-Jun-02	SD5-1	0.086	U	0.071	U	0.18	U
B14595	20-Jun-02	SD4-12	0.071	U	0.159		0.29	U
B14594	20-Jun-02	SD4-9	0.13	U	0.644		1.42	
B14593	20-Jun-02	SD4-7	0.2	U	0.378		0.49	U
B14592	20-Jun-02	SD4-4	0.1	U	0.147		0.442	
B14591	20-Jun-02	SD4-3	0.14	U	0.13	U	0.36	U
B14590	20-Jun-02	SD3-11	0.18	U	0.16	U	0.39	U
B145B3	21-Jun-02	SD6-1	0.055	U	0.051	U	0.12	U
B145D9	21-Jun-02	SE10-8	0.16	U	1.62		3.52	
B145F9	24-Jun-02	SF2-3	0.097	U	0.704		1.05	
B145F8	24-Jun-02	SF1-16	0.16	U	1.93		8.55	
B145F7	24-Jun-02	SF1-13	0.048	U	0.071	J	0.11	U
B145F6	24-Jun-02	SF1-10	0.072	U	0.102		0.18	U
B145F5	24-Jun-02	SF1-4	0.11	U	0.11	U	0.25	U
B145F4	24-Jun-02	SF1-3	0.116		0.812		2.74	
B145F3	24-Jun-02	SF1-2	0.13	U	0.178		0.25	U
B145F2	21-Jun-02	SE10-16	0.668		0.749		12.2	
B145C5	21-Jun-02	SE8-2	0.037	U	0.034	U	0.087	U
B145F0	21-Jun-02	SE10-10	0.19	U	1.53		2.71	
B145C6	21-Jun-02	SE8-3	0.08	U	0.074	U	0.16	U
B145D8	21-Jun-02	SE10-4	0.12	U	0.103		0.34	U
B145D7	21-Jun-02	SE10-3	0.067	U	0.396		1.02	
B145D4	21-Jun-02	SE9-10	0.118		0.865		2.21	
B145D3	21-Jun-02	SE9-5	0.18	U	2.47		4.79	
B145D2	21-Jun-02	SE9-4	0.076	U	0.083	U	0.18	U
B145D0	21-Jun-02	SE8-13	0.055	U	0.135		0.18	U
B142D5	18-Jun-02	SE9-14	0.075	U	0.151		0.2	U
B145C8	21-Jun-02	SE8-8	0.1	U	0.201		0.38	U
B14587	20-Jun-02	SD3-4	0.078	U	0.58		1.3	
B145F1	21-Jun-02	SE10-14	0.093	U	0.208		0.2	U
B14543	18-Jun-02	SB6-1	0.079	U	0.094	U	0.2	U
B14589	20-Jun-02	SD3-9	0.083	U	1.02		1.5	
B14555	18-Jun-02	SB8-2	0.074	U	0.058	U	0.294	
B14554	18-Jun-02	SB7-11	0.12	U	0.064	J	0.209	
B14552	18-Jun-02	SB7-5	0.039	U	0.069	J	0.087	U
B14551	18-Jun-02	SB7-4	0.057	U	0.075	J	0.12	U
B14550	18-Jun-02	SB7-3	0.098	U	0.11	U	0.513	
B14549	18-Jun-02	SB7-1	0.11	U	0.1	U	0.23	U
B14546	18-Jun-02	SB6-13	0.059	U	0.065	U	0.14	U
B14557	18-Jun-02	SB8-4	0.094	U	0.1	U	0.22	U
B14544	18-Jun-02	SB6-10	0.072	U	0.072	J	0.14	U
B14559	18-Jun-02	SB8-12	0.12	U	0.1	U	0.26	U
B14541	18-Jun-02	SB5-13	0.11	U	0.285		0.2	U
B14539	18-Jun-02	SB5-5	0.047	U	0.051	U	0.13	U
B14538	18-Jun-02	SB5-2	0.064	U	0.05	J	0.12	U
B14537	18-Jun-02	SB5-13	0.088	U	0.063	U	0.14	U
B14518	18-Jun-02	SA1-16	0.053	U	0.128		0.236	
B14517	18-Jun-02	SA1-13	0.081	U	0.332		0.215	
B14516	18-Jun-02	SA1-10	0.1	U	0.078	U	0.17	U
B14515	18-Jun-02	SA1-4	0.068	U	0.055	U	0.13	U
B14514	18-Jun-02	SA1-3	0.059	U	0.096	J	0.17	U

Shallow Zone

CALCULATION SHEET 1

Bechtel Hanford Inc.

Originator M. T. Stankovich | Date 7/10/2002 | Calc. No. 0100F-CA-V0119 | Rev. No. 0
Project 100F Group 4 Remedial Action | Job No. 22192 | Checked DWSHEA | Date 9/3/02
Subject 126-F-1Ash Pit Sample Variance Calculation | Sheet No. 3 of 7

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 0100F-CA-V0118.
Mean, Standard Deviation, *t*, and Number of Samples formulas are from DOE/RL-96-22, Appendix A.

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

Sample #	Sample Date	Location	Constituent Cobalt-60 pCi/g	Q	Cesium-137 pCi/g	Q	Europium-152 pCi/g	Q
Look-up Value (HT) ==========>			1.4		6.2		3.3	
B14545	18-Jun-02	SB6-12	0.14	U	0.15	U	0.26	U
B14573	20-Jun-02	SC1-2	0.12	U	0.086	U	0.22	U
B145D1	21-Jun-02	SE9-3	0.178		0.816		3.64	
B14586	20-Jun-02	SD3-2	0.085	U	0.078	U	0.18	U
B14585	20-Jun-02	SD3-1	0.11	U	0.095	U	0.23	U
B14582	20-Jun-02	SC2-10	0.078	U	0.142		0.21	U
B14581	20-Jun-02	SC2-7	0.15	U	0.42		0.545	
B14580	20-Jun-02	SC2-6	0.13	U	0.161		0.439	
B14579	20-Jun-02	SC2-3	0.12	U	0.13	U	0.31	U
B14576	20-Jun-02	SC1-10	0.13	U	0.651		0.985	
B14556	18-Jun-02	SB8-3	0.08	U	0.162		0.419	
B14574	20-Jun-02	SC1-3	0.069	U	0.08	U	0.17	U
B14588	20-Jun-02	SD3-5	0.14	U	0.378		0.72	
B14570	20-Jun-02	SC10-10	0.14	U	0.16	U	0.31	U
B14569	20-Jun-02	SC10-8	0.059	U	0.455		0.648	
B14568	20-Jun-02	SC10-4	0.15	U	0.13	U	0.45	U
B14567	20-Jun-02	SC10-3	0.254		0.658		2.44	
B14564	20-Jun-02	SC9-10	0.07	U	0.202		0.18	U
B14563	20-Jun-02	SC9-5	0.12	U	0.11	U	0.3	U
B14562	20-Jun-02	SC9-4	0.083	U	0.16	U	0.663	
B14561	20-Jun-02	SC9-3	0.12	U	0.238		0.957	
B14560	18-Jun-02	SB8-13	0.09	U	0.304		0.334	
B14575	20-Jun-02	SC1-4	0.11	U	0.11	U	0.28	U
B145J0	24-Jun-02	SF3-11	0.057	U	0.147		0.511	
B145H1	24-Jun-02	SF2-7	0.1	U	0.148		0.32	U
B145M3	24-Jun-02	SH9-5	0.053	U	0.059	J	0.523	
B145J5	24-Jun-02	SF4-12	0.046	U	0.049	U	0.1	U
B145J4	24-Jun-02	SF4-9	0.063	U	0.07	U	0.18	U
B145J3	24-Jun-02	SF4-7	0.043	U	0.044	U	0.1	U
B145C9	21-Jun-02	SE8-12	0.12	U	0.6		0.5	U
B145J1	24-Jun-02	SF4-3	0.047	U	0.1	U	0.1	U
B145H9	24-Jun-02	SF3-9	0.038	U	0.053	U	0.16	U
B145H8	24-Jun-02	SF3-5	0.057	U	0.048	U	0.1	U
B145H7	24-Jun-02	SF3-4	0.076	U	0.079	U	0.24	U
B145H6	24-Jun-02	SF3-2	0.044	U	0.039	U	0.1	U
B145H5	24-Jun-02	SF3-1	0.11	U	0.12	U	0.39	U
B145H4	24-Jun-02	SF2-15	0.11	U	0.087	U	0.24	U
B145H3	24-Jun-02	SF2-14	0.099	U	0.061	U	0.18	U
B145H2	24-Jun-02	SF2-10	0.047	U	0.053	U	0.11	U
B145J2	24-Jun-02	SF4-4	0.046	U	0.059	U	0.15	U
B145P5	06-Mar-02	S13-1	0.057	U	0.058	U	0.13	U
B145R0	06-Mar-02	S13-11	0.063	U	0.054	U	0.23	U
B145P6	06-Mar-02	S13-2	0.096	U	0.09	U	0.19	U
B145P7	06-Mar-02	S13-4	0.054	U	0.051	U	0.13	U
B145P8	06-Mar-02	S13-5	0.053	U	0.047	U	0.12	U
B145P9	06-Mar-02	S13-9	0.096	U	0.097	U	0.361	
B145R5	06-Mar-02	S14-12	0.073	U	0.077	U	0.16	U
B145R6	06-Mar-02	S14-13	0.061	U	0.051	U	0.11	U
B145R1	06-Mar-02	S14-3	0.053	U	0.054	U	0.13	U
B145R2	06-Mar-02	S14-4	0.065	U	0.062	U	0.16	U
B145R3	06-Mar-02	S14-7	0.052	U	0.052	U	0.12	U
B145R4	06-Mar-02	S14-9	0.049	U	0.048	U	0.12	U
B145R7	06-Mar-02	S15-1	0.14	U	0.1	U	0.29	U
B145T1	06-Mar-02	S15-13	0.045	U	0.051	U	0.13	U
B145T2	06-Mar-02	S15-15	0.076	U	0.075	U	0.18	U
B145R8	06-Mar-02	S15-2	0.11	U	0.09	U	0.21	U
B145R9	06-Mar-02	S15-5	0.11	U	0.1	U	0.26	U
B145T0	06-Mar-02	S15-7	0.049	U	0.052	U	0.11	U
B145T3	06-Mar-02	S16-1	0.043	U	0.042	U	0.1	U
B145T4	06-Mar-02	S16-10	0.066	U	0.066	U	0.16	U
B145T5	06-Mar-02	S16-12	0.041	U	0.069	U	0.18	U
B145T6	06-Mar-02	S16-13	0.14	U	0.098	U	0.26	U
B145T7	06-Mar-02	S16-15	0.059	U	0.058	U	0.13	U
B145T8	06-Mar-02	S16-16	0.069	U	0.071	U	0.18	U
B14522	14-Mar-02	SA2-10	0.057	U	0.058	U	0.13	U

Shallow Zone

CALCULATION SHEET 1

Bechtel Hanford Inc.
Originator M. T. Stankovich Date 7/10/2002 Calc. No. 0100F-CA-V0119 Rev. No. 0
Project 100F Group 4 Remedial Action Job No. 22192 Checked Date 9/3/02
Subject 126-F-1Ash Pit Sample Variance Calculation Sheet No. 4 of 7

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 0100F-CA-V0118.
Mean, Standard Deviation, t, and Number of Samples formulas are from DOE/RL-96-22, Appendix A.

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

Sample #	Sample Date	Location	Constituent Cobalt-60 pCi/g	Q	Cesium-137 pCi/g	Q	Europium-152 pCi/g	Q
Look-up Value (HT)			1.4		6.2		3.3	
B14523	14-Mar-02	SA2-14	0.089	U	0.071	U	0.15	U
B14524	14-Mar-02	SA2-15	0.083	U	0.09	U	0.24	U
B14519	14-Mar-02	SA2-3	0.091	U	0.074	U	0.17	U
B14520	14-Mar-02	SA2-6	0.059	U	0.061	U	0.13	U
B14521	14-Mar-02	SA2-7	0.1	U	0.082	U	0.19	U
B14525	14-Mar-02	SA3-1	0.054	U	0.047	U	0.12	U
B14530	14-Mar-02	SA3-11	0.075	U	0.07	U	0.17	U
B14526	14-Mar-02	SA3-2	0.054	U	0.041	U	0.13	U
B14527	14-Mar-02	SA3-4	0.075	U	0.087	U	0.18	U
B14528	14-Mar-02	SA3-5	0.082	U	0.072	U	0.16	U
B14529	14-Mar-02	SA3-9	0.092	U	0.085	U	0.19	U
B14535	14-Mar-02	SA4-12	0.056	U	0.094	J	0.176	
B14536	14-Mar-02	SA4-13	0.09	U	0.11	U	0.26	U
B14531	14-Mar-02	SA4-3	0.088	U	0.077	U	0.2	U
B14532	14-Mar-02	SA4-4	0.052	U	0.049	U	0.14	U
B14533	14-Mar-02	SA4-7	0.058	U	0.061	U	0.14	U
B14534	14-Mar-02	SA4-9	0.077	U	0.084	U	0.15	U
B14542	14-Mar-02	SB5-15	0.076	U	0.14	U	0.29	U
B14540	14-Mar-02	SB5-7	0.058	U	0.067	U	0.18	U
B14547	14-Mar-02	SB6-15	0.15	U	0.16	U	0.31	U
B14548	14-Mar-02	SB6-16	0.13	U	0.17	U	0.96	U
B14553	14-Mar-02	SB7-8	0.086	U	0.1		0.765	
B14558	14-Mar-02	SB8-8	0.11	U	0.178		0.733	
B14577	15-Mar-02	SC1-13	0.16	U	0.12	U	0.31	U
B14578	15-Mar-02	SC1-16	0.1	U	0.194		0.517	
B14571	15-Mar-02	SC10-14	0.058	U	0.07	U	0.16	U
B14572	15-Mar-02	SC10-16	0.12	U	0.17	U	0.8	
B14583	15-Mar-02	SC2-14	0.074	U	0.072	U	0.19	U
B14584	15-Mar-02	SC2-15	0.12	U	0.14	U	0.34	U
B14565	15-Mar-02	SC9-14	0.15	U	0.14	U	0.31	U
-B14566	15-Mar-02	SC9-16	0.14	U	0.174		0.622	
B14596	15-Mar-02	SD4-13	0.1	U	0.097	U	0.26	U
B145B1	15-Mar-02	SD5-13	0.064	U	0.091	J	0.246	
B145B2	15-Mar-02	SD5-15	0.057	U	0.09	U	0.21	U
B145B6	15-Mar-02	SD6-13	0.054	U	0.051	U	0.21	U
B145B7	15-Mar-02	SD6-15	0.059	U	0.055	U	0.14	U
B145B8	15-Mar-02	SD6-16	0.068	U	0.069	U	0.17	U
B145D5	15-Mar-02	SE9-14	0.11	U	0.108		0.719	
B145D6	15-Mar-02	SE9-16	0.049	U	0.041	U	0.13	U
B145J6	12-Mar-02	SF4-13	0.11	U	0.078	U	0.18	U
B145J7	07-Mar-02	SG5-1	0.083	U	0.057	U	0.14	U
B145K1	07-Mar-02	SG5-13	0.067	U	0.065	U	0.15	U
B145K2	07-Mar-02	SG5-15	0.083	U	0.071	U	0.17	U
B145J8	07-Mar-02	SG5-2	0.041	U	0.043	U	0.11	U
B145J9	07-Mar-02	SG5-5	0.056	U	0.059	U	0.13	U
B145K0	07-Mar-02	SG5-7	0.044	U	0.048	U	0.11	U
B145K3	07-Mar-02	SG6-1	0.04	U	0.037	U	0.087	U
B145K4	07-Mar-02	SG6-10	0.05	U	0.041	U	0.1	U
B145K5	07-Mar-02	SG6-12	0.073	U	0.083	U	0.18	U
B145K6	07-Mar-02	SG6-13	0.054	U	0.055	U	0.17	U
B145K7	07-Mar-02	SG6-15	0.055	U	0.032	U	0.054	U
B145K8	07-Mar-02	SG6-16	0.053	U	0.047	U	0.11	U
B145K9	07-Mar-02	SG7-1	0.15	U	0.12	U	0.24	U
B145L4	07-Mar-02	SG7-11	0.12	U	0.082	U	0.25	U
B145L0	07-Mar-02	SG7-3	0.065	U	0.049	U	0.13	U
B145L1	07-Mar-02	SG7-4	0.079	U	0.085	U	0.16	U
B145L2	07-Mar-02	SG7-5	0.062	U	0.063	U	0.14	U
B145L3	07-Mar-02	SG7-8	0.058	U	0.051	U	0.14	U
B145L9	07-Mar-02	SG8-12	0.084	U	0.068	U	0.17	U
B145M0	07-Mar-02	SG8-13	0.035	U	0.032	U	0.084	U
B145L5	07-Mar-02	SG8-2	0.051	U	0.048	U	0.12	U
B145L6	07-Mar-02	SG8-3	0.078	U	0.077	U	0.18	U
B145L7	07-Mar-02	SG8-4	0.074	U	0.059	U	0.15	U
B145L8	07-Mar-02	SG8-8	0.038	U	0.033	U	0.086	U
B145N6	12-Mar-02	SH1-10	0.061	U	0.054	U	0.14	U

Shallow Zone

CALCULATION SHEET 1

Bechtel Hanford Inc.

Originator M. T. Stankovich Date 7/10/2002 Calc. No. 0100F-CA-V0119 Rev. No. 0
Project 100F Group 4 Remedial Action Job No. 22192 Checked DWS Date 9/3/02
Subject 126-F-1Ash Pit Sample Variance Calculation Sheet No. 5 of 7

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 0100F-CA-V0118.
Mean, Standard Deviation, t, and Number of Samples formulas are from DOE/RL-96-22, Appendix A.

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

Sample #	Sample Date	Location	Constituent Cobalt-60 pCi/g	Q	Cesium-137 pCi/g	Q	Europium-152 pCi/g	Q
Look-up Value (HT) ==========>			1.4		6.2		3.3	
B145N7	12-Mar-02	SH1-13	0.039	U	0.042	U	0.16	U
B145N8	12-Mar-02	SH1-16	0.054	U	0.088	U	0.13	U
B145N3	12-Mar-02	SH1-2	0.13	U	0.1	U	0.35	
B145N4	12-Mar-02	SH1-3	0.073	U	0.078	J	0.633	
B145N5	12-Mar-02	SH1-4	0.083	U	0.087	U	0.21	U
B145P0	12-Mar-02	SH1-6	0.08	U	0.086	U	0.2	U
B145N0	12-Mar-02	SH10-10	0.079	U	0.109		0.937	
B145N1	12-Mar-02	SH10-14	0.096	U	0.088	U	0.23	U
B145N2	12-Mar-02	SH10-16	0.085	U	0.078	U	0.418	
B145M7	12-Mar-02	SH10-3	0.049	U	0.047	U	0.12	U
B145M8	12-Mar-02	SH10-4	0.056	U	0.048	U	0.12	U
B145M9	12-Mar-02	SH10-8	0.063	U	0.078	U	0.18	U
B145P2	12-Mar-02	SH2-10	0.1	U	0.11	U	0.26	U
B145P3	12-Mar-02	SH2-14	0.12	U	0.14	U	0.32	U
B145P4	12-Mar-02	SH2-15	0.07	U	0.057	U	0.15	U
B145N9	12-Mar-02	SH2-3	0.15	U	0.12	U	0.3	U
B145P1	12-Mar-02	SH2-7	0.085	U	0.08	U	0.18	U
B145M4	12-Mar-02	SH9-10	0.049	U	0.045	U	0.14	U
B145M5	12-Mar-02	SH9-14	0.088	U	0.076	U	0.249	
B145M6	12-Mar-02	SH9-16	0.096	U	0.095	U	0.186	
B145M1	12-Mar-02	SH9-3	0.054	U	0.048	U	0.11	U
B145M2	12-Mar-02	SH9-4	0.077	U	0.069	U	0.17	U
Mean (LV) ==========>			0.09		0.18		0.49	
Standard Deviation (S) ==========>			0.05		0.31		1.15	
α (5%) ==========>			1.645		1.645		1.645	
β (20%) ==========>			0.842		0.842		0.842	
Number of Samples ==========>			1		1		2	

Shallow Zone

CALCULATION SHEET 2

Bechtel Hanford Inc.

Originator M. T. Stankovich Date 7/10/2002 Calc. No. 0100F-CA-V0119 Rev. No. 0

Project 100F Group 4 Remedial Action Job No. 22192 Checked DWSha Date 7/3/02

Subject 126-F-1Ash Pit Sample Variance Calculation Sheet No. 6 of 7

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 0100F-CA-V0061.
Mean, Standard Deviation, *t*, and Number of Samples formulas are from DOE/RL-96-22, Appendix A.

Decision Unit: Overburden Zone
Samples values from GEA analysis.
Sample Areas A, B, & C

Sample #	Sample Date	Location	Cobalt-60 mg/kg	Q	Cesium-137 mg/kg	Q	Europium-152 mg/kg	Q
			Constituent					
Look-up Value (HT) ==========>			1.4		6.2		3.3	
B147B4	March 19, 2002	OA1-2	0.09	U	0.08	U	0.19	U
B147B5	March 19, 2002	OA1-3	0.07	U	0.05	U	0.13	U
B147B6	March 19, 2002	OA1-4	0.08	U	0.08	U	0.23	U
B147B7	March 19, 2002	OA1-10	0.05	U	0.04	U	0.10	U
B147B8	March 19, 2002	OA1-13	0.08	U	0.06	U	0.17	U
B147B9	March 19, 2002	OA1-16	0.10	U	0.09	U	0.23	U
B147C0	March 19, 2002	OA2-3	0.05	U	0.05	U	0.12	U
B147C1	March 19, 2002	OA2-6	0.04	U	0.04	U	0.10	U
B147C2	March 19, 2002	OA2-7	0.06	U	0.06	U	0.16	U
B147C3	March 19, 2002	OA2-10	0.05	U	0.04	U	0.12	U
B147C4	March 19, 2002	OA2-14	0.09	U	0.07	U	0.15	U
B147C5	March 19, 2002	OA2-15	0.04	U	0.05	U	0.12	U
B147C6	March 19, 2002	OA3-1	0.06	U	0.06	U	0.13	U
B147C7	March 19, 2002	OA3-2	0.05	U	0.05	U	0.11	U
B147C8	March 19, 2002	OA3-4	0.10	U	0.06	U	0.16	U
B147C9	March 19, 2002	OA3-5	0.05	U	0.04	U	0.10	U
B147D0	March 19, 2002	OA3-9	0.06	U	0.06	U	0.14	U
B147D1	March 19, 2002	OA3-11	0.05	U	0.05	U	0.10	U
B147D2	March 19, 2002	OA4-3	0.08	U	0.06	U	0.13	U
B147D3	March 19, 2002	OA4-4	0.06	U	0.04	U	0.11	U
B147D4	March 19, 2002	OA4-7	0.06	U	0.05	U	0.13	U
B147D5	March 19, 2002	OA4-9	0.04	U	0.04	U	0.09	U
B147D6	March 19, 2002	OA4-12	0.10	U	0.07	U	0.17	U
B147D7	March 19, 2002	OA4-13	0.05	U	0.04	U	0.11	U
B147D8	March 19, 2002	OB5-1	0.09	U	0.08	U	0.15	U
B147D9	March 19, 2002	OB5-2	0.05	U	0.05	U	0.12	U
B147F0	March 19, 2002	OB5-5	0.06	U	0.05	U	0.12	U
B147F1	March 19, 2002	OB5-7	0.05	U	0.04	U	0.10	U
B147F2	March 19, 2002	OB5-13	0.08	U	0.07	U	0.19	U
B147F3	March 19, 2002	OB5-15	0.04	U	0.04	U	0.10	U
B147F4	March 19, 2002	OB6-1	0.06	U	0.06	U	0.13	U
B147F5	March 19, 2002	OB6-10	0.06	U	0.06	U	0.18	U
B147F6	March 19, 2002	OB6-12	0.04	U	0.04	U	0.10	U
B147F7	March 19, 2002	OB6-13	0.06	U	0.05	U	0.11	U
B147F8	March 19, 2002	OB6-15	0.06	U	0.05	U	0.14	U
B147F9	March 19, 2002	OB6-16	0.03	U	0.03	U	0.10	U
B147H0	March 19, 2002	OB7-1	0.04	U	0.04	U	0.10	U
B147H1	March 19, 2002	OB7-3	0.08	U	0.10	U	0.16	U
B147H2	March 19, 2002	OB7-4	0.08	U	0.07	U	0.18	U
B147H3	March 19, 2002	OB7-5	0.04	U	0.04	U	0.10	U
B147H4	March 19, 2002	OB7-8	0.06	U	0.07	U	0.34	U
B147H5	March 19, 2002	OB7-11	0.08	U	0.08	U	0.17	U
B147H6	March 19, 2002	OB8-2	0.07	U	0.07	U	0.18	U
B147H7	March 19, 2002	OB8-3	0.05	U	0.04	U	0.10	U
B147H8	March 19, 2002	OB8-4	0.07	U	0.06	U	0.15	U

Overburden Zone

CALCULATION SHEET 2

Bechtel Hanford Inc.

Originator M. T. Stankovich Date 7/10/2002 Calc. No. 0100F-CA-V0119 Rev. No. 0
Project 100F Group 4 Remedial Action Job No. 22192 Checked DWSh Date 7/3/02
Subject 126-F-1Ash Pit Sample Variance Calculation Sheet No. 7 of 7

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 0100F-CA-V0061.
Mean, Standard Deviation, *t*, and Number of Samples formulas are from DOE/RL-96-22, Appendix A.

Decision Unit: Overburden Zone
Samples values from GEA analysis.
Sample Areas A, B, & C

Sample #	Sample Date	Location	Cobalt-60 mg/kg	Q	Cesium-137 mg/kg	Q	Europium-152 mg/kg	Q
			Constituent					
Look-up Value (HT) ==========>			1.4		6.2		3.3	
B147H9	March 19, 2002	OB8-8	0.08	U	0.28		1.20	
B147J0	March 19, 2002	OB8-12	0.07	U	0.06	U	0.14	U
B147J1	March 19, 2002	OB8-13	0.09	U	0.09	U	0.20	U
B147J2	March 21, 2002	OC9-3	0.04	U	0.04	U	0.10	U
B147J3	March 21, 2002	OC9-4	0.06	U	0.06	U	0.13	U
B147J4	March 21, 2002	OC9-5	0.04	U	0.04	U	0.09	U
B147J5	March 21, 2002	OC9-10	0.06	U	0.06	U	0.15	U
B147J6	March 21, 2002	OC9-14	0.04	U	0.09	J	0.19	U
B147J7	March 21, 2002	OC9-16	0.06	U	0.06	U	0.14	U
B147J8	March 21, 2002	OC10-3	0.06	U	0.06	J	0.21	U
B147J9	March 21, 2002	OC10-4	0.08	U	0.07	U	0.20	U
B147K0	March 21, 2002	OC10-8	0.09	U	0.07	U	0.17	U
B147K1	March 21, 2002	OC10-10	0.09	U	0.08	U	0.23	U
B147K2	March 21, 2002	OC10-14	0.04	U	0.04	U	0.10	U
B147K3	March 21, 2002	OC10-16	0.06	U	0.06	U	0.19	U
B147K4	March 21, 2002	OC1-2	0.06	U	0.05	U	0.14	U
B147K5	March 21, 2002	OC1-3	0.10	U	0.07	U	0.20	U
B147K6	March 21, 2002	OC1-4	0.06	U	0.07	U	0.17	U
B147K7	March 21, 2002	OC1-10	0.06	U	0.06	U	0.15	U
B147K8	March 21, 2002	OC1-14	0.05	U	0.07	U	0.13	U
B147K9	March 21, 2002	OC1-15	0.11	U	0.08	U	0.23	U
B147L0	March 21, 2002	OC2-3	0.07	U	0.07	U	0.16	U
B147L1	March 21, 2002	OC2-6	0.06	U	0.05	U	0.12	U
B147L2	March 21, 2002	OC2-7	0.10	U	0.08	U	0.19	U
B147L3	March 21, 2002	OC2-10	0.08	U	0.06	U	0.16	U
B147L4	March 21, 2002	OC2-14	0.11	U	0.08	U	0.22	U
B147L5	March 21, 2002	OC2-15	0.04	U	0.04	U	0.11	U
Mean (LV) ==========>			0.06		0.06		0.16	
Standard Deviation (S) ==========>			0.02		0.03		0.13	
α (5%) ==========>			1.645		1.645		1.645	
β (20%) ==========>			0.842		0.842		0.842	
Number of Samples>			1		1		1	

Overburden Zone

ATTACHMENT 3

Bechtel Hanford Inc.

Originator	M. T. Stankovich	Date	7/10/2002	Calc. No.	0100F-CA-V0119	Rev. No.	0
Project	100-F Group 4 Remedial Action	Job No.	22192	Checked		Date	9/3/02
Subject	126-F-1Ash Pit Sample Variance Calculation					Sheet No.	1 of 5

	samp_num	samp_date_time	Sample Node	Co60	Q	Cs137	Q	Eu152	Q
1	B14599	6/21/2002 8:12	SD5-5	0.11	U	0.205		0.29	U
2	B145C4	6/21/2002 8:33	SE7-11	0.11	U	0.607		0.942	
3	B145C3	6/21/2002 8:30	SE7-8	0.095	U	0.719		1.32	
4	B145C2	6/21/2002 8:29	SE7-5	0.17	U	1.35		3.25	
5	B145C1	6/21/2002 8:27	SE7-4	0.11	U	0.542		0.962	
6	B145C0	6/21/2002 8:27	SE7-3	0.045	U	0.037	U	0.084	U
7	B145B9	6/21/2002 8:35	SE7-1	0.08	U	0.069	U	0.17	U
8	B145B5	6/21/2002 8:15	SD6-12	0.053	U	0.332		0.45	
9	B145B4	6/21/2002 8:22	SD6-10	0.045	U	0.044	U	0.11	U
10	B145H0	6/24/2002 7:50	SF2-6	0.093	U	0.386		0.34	
11	B145B0	6/21/2002 8:14	SD5-7	0.120	U	0.16	U	0.31	U
12	B145C7	6/21/2002 8:39	SE8-4	0.11	U	0.186		0.668	
13	B14598	6/21/2002 8:09	SD5-2	0.065	U	0.112		0.22	U
14	B14597	6/21/2002 8:07	SD5-1	0.086	U	0.071	U	0.18	U
15	B14595	6/20/2002 8:48	SD4-12	0.071	U	0.159		0.29	U
16	B14594	6/20/2002 8:45	SD4-9	0.130	U	0.644		1.42	
17	B14593	6/20/2002 8:44	SD4-7	0.2	U	0.378		0.490	U
18	B14592	6/20/2002 8:43	SD4-4	0.100	U	0.147		0.442	
19	B14591	6/20/2002 8:41	SD4-3	0.14	U	0.13	U	0.36	U
20	B14590	6/20/2002 8:39	SD3-11	0.180	U	0.16	U	0.39	U
21	B145B3	6/21/2002 8:19	SD6-1	0.055	U	0.051	U	0.12	U
22	B145D9	6/21/2002 9:05	SE10-8	0.16	U	1.620		3.52	
23	B145F9	6/24/2002 7:50	SF2-3	0.097	U	0.704		1.05	
24	B145F8	6/24/2002 7:50	SF1-16	0.160	U	1.930		8.55	
25	B145F7	6/24/2002 7:50	SF1-13	0.048	U	0.071	J	0.11	U
26	B145F6	6/24/2002 7:50	SF1-10	0.072	U	0.102		0.18	U
27	B145F5	6/24/2002 7:50	SF1-4	0.110	U	0.110	U	0.25	U
28	B145F4	6/24/2002 7:50	SF1-3	0.116		0.812		2.74	
29	B145F3	6/24/2002 7:50	SF1-2	0.130	U	0.178		0.25	U
30	B145F2	6/21/2002 9:12	SE10-16	0.668		0.749		12.2	
31	B145C5	6/21/2002 8:48	SE8-2	0.037	U	0.034	U	0.087	U
32	B145F0	6/21/2002 9:07	SE10-10	0.19	U	1.53		2.71	
33	B145C6	6/21/2002 8:50	SE8-3	0.08	U	0.074	U	0.16	U
34	B145D8	6/21/2002 9:03	SE10-4	0.12	U	0.103		0.34	U
35	B145D7	6/21/2002 9:02	SE10-3	0.067	U	0.396		1.02	
36	B145D4	6/21/2002 8:59	SE9-10	0.118		0.865		2.21	
37	B145D3	6/21/2002 8:56	SE9-5	0.18	U	2.47		4.79	
38	B145D2	6/21/2002 8:55	SE9-4	0.076	U	0.083	U	0.18	U
39	B145D0	6/21/2002 8:44	SE8-13	0.055	U	0.135		0.18	U
40	B142D5	6/18/2002 8:12	SE9-14	0.075	U	0.151		0.2	U
41	B145C8	6/21/2002 8:40	SE8-8	0.1	U	0.201		0.38	U
42	B14587	6/20/2002 8:35	SD3-4	0.078	U	0.58		1.3	
43	B145F1	6/21/2002 9:09	SE10-14	0.093	U	0.208		0.2	U
44	B14543	6/18/2002 8:36	SB6-1	0.079	U	0.094	U	0.2	U
45	B14589	6/20/2002 8:37	SD3-9	0.083	U	1.02		1.5	
46	B14555	6/18/2002 8:50	SB8-2	0.074	U	0.058	U	0.294	
47	B14554	6/18/2002 8:49	SB7-11	0.12	U	0.084	J	0.209	

Shallow Zone Data

ATTACHMENT 3

Bechtel Hanford Inc.

Originator	M. T. Stankovich	Date	7/10/2002	Calc. No.	0100F-CA-V0119	Rev. No.	0
Project	100-F Group 4 Remedial Action	Job No.	22192	Checked	MWSher	Date	9/3/02
Subject	126-F-1Ash Pit Sample Variance Calculation					Sheet No.	2of 5

	samp_num	samp_date_time	Sample Node	Co60	Q	Cs137	Q	Eu152	Q
48	B14552	6/18/2002 8:46	SB7-5	0.039	U	0.069	J	0.087	U
49	B14551	6/18/2002 8:45	SB7-4	0.057	U	0.075	J	0.12	U
50	B14550	6/18/2002 8:44	SB7-3	0.098	U	0.11	U	0.513	
51	B14549	6/18/2002 8:43	SB7-1	0.110	U	0.1	U	0.23	U
52	B14546	6/18/2002 8:41	SB6-13	0.059	U	0.085	U	0.14	U
53	B14557	6/18/2002 8:52	SB8-4	0.094	U	0.1	U	0.22	U
54	B14544	6/18/2002 8:37	SB6-10	0.072	U	0.072	J	0.14	U
55	B14559	6/18/2002 8:53	SB8-12	0.12	U	0.100	U	0.26	U
56	B14541	6/18/2002 8:33	SB5-13	0.11	U	0.285		0.20	U
57	B14539	6/18/2002 8:31	SB5-5	0.047	U	0.051	U	0.13	U
58	B14538	6/18/2002 8:29	SB5-2	0.064	U	0.050	J	0.12	U
59	B14537	6/18/2002 8:28	SB5-13	0.088	U	0.063	U	0.14	U
60	B14518	6/18/2002 8:25	SA1-16	0.053	U	0.128		0.236	
61	B14517	6/18/2002 8:22	SA1-13	0.081	U	0.332		0.215	
62	B14516	6/18/2002 8:19	SA1-10	0.1	U	0.078	U	0.17	U
63	B14515	6/18/2002 8:18	SA1-4	0.068	U	0.055	U	0.13	U
64	B14514	6/18/2002 8:15	SA1-3	0.059	U	0.096	J	0.17	U
65	B14545	6/18/2002 8:39	SB6-12	0.14	U	0.150	U	0.260	U
66	B14573	6/20/2002 8:19	SC1-2	0.120	U	0.086	U	0.22	U
67	B145D1	6/21/2002 8:51	SE9-3	0.178		0.816		3.64	
68	B14586	6/20/2002 8:32	SD3-2	0.085	U	0.078	U	0.18	U
69	B14585	6/20/2002 8:31	SD3-1	0.11	U	0.095	U	0.23	U
70	B14582	6/20/2002 8:29	SC2-10	0.078	U	0.142		0.21	U
71	B14581	6/20/2002 8:28	SC2-7	0.15	U	0.420		0.545	
72	B14580	6/20/2002 8:27	SC2-6	0.130	U	0.161		0.439	
73	B14579	6/20/2002 8:26	SC2-3	0.120	U	0.130	U	0.31	U
74	B14576	6/20/2002 8:23	SC1-10	0.130	U	0.651		0.985	
75	B14556	6/18/2002 8:51	SB8-3	0.080	U	0.162		0.419	
76	B14574	6/20/2002 8:21	SC1-3	0.069	U	0.060	U	0.17	U
77	B14588	6/20/2002 8:36	SD3-5	0.140	U	0.378		0.72	
78	B14570	6/20/2002 8:17	SC10-10	0.140	U	0.160	U	0.31	U
79	B14569	6/20/2002 8:16	SC10-8	0.059	U	0.455		0.648	
80	B14568	6/20/2002 8:14	SC10-4	0.15	U	0.13	U	0.45	U
81	B14567	6/20/2002 8:13	SC10-3	0.254		0.658		2.44	
82	B14564	6/20/2002 8:10	SC9-10	0.07	U	0.202		0.18	U
83	B14563	6/20/2002 8:09	SC9-5	0.12	U	0.11	U	0.3	U
84	B14562	6/20/2002 8:07	SC9-4	0.083	U	0.16	U	0.663	
85	B14561	6/20/2002 8:05	SC9-3	0.12	U	0.238		0.957	
86	B14560	6/18/2002 8:55	SB8-13	0.09	U	0.304		0.334	
87	B14575	6/20/2002 8:22	SC1-4	0.11	U	0.11	U	0.28	U
88	B145J0	6/24/2002 7:50	SF3-11	0.057	U	0.147		0.511	
89	B145H1	6/24/2002 7:50	SF2-7	0.1	U	0.148		0.32	U
90	B145M3	6/24/2002 8:52	SH9-5	0.053	U	0.059	J	0.523	
91	B145J5	6/24/2002 7:50	SF4-12	0.046	U	0.049	U	0.1	U
92	B145J4	6/24/2002 7:50	SF4-9	0.063	U	0.07	U	0.18	U
93	B145J3	6/24/2002 7:50	SF4-7	0.043	U	0.044	U	0.1	U
94	B145C9	6/21/2002 8:41	SE8-12	0.12	U	0.6		0.5	U

Shallow Zone Data

ATTACHMENT 3

Bechtel Hanford Inc.

Originator	M. T. Stankovich	Date	7/10/2002	Calc. No.	0100F-CA-V0119	Rev. No.	0
Project	100-F Group 4 Remedial Action	Job No.	22192	Checked		Date	7/3/02
Subject	126-F-1Ash Pit Sample Variance Calculation					Sheet No.	3 of 5

	samp_num	samp_date_time	Sample Node	Co60	Q	Cs137	Q	Eu152	Q
95	B145J1	6/24/2002 7:50	SF4-3	0.047	U	0.1	U	0.1	U
96	B145H9	6/24/2002 7:50	SF3-9	0.038	U	0.053	U	0.16	U
97	B145H8	6/24/2002 7:50	SF3-5	0.057	U	0.048	U	0.1	U
98	B145H7	6/24/2002 7:50	SF3-4	0.076	U	0.079	U	0.24	U
99	B145H6	6/24/2002 7:50	SF3-2	0.044	U	0.039	U	0.1	U
100	B145H5	6/24/2002 7:50	SF3-1	0.11	U	0.12	U	0.39	U
101	B145H4	6/24/2002 7:50	SF2-15	0.11	U	0.087	U	0.24	U
102	B145H3	6/24/2002 7:50	SF2-14	0.099	U	0.061	U	0.16	U
103	B145H2	6/24/2002 7:50	SF2-10	0.05	U	0.053	U	0.11	U
104	B145J2	6/24/2002 7:50	SF4-4	0.048	U	0.059	U	0.15	U
105	B145P5	3/6/2002 9:49	S13-1	0.057	U	0.058	U	0.13	U
106	B145R0	3/6/2002 9:41	S13-11	0.063	U	0.054	U	0.23	U
107	B145P6	3/6/2002 9:47	S13-2	0.096	U	0.09	U	0.19	U
108	B145P7	3/6/2002 9:44	S13-4	0.054	U	0.051	U	0.13	U
109	B145P8	3/6/2002 9:42	S13-5	0.053	U	0.047	U	0.12	U
110	B145P9	3/6/2002 9:39	S13-9	0.096	U	0.097	U	0.36	
111	B145R5	3/6/2002 9:28	S14-12	0.073	U	0.077	U	0.16	U
112	B145R6	3/6/2002 9:26	S14-13	0.061	U	0.051	U	0.11	U
113	B145R1	3/6/2002 9:36	S14-3	0.053	U	0.054	U	0.130	U
114	B145R2	3/6/2002 9:34	S14-4	0.065	U	0.062	U	0.16	U
115	B145R3	3/6/2002 9:32	S14-7	0.052	U	0.052	U	0.12	U
116	B145R4	3/6/2002 9:30	S14-9	0.049	U	0.048	U	0.12	U
117	B145R7	3/6/2002 9:23	S15-1	0.14	U	0.100	U	0.29	U
118	B145T1	3/6/2002 9:15	S15-13	0.045	U	0.051	U	0.13	U
119	B145T2	3/6/2002 9:13	S15-15	0.076	U	0.075	U	0.18	U
120	B145R8	3/6/2002 9:21	S15-2	0.110	U	0.090	U	0.21	U
121	B145R9	3/6/2002 9:19	S15-5	0.110	U	0.100	U	0.26	U
122	B145T0	3/6/2002 9:17	S15-7	0.049	U	0.052	U	0.11	U
123	B145T3	3/6/2002 9:10	S16-1	0.043	U	0.042	U	0.1	U
124	B145T4	3/6/2002 9:08	S16-10	0.066	U	0.068	U	0.16	U
125	B145T5	3/6/2002 9:06	S16-12	0.041	U	0.069	U	0.18	U
126	B145T6	3/6/2002 9:04	S16-13	0.140	U	0.098	U	0.26	U
127	B145T7	3/6/2002 9:02	S16-15	0.059	U	0.058	U	0.13	U
128	B145T8	3/6/2002 9:00	S16-16	0.069	U	0.071	U	0.18	U
129	B14522	3/14/2002 8:46	SA2-10	0.057	U	0.058	U	0.13	U
130	B14523	3/14/2002 8:48	SA2-14	0.089	U	0.071	U	0.15	U
131	B14524	3/14/2002 8:50	SA2-15	0.083	U	0.09	U	0.24	U
132	B14519	3/14/2002 8:40	SA2-3	0.091	U	0.074	U	0.17	U
133	B14520	3/14/2002 8:42	SA2-6	0.059	U	0.061	U	0.13	U
134	B14521	3/14/2002 8:44	SA2-7	0.1	U	0.082	U	0.19	U
135	B14525	3/14/2002 8:53	SA3-1	0.054	U	0.047	U	0.12	U
136	B14530	3/14/2002 9:03	SA3-11	0.075	U	0.07	U	0.17	U
137	B14526	3/14/2002 8:55	SA3-2	0.054	U	0.041	U	0.13	U
138	B14527	3/14/2002 8:57	SA3-4	0.075	U	0.087	U	0.18	U
139	B14528	3/14/2002 8:59	SA3-5	0.082	U	0.072	U	0.16	U
140	B14529	3/14/2002 9:01	SA3-9	0.092	U	0.085	U	0.19	U
141	B14535	3/14/2002 9:14	SA4-12	0.056	U	0.094	J	0.176	

Shallow Zone Data

ATTACHMENT 3

Bechtel Hanford Inc.

Originator M. T. Stankovich Date 7/10/2002 Calc. No. 0100F-CA-V0119 Rev. No. ____
Project 100-F Group 4 Remedial Action Job No. 22192 Checked DWSlen Date 9/3/02
Subject 126-F-1Ash Pit Sample Variance Calculation Sheet No. 4 of

	samp_num	samp_date_time	Sample Node	Co60	Q	Cs137	Q	Eu152	Q
142	B14536	3/14/2002 9:16	SA4-13	0.09	U	0.11	U	0.26	U
143	B14531	3/14/2002 9:06	SA4-3	0.088	U	0.077	U	0.2	U
144	B14532	3/14/2002 9:08	SA4-4	0.052	U	0.049	U	0.14	U
145	B14533	3/14/2002 9:10	SA4-7	0.058	U	0.061	U	0.14	U
146	B14534	3/14/2002 9:12	SA4-9	0.077	U	0.064	U	0.15	U
147	B14542	3/14/2002 9:21	SB5-15	0.076	U	0.14	U	0.29	U
148	B14540	3/14/2002 9:19	SB5-7	0.058	U	0.067	U	0.18	U
149	B14547	3/14/2002 9:23	SB6-15	0.15	U	0.16	U	0.31	U
150	B14548	3/14/2002 9:25	SB6-16	0.13	U	0.170	U	0.96	U
151	B14553	3/14/2002 9:27	SB7-8	0.09	U	0.100		0.765	
152	B14558	3/14/2002 9:29	SB8-8	0.11	U	0.178		0.73	
153	B14577	3/15/2002 8:38	SC1-13	0.16	U	0.12	U	0.31	U
154	B14578	3/15/2002 8:40	SC1-16	0.1	U	0.194		0.52	
155	B14571	3/15/2002 8:34	SC10-14	0.058	U	0.07	U	0.16	U
156	B14572	3/15/2002 8:36	SC10-16	0.12	U	0.170	U	0.8	
157	B14583	3/15/2002 8:43	SC2-14	0.074	U	0.072	U	0.19	U
158	B14584	3/15/2002 8:45	SC2-15	0.12	U	0.14	U	0.34	U
159	B14565	3/15/2002 8:30	SC9-14	0.150	U	0.14	U	0.31	U
160	B14566	3/15/2002 8:32	SC9-16	0.140	U	0.174		0.62	
161	B14596	3/15/2002 8:47	SD4-13	0.1	U	0.097	U	0.260	U
162	B145B1	3/15/2002 8:49	SD5-13	0.064	U	0.091	J	0.246	
163	B145B2	3/15/2002 8:51	SD5-15	0.057	U	0.09	U	0.21	U
164	B145B6	3/15/2002 8:54	SD6-13	0.054	U	0.051	U	0.21	U
165	B145B7	3/15/2002 8:56	SD6-15	0.059	U	0.055	U	0.14	U
166	B145B8	3/15/2002 8:58	SD6-16	0.068	U	0.069	U	0.17	U
167	B145D5	3/15/2002 9:00	SE9-14	0.11	U	0.108		0.719	
168	B145D6	3/15/2002 9:02	SE9-16	0.049	U	0.041	U	0.13	U
169	B145J6	3/12/2002 8:44	SF4-13	0.110	U	0.078	U	0.18	U
170	B145J7	3/7/2002 9:19	SG5-1	0.083	U	0.057	U	0.14	U
171	B145K1	3/7/2002 9:27	SG5-13	0.067	U	0.065	U	0.15	U
172	B145K2	3/7/2002 9:29	SG5-15	0.083	U	0.071	U	0.17	U
173	B145J8	3/7/2002 9:21	SG5-2	0.041	U	0.043	U	0.11	U
174	B145J9	3/7/2002 9:23	SG5-5	0.056	U	0.059	U	0.13	U
175	B145K0	3/7/2002 9:25	SG5-7	0.044	U	0.048	U	0.11	U
176	B145K3	3/7/2002 9:06	SG6-1	0.04	U	0.037	U	0.087	U
177	B145K4	3/7/2002 9:08	SG6-10	0.05	U	0.041	U	0.1	U
178	B145K5	3/7/2002 9:10	SG6-12	0.073	U	0.083	U	0.18	U
179	B145K6	3/7/2002 9:12	SG6-13	0.054	U	0.055	U	0.17	U
180	B145K7	3/7/2002 9:14	SG6-15	0.055	U	0.032	U	0.054	U
181	B145K8	3/7/2002 9:16	SG6-16	0.053	U	0.047	U	0.11	U
182	B145K9	3/7/2002 8:53	SG7-1	0.15	U	0.12	U	0.24	U
183	B145L4	3/7/2002 9:03	SG7-11	0.12	U	0.082	U	0.25	U
184	B145L0	3/7/2002 8:55	SG7-3	0.065	U	0.049	U	0.13	U
185	B145L1	3/7/2002 8:57	SG7-4	0.079	U	0.085	U	0.16	U
186	B145L2	3/7/2002 8:59	SG7-5	0.062	U	0.063	U	0.14	U
187	B145L3	3/7/2002 9:01	SG7-8	0.058	U	0.051	U	0.14	U
188	B145L9	3/7/2002 8:48	SG8-12	0.084	U	0.068	U	0.17	U

ATTACHMENT 3

Bechtel Hanford Inc.

Originator M. T. Stankovich Date 7/10/2002 Calc. No. 0100F-CA-V0119 Rev. No. 0
Project 100-F Group 4 Remedial Action Job No. 22192 Checked Date 9/3/02
Subject 126-F-1Ash Pit Sample Variance Calculation Sheet No. 5 of 5

	samp_num	samp_date_time	Sample Node	Co60	Q	Cs137	Q	Eu152	Q
189	B145M0	3/7/2002 8:50	SG8-13	0.035	U	0.032	U	0.084	U
190	B145L5	3/7/2002 8:40	SG8-2	0.051	U	0.048	U	0.12	U
191	B145L6	3/7/2002 8:42	SG8-3	0.078	U	0.077	U	0.18	U
192	B145L7	3/7/2002 8:44	SG8-4	0.074	U	0.059	U	0.15	U
193	B145L8	3/7/2002 8:46	SG8-8	0.036	U	0.033	U	0.086	U
194	B145N6	3/12/2002 9:12	SH1-10	0.061	U	0.054	U	0.14	U
195	B145N7	3/12/2002 9:14	SH1-13	0.039	U	0.042	U	0.16	U
196	B145N8	3/12/2002 9:16	SH1-16	0.054	U	0.088	U	0.13	U
197	B145N3	3/12/2002 9:06	SH1-2	0.13	U	0.1	U	0.35	
198	B145N4	3/12/2002 9:06	SH1-3	0.073	U	0.078	J	0.633	
199	B145N5	3/12/2002 9:10	SH1-4	0.08	U	0.087	U	0.21	U
200	B145P0	3/12/2002 9:21	SH1-6	0.08	U	0.086	U	0.20	U
201	B145N0	3/12/2002 8:59	SH10-10	0.079	U	0.109		0.94	
202	B145N1	3/12/2002 9:01	SH10-14	0.096	U	0.088	U	0.23	U
203	B145N2	3/12/2002 9:03	SH10-16	0.085	U	0.078	U	0.418	
204	B145M7	3/12/2002 8:53	SH10-3	0.049	U	0.047	U	0.12	U
205	B145M8	3/12/2002 8:55	SH10-4	0.056	U	0.048	U	0.12	U
206	B145M9	3/12/2002 8:57	SH10-8	0.063	U	0.078	U	0.18	U
207	B145P2	3/12/2002 9:25	SH2-10	0.100	U	0.11	U	0.26	U
208	B145P3	3/12/2002 9:29	SH2-14	0.120	U	0.14	U	0.32	U
209	B145P4	3/12/2002 9:29	SH2-15	0.07	U	0.057	U	0.150	U
210	B145N9	3/12/2002 9:19	SH2-3	0.150	U	0.12	U	0.3	U
211	B145P1	3/12/2002 9:23	SH2-7	0.085	U	0.08	U	0.18	U
212	B145M4	3/12/2002 8:46	SH9-10	0.049	U	0.045	U	0.14	U
213	B145M5	3/12/2002 8:48	SH9-14	0.088	U	0.076	U	0.249	
214	B145M6	3/12/2002 8:53	SH9-16	0.096	U	0.095	U	0.186	
215	B145M1	3/12/2002 8:40	SH9-3	0.054	U	0.048	U	0.11	U
216	B145M2	3/12/2002 8:42	SH9-4	0.077	U	0.069	U	0.17	U

ATTACHMENT 4

Bechtel Hanford Inc.

Originator	M. T. Stankovich	Date	7/10/2002	Calc. No.	0100F-CA-V0119	Rev. No.	0
Project	100-F Group 4 Remedial Action	Job No.	22192	Checked	MWSh	Date	9/3/02
Subject	126-F-1Ash Pit Sample Variance Calculation					Sheet No.	1 of 2

	samp_num	samp_date_time	Sample Node	Co60	Q	Cs137	Q	Eu152	Q
2	B147B4	19-Mar-2002	OA1-2	0.088	U	0.082	U	0.19	U
3	B147B5	19-Mar-2002	OA1-3	0.066	U	0.054	U	0.13	U
4	B147B6	19-Mar-2002	OA1-4	0.083	U	0.083	U	0.23	U
5	B147B7	19-Mar-2002	OA1-10	0.045	U	0.044	U	0.098	U
6	B147B8	19-Mar-2002	OA1-13	0.079	U	0.056	U	0.17	U
7	B147B9	19-Mar-2002	OA1-16	0.1	U	0.093	U	0.23	U
8	B147C0	19-Mar-2002	OA2-3	0.053	U	0.045	U	0.12	U
9	B147C1	19-Mar-2002	OA2-6	0.044	U	0.038	U	0.097	U
10	B147C2	19-Mar-2002	OA2-7	0.062	U	0.062	U	0.16	U
11	B147C3	19-Mar-2002	OA2-10	0.049	U	0.038	U	0.12	U
12	B147C4	19-Mar-2002	OA2-14	0.086	U	0.072	U	0.15	U
13	B147C5	19-Mar-2002	OA2-15	0.044	U	0.047	U	0.12	U
14	B147C6	19-Mar-2002	OA3-1	0.056	U	0.056	U	0.13	U
15	B147C7	19-Mar-2002	OA3-2	0.048	U	0.045	U	0.11	U
16	B147C8	19-Mar-2002	OA3-4	0.1	U	0.064	U	0.16	U
17	B147C9	19-Mar-2002	OA3-5	0.047	U	0.042	U	0.099	U
18	B147D0	19-Mar-2002	OA3-9	0.064	U	0.057	U	0.14	U
19	B147D1	19-Mar-2002	OA3-11	0.05	U	0.051	U	0.1	U
20	B147D2	19-Mar-2002	OA4-3	0.08	U	0.061	U	0.13	U
21	B147D3	19-Mar-2002	OA4-4	0.055	U	0.041	U	0.11	U
22	B147D4	19-Mar-2002	OA4-7	0.056	U	0.053	U	0.13	U
23	B147D5	19-Mar-2002	OA4-9	0.041	U	0.04	U	0.09	U
24	B147D6	19-Mar-2002	OA4-12	0.096	U	0.072	U	0.17	U
25	B147D7	19-Mar-2002	OA4-13	0.045	U	0.044	U	0.11	U
26	B147D8	19-Mar-2002	OB5-1	0.088	U	0.076	U	0.15	U
27	B147D9	19-Mar-2002	OB5-2	0.046	U	0.045	U	0.12	U
28	B147F0	19-Mar-2002	OB5-5	0.057	U	0.054	U	0.12	U
29	B147F1	19-Mar-2002	OB5-7	0.046	U	0.043	U	0.1	U
30	B147F2	19-Mar-2002	OB5-13	0.077	U	0.067	U	0.19	U
31	B147F3	19-Mar-2002	OB5-15	0.035	U	0.036	U	0.098	U
32	B147F4	19-Mar-2002	OB6-1	0.061	U	0.057	U	0.13	U
33	B147F5	19-Mar-2002	OB6-10	0.062	U	0.063	U	0.18	U
34	B147F6	19-Mar-2002	OB6-12	0.038	U	0.037	U	0.098	U
35	B147F7	19-Mar-2002	OB6-13	0.055	U	0.054	U	0.11	U
36	B147F8	19-Mar-2002	OB6-15	0.059	U	0.045	U	0.14	U
37	B147F9	19-Mar-2002	OB6-16	0.034	U	0.031	U	0.099	U
38	B147H0	19-Mar-2002	OB7-1	0.044	U	0.041	U	0.1	U
39	B147H1	19-Mar-2002	OB7-3	0.081	U	0.1	U	0.16	U
40	B147H2	19-Mar-2002	OB7-4	0.079	U	0.07	U	0.18	U
41	B147H3	19-Mar-2002	OB7-5	0.039	U	0.04	U	0.1	U
42	B147H4	19-Mar-2002	OB7-8	0.063	U	0.065	U	0.34	U
43	B147H5	19-Mar-2002	OB7-11	0.084	U	0.078	U	0.17	U
44	B147H6	19-Mar-2002	OB8-2	0.074	U	0.065	U	0.18	U
45	B147H7	19-Mar-2002	OB8-3	0.045	U	0.039	U	0.1	U
46	B147H8	19-Mar-2002	OB8-4	0.071	U	0.064	U	0.15	U
47	B147H9	19-Mar-2002	OB8-8	0.076	U	0.281		1.2	

Overburden Zone Data

ATTACHMENT 4

Bechtel Hanford Inc.

Originator	M. T. Stankovich	Date	7/10/2002	Calc. No.	0100F-CA-V0119	Rev. No.	0
Project	100-F Group 4 Remedial Action	Job No.	22192	Checked		Date	9/3/02
Subject	126-F-1Ash Pit Sample Variance Calculation					Sheet No.	2 of 2

1	samp_num	samp_date_time	Sample Node	Co60	Q	Cs137	Q	Eu152	Q
48	B147J0	19-Mar-2002	OB8-12	0.072	U	0.064	U	0.14	U
49	B147J1	19-Mar-2002	OB8-13	0.09	U	0.085	U	0.2	U
50	B147J2	21-Mar-2002	OC9-3	0.041	U	0.04	U	0.099	U
51	B147J3	21-Mar-2002	OC9-4	0.055	U	0.06	U	0.13	U
52	B147J4	21-Mar-2002	OC9-5	0.04	U	0.04	U	0.094	U
53	B147J5	21-Mar-2002	OC9-10	0.062	U	0.059	U	0.15	U
54	B147J6	21-Mar-2002	OC9-14	0.042	U	0.085	J	0.19	U
55	B147J7	21-Mar-2002	OC9-16	0.057	U	0.059	U	0.14	U
56	B147J8	21-Mar-2002	OC10-3	0.059	U	0.058	J	0.21	U
57	B147J9	21-Mar-2002	OC10-4	0.078	U	0.07	U	0.2	U
58	B147K0	21-Mar-2002	OC10-8	0.094	U	0.069	U	0.17	U
59	B147K1	21-Mar-2002	OC10-10	0.089	U	0.076	U	0.23	U
60	B147K2	21-Mar-2002	OC10-14	0.04	U	0.035	U	0.096	U
61	B147K3	21-Mar-2002	OC10-16	0.064	U	0.056	U	0.19	U
62	B147K4	21-Mar-2002	OC1-2	0.055	U	0.052	U	0.14	U
63	B147K5	21-Mar-2002	OC1-3	0.098	U	0.069	U	0.2	U
64	B147K6	21-Mar-2002	OC1-4	0.063	U	0.073	U	0.17	U
65	B147K7	21-Mar-2002	OC1-10	0.06	U	0.062	U	0.15	U
66	B147K8	21-Mar-2002	OC1-14	0.054	U	0.066	U	0.13	U
67	B147K9	21-Mar-2002	OC1-15	0.11	U	0.075	U	0.23	U
68	B147L0	21-Mar-2002	OC2-3	0.067	U	0.073	U	0.16	U
69	B147L1	21-Mar-2002	OC2-6	0.057	U	0.048	U	0.12	U
70	B147L2	21-Mar-2002	OC2-7	0.095	U	0.083	U	0.19	U
71	B147L3	21-Mar-2002	OC2-10	0.076	U	0.064	U	0.16	U
72	B147L4	21-Mar-2002	OC2-14	0.11	U	0.082	U	0.22	U
73	B147L5	21-Mar-2002	OC2-15	0.04	U	0.044	U	0.11	U

Overburden Zone Data

2 of 2

CALCULATION COVER SHEET

Project Title: 126-F-1 Overburden Sample Design **Job No.** 22192

Area 100-F

Discipline Environmental Engineering ***Calc. No.** 0100F-CA-V0061

Subject 126-F-1 Overburden Sampling Design

Computer Program Excel **Program No.** Office 97 Version

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

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover = 1 Sheet Calc = 1 Sheets Attach1 = 1 Sheet Attach2 = 1 Sheet Attach3 = 1 Sheets Total = 5 Sheets	G.Cruz 5/23/02	C.A. Bentz 5/24/02	M.T. Stankovich 5-30-02	~~F.M.Corpuz~~ M. Fuckmaster 5/30/02	5/30/02

SUMMARY OF REVISIONS

* Obtain Calc. No. from DIS

Bechtel Hanford, Inc. **CALCULATION SHEET**

Originator Gerardo Cruz Date 04/23/02 Calc. No. 0100F-CA-V0061 Rev. No. 0
Project 126-F-1 Overburden Sample Design Job No. 22192 Checked ab Date 5/24/02
Subject 126-F-1 Overburden Sampling Design Sheet No. _____

Problem: Calculate and display required sampling nodes in concurrence with 100 Area SAP DOE/RL-96-22 Rev. 3 for verification and closure.

Given:
-SAP (DOE/RL-96-22 Rev.3) and IG (0100X-IG-G0001 Rev. 3) requirements
-Overburden Sampling Area (Surface area of each zone determined from CAD program, Attachment 3, Sht 1, CAD file 1F:042302A, 126-F-1 Overburden Sampling Plan)

SAP and IG Requirements:
-Develop a 16 node sampling grid for the sampling area
Overburden Zone: -Use appendix A of the IG to determine which six of the sixteen will be sampled to collect HPGe and clean up verification samples

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:	2335.28 m^2
Area of Decision Subunits (total area 3 subunits)	778.42 m^2
Decision Subunit divided into 4 Sampling Areas:	194.60 m^2
Sampling Areas divided into a 16 node grid (node numbers 1-16):	12.16 m^2

Nodes to be Sampled (as determined from Attachment 1, Table A-1, Sample Grid Point Lookup Table)
See Attachment 3, Sht 1, 126-F-1 Overburden Sampling Plan, for Sample Location Table

Bechtel Hanford, Inc.

Originator Gerardo Cruz Date 04/23/02 Calc. No. 0100F-CA-V0061 Rev. No. 0

Project 126-F-1 Overburden Sample Design Job No. 22192 Checked CAB Date 5/24/02

Subject 126-F-1 Overburden Sampling Design Sheet No.

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
HPGe/Closeout	3	6	1	4	5	1	3	3	4	16
HPGe/Closeout	4	7	11	3	15	15	5	13	10	10
HPGe/Closeout	16	3	2	7	7	10	11	4	3	14
HPGe/Closeout	10	15	4	12	1	13	4	8	16	4
HPGe	2	14	5	9	13	12	8	2	14	8
HPGe	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 northwesternmost node. Then number consecutively left to right as shown in Fig. 5-1 of this IG

Bechtel Hanford, Inc.

Originator Gerardo Cruz Date 04/23/02 Calc. No. 0100F-CA-V0061 Rev. No. 0
Project 126-F-1 Overburden Sample Design Job No. 22192 Checked CAB Date 5/24/02
Subject 126-F-1 Overburden Sampling Design Sheet No.

ATTACHMENT 2

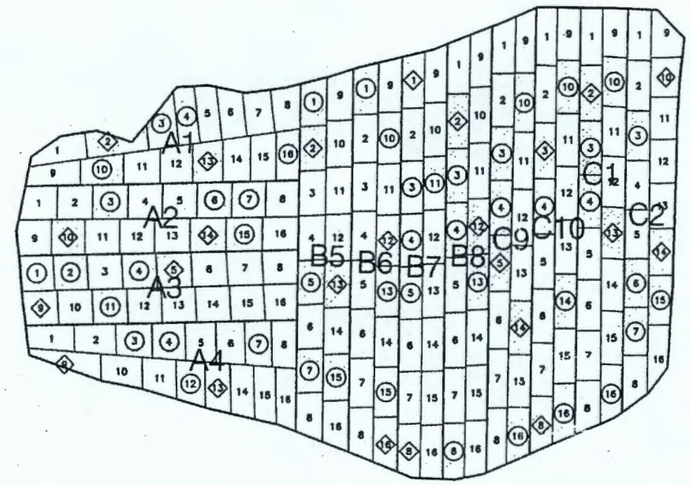
Number of Decision Subunits Based on Area.

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.	

1F:042302A

E 580950

N 147600



NOTES

1. OVERBURDEN ZONE NODE AREAS ARE APPROXIMATELY 12.16 SQUARE METERS.
2. SAMPLES ARE TAKEN FROM THE APPROXIMATE CENTER OF EACH NODE.
3. THE OVERBURDEN ZONE CONSISTS OF SAMPLING AREAS A1, A2, A3 & A4 WITHIN DECISION SUBUNIT 1. SAMPLING AREAS B5, B6, B7, & B8 WITHIN DECISION SUBUNIT 2. SAMPLING AREAS C9, C10, C1, & C2 WITHIN DECISION SUBUNIT 3.

LEGEND

(8) GAMMA ENERGY ANALYSIS & CLOSEOUT VERIFICATION SAMPLING NODE

◇8 GAMMA ENERGY ANALYSIS SAMPLING NODE

SAMPLE LOCATION TABLE

DECISION SUBUNIT	SAMPLING AREA	SAMPLE NODE	NORTHING	EASTING
1	A1	OA1-2	147604.10	580976.57
		OA1-3	147605.96	580981.89
		OA1-4	147606.68	580984.41
		OA1-10	147601.30	580976.03
		OA1-13	147602.16	580986.56
		OA1-16	147602.80	580994.53
	A2	OA2-3	147598.06	580976.92
		OA2-6	147598.26	580987.30
		OA2-7	147598.33	580990.69
		OA2-10	147594.47	580972.77
		OA2-14	147594.75	580986.72
		OA2-15	147594.82	580990.30
	A3	OA3-1	147590.84	580969.66
		OA3-2	147590.93	580973.09
		OA3-4	147591.12	580979.95
		OA3-5	147591.22	580983.41
		OA3-9	147587.30	580970.11
		OA3-11	147587.50	580977.08
	A4	OA4-3	147584.04	580979.60
		OA4-4	147583.96	580983.06
		OA4-7	147583.76	580991.91
		OA4-9	147581.63	580972.64
		OA4-12	147579.72	580985.28
		OA4-13	147579.31	580987.96
2	B5	OB5-1	147608.13	580997.05
		OB5-2	147603.47	580997.06
		OB5-5	147589.99	580997.10
		OB5-7	147581.06	580997.12
		OB5-13	147589.80	580999.75
		OB5-15	147580.40	580999.79
3	C9	OC9-3	147603.12	581015.90
		OC9-4	147597.65	581015.89
		OC9-5	147592.05	581015.87
		OC9-10	147608.20	581018.07
		OC9-14	147585.56	581017.98
		OC9-18	147574.59	581017.93

CALCULATION COVER SHEET

Project Title 126-F-1 Ash Pit Cleanup Verification **Job No.** 22192
Area 100-F Area
Discipline Environmental ***Calc. No.** 0100F-CA-V0146
Subject 126-F-1 Ash Pit (Northern Portion) RESRAD Calculation
Computer Program RESRAD **Program No.** Version 6.21

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

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover – 1 pg Summary – 5 pg Attm. 1 - 1 pg Attm. 2 - 20 pg Attm. 3 - 10 pg Attm. 4 - 29 pg Attm. 5 - 19 pg Attm. 6 - 10 pg Attm. 7 - 20 pg Total – 115 pages	J. E. Thomson 11/12/02	S. W. Clark 11/12/02	K. E. Cook 11/13/02	M. A. Buckmaster 12/01/02	12/01/02

SUMMARY OF REVISION

*Obtain Calc. No. from DIS

November 1998

DE01-437.03

Project:	126-F-1 Cleanup Verification	Job No:	22192	Checked:	S. W. Clark	Date:	11/12/02
Subject:	126-F-1 Ash Pit (Northern Portion) RESRAD Calculation					Sheet No:	1 of 5

PURPOSE:

Calculate the soil and groundwater concentrations, dose, and risk contributions from remaining radionuclide contaminants in shallow zone and overburden soil in the northern portion of the 126-F-1 Ash Pit remediation site over a period of 1,000 years.

GIVEN/REFERENCES:

1. Cleanup verification data from *126-F-1 Northern Portion Cleanup Verification 95% UCL Calculation*, Calculation No. 0100F-CA-V0144, 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. 3, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
3. Radioactive 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 cobalt-60, cesium-137, europium-152, europium-154, and europium-155. There are no nonradionuclide COCs.
4. RESidual RADioactivity (RESRAD) computer code, version 6.21, to calculate compliance with residual radioactivity guidelines, developed for the U.S. Department of Energy by the Environmental Assessment Division of Argonne National Laboratory, Argonne, Illinois.
5. Sample design data from *126-F-1 Ash Pit Shallow Zone Design*, Calculation No. 0100F-CA-V0118, Rev. 0, Bechtel Hanford, Inc., Richland, Washington and *126-F-1 Ash Pit Overburden Design*, Calculation No. 0100F-CA-V0061, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.
6. Ecology, EPA, and DOE, 1998, *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.

Bechtel Hanford, Inc. CALCULATION SHEET

Originator:	J. E. Thomson	Date:	11/13/02	Calc. No.:	0100F-CA-V0146	Rev.:	0
Project:	126-F-1 Cleanup Verification	Job No:	22192	Checked:	S. W. Clark	Date:	11/12/02
Subject:	126-F-1 Ash Pit (Northern Portion) RESRAD Calculation					Sheet No.	2 of 5

SOLUTION:

1) Separate RESRAD runs were performed for the relevant vadose zone soil horizons (shallow zone and overburden soil). Table 1 shows the elevations (NAVD88) and dimensions of each soil horizon. The shallow zone verification sample data set is being used to conservatively represent the entire Vadose Zone below the site. Conservative assumptions were made to simplify the process for estimating dose, excess lifetime cancer risk, and groundwater concentrations at the 126-F-1 site, such that it was assumed that that the concentrations of contaminants detected in the shallow zone soils were consistent to the groundwater table. The total-plan view area of the excavation was used to conservatively estimate the site area input parameter for each soil horizon.

   A separate RESRAD run was performed using the verification samples collected from the overburden soils. Because overburden soil was used to backfill the site excavation, the contaminated zone thickness model assumes that the contamination is equal to the depth of the remedial site excavation.

   Attachment 1 shows the dimensions of each soil horizon and the contaminant pathways considered for dose, risk, and groundwater protection. RESRAD input parameters for each run are shown in the "Summary" section of the RESRAD "Part I: Mixture Sums and Single Radionuclide Guidelines" printouts in the Attachments to this Calculation Summary.

Table 1. Dimensions and Elevation (NAVD88) of 126-F-1 Soil Horizons

RESRAD Run #	Vadose Zone Horizon	Upper Elevation (m)	Lower Elevation (m)	Thickness (m)
1 - Radionuclides	Vadose Zone (Shallow zone data set)	123.8	115.0	8.8
2 - Radionuclides	Overburden	123.8	119.8	4.0

2) The year where the peak dose (or concentration) occurs from each individual radionuclide COC and layer is determined by a preliminary run. This year is then included for all horizons for the 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 2002) for all radionuclide COCs. For the water pathway (i.e. drinking water and food ingestion) the peak year was 7 for cobalt-60, and 43 for cesium-137. The 7- and 43-year time-periods were added to the RESRAD runs. The year 2018 is included for evaluation in all horizons (the year 16 time-period) as 2018 corresponds to the 30-year site cleanup schedule of the

Bechtel Hanford, Inc. CALCULATION SHEET

Originator:	J. E. Thomson	Date:	11/12/02	Calc. No.:	0100F-CA-V0146	Rev.:	0
Project:	126-F-1 Cleanup Verification	Job No:	22192	Checked:	S. W. Clark	Date:	11/12/02
Subject:	126-F-1 Ash Pit (Northern Portion) RESRAD Calculation					Sheet No. 3 of 5	

METHODOLOGY:

1) Runs of RESRAD version 6.21 were completed for the shallow zone and overburden soil using the radionuclide concentrations shown in Table 2. RESRAD numerical output reports for radionuclide dose, risk, and concentration for the shallow zone and overburden soil are presented in the Attachments to this Calculation Summary.

Table 2. Cleanup Verification Data Set

Radionuclide COCs	Radionuclide Activity, pCi/g	
	Shallow Zone[a]	Overburden[a]
Cs-137	3.9E-01	0 (< BG)[b]
Co-60	4.1E-02	2.7E-02
Eu-152	6.6E-01	2.9E-01
Eu-154	9.1E-02	4.4E-02 (U)[b]
Eu-155	1.2E-01	2.8E-04 (U)[b]

[a] The Shallow Zone and Overburden concentrations are from the *126-F-1 Cleanup Verification 95% UCL Calculation*, Calculation No. 0100F-CA-V0144, Rev. 0.
[b] Value was not input into RESRAD because the concentration is below RAGs, below Hanford Site background, below Washington State background, or because the analyte was not detected in cleanup verification samples at the indicated PQLs.
U = All analytical results for the data set were below laboratory detection limits.

RESULTS:

1) Radionuclide "All Pathways" Dose Rate

The "all pathways" (maximum) dose rates are shown in Table 3. The vadose zone maximum total all pathways dose rate of 4.8 mrem/yr occurs at year zero (2002). The vadose zone all pathways dose rate for year 2018 (time slice 16) is 2.1 mrem/yr. The maximum overburden dose rate of 1.6 mrem/yr occurs in year zero.

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	7	16	43	100	300	1000
1	Shallow Zone	4.8E+00	4.5E+00	4.1E+00	3.3E+00	2.1E+00	7.0E-01	1.2E-01	9.9E-04	9.5E-11
Total Vadose Zone All Pathways Dose Rate (mrem/yr)		4.8E+00	4.5E+00	4.1E+00	3.3E+00	2.1E+00	7.0E-01	1.2E-01	9.9E-04	9.5E-11
2	Overburden	1.6E+00	1.5E+00	1.3E+00	1.0E+00	5.9E-01	1.4E-01	7.0E-03	2.1E-07	5.0E-16

Bechtel Hanford, Inc. CALCULATION SHEET

Originator:	J. E. Thomson	Date:	11/12/02	Calc. No.:	0100F-CA-V0146	Rev.:	0
Project:	126-F-1 Cleanup Verification	Job No:	22192	Checked:	S. W. Clark	Date:	11/12/02
Subject:	126-F-1 Ash Pit (Northern Portion) RESRAD Calculation					Sheet No. 4 of 5	

2) Radionuclide Excess Cancer Risk

The radionuclide excess lifetime cancer risk results are shown in Table 4. The vadose zone maximum total excess lifetime cancer risk (5.8×10^{-5}) occurs at year zero (2002). The vadose zone excess lifetime cancer risk for year 2018 (time slice 16) is 2.8×10^{-5}. The maximum risk from overburden soil (1.7×10^{-5}) occurs in year zero.

Table 4. Radionuclide Excess Lifetime Cancer Risk

RESRAD Run #	Vadose Zone Horizons	Excess Cancer Risk at Each Time Slice (yr)								
		0	1	3	7	16	43	100	300	1000
1	Shallow Zone	5.8E-05	5.5E-05	5.0E-05	4.1E-05	2.8E-05	9.9E-06	1.8E-06	1.6E-08	1.5E-15
Total Excess Cancer Risk		5.8E-05	5.5E-05	5.0E-05	4.1E-05	2.8E-05	9.9E-06	1.8E-06	1.6E-08	1.5E-15
2	Overburden	1.7E-05	1.6E-05	1.4E-05	1.1E-05	6.8E-06	1.6E-05	8.3E-08	2.5E-12	3.4E-21

3) Radionuclide Groundwater Protection

The radionuclide concentrations in groundwater calculated by the RESRAD model are summarized in Table 7. The organ specific dose via the groundwater (and river) pathway is calculated in a separate calculation brief. Only concentrations are presented here. Cobalt-60 and cesium-137 were predicted to reach groundwater in the 1,000 years of the RESRAD model run for the vadose zone. These radionuclide contaminants reach groundwater at concentrations significantly below the RAGs. Radionuclide contaminants of concern in overburden soil are not predicted to reach groundwater.

Table 5. RESRAD Predicted Groundwater (Well Water/Drinking Water) Concentrations

COC	Vadose Zone Horizon	Groundwater Concentrations in pCi/L at Each Time Slice (yr)									RAGs From RDR (pCi/L)
		0	1	3	7	16	43	100	300	1000	
Co-60	Shallow Zone	0	9.2E-05	2.1E-04	2.9E-04	2.1E-04	1.6E-05	2.0E-08	2.3E-19	0	100
	Vadose Zone Total	0	9.2E-05	2.1E-04	2.9E-04	2.1E-04	1.6E-05	2.0E-08	2.3E-19	0	
	Overburden	0	0	0	0	0	0	0	0	0	
Cs-137	Shallow Zone	0	9.7E-04	2.8E-03	6.0E-03	1.1E-02	1.6E-02	9.9E-03	2.9E-04	8.9E-11	60
	Vadose Zone Total	0	9.7E-04	2.8E-03	6.0E-03	1.1E-02	1.6E-02	9.9E-03	2.9E-04	8.9E-11	
Eu-152	Shallow Zone	0	0	0	0	0	0	0	0	0	200
	Vadose Zone Total	0	0	0	0	0	0	0	0	0	
	Overburden	0	0	0	0	0	0	0	0	0	
Eu-154	Shallow Zone	0	0	0	0	0	0	0	0	0	60
	Vadose Zone Total	0	0	0	0	0	0	0	0	0	
Eu-155	Shallow Zone	0	0	0	0	0	0	0	0	0	600
	Vadose Zone Total	0	0	0	0	0	0	0	0	0	

Originator:	J. E. Thomson	Date:	11/12/02	Calc. No.:	0100F-CA-V0146	Rev.:	0
Project:	126-F-1 Cleanup Verification	Job No:	22192	Checked:	S. W. Clark	Date:	11/12/02
Subject:	126-F-1 Ash Pit (Northern Portion) RESRAD Calculation					Sheet No:	5 of 5

CONCLUSIONS:

- The maximum total all pathways dose rate of 4.8 mrem/yr occurs at year zero (2002). The maximum overburden dose rate of 1.6 mrem/yr occurs in year zero. The all pathways dose rate for year 2018 (time slice 16) is 2.1 mrem/yr.

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

- The primary radionuclide contributing to the direct exposure pathway dose rate is europium-152.

- The maximum total excess lifetime cancer risk (5.8×10^{-5}) occurs at year zero (2002). The maximum risk from overburden soil (1.7×10^{-5}) occurs in year zero. The excess lifetime cancer risk for year 2018 (time slice 16) is 2.8×10^{-5}.

- Among the radionuclide contaminants of concern in the vadose zone, cobalt-60, and cesium-137 are predicted to reach groundwater in the 1,000 years of the RESRAD model run. These radionuclides are predicted to reach groundwater at concentrations significantly below the RAGs. Radionuclide contaminants of concern in overburden soil are not predicted to reach groundwater.

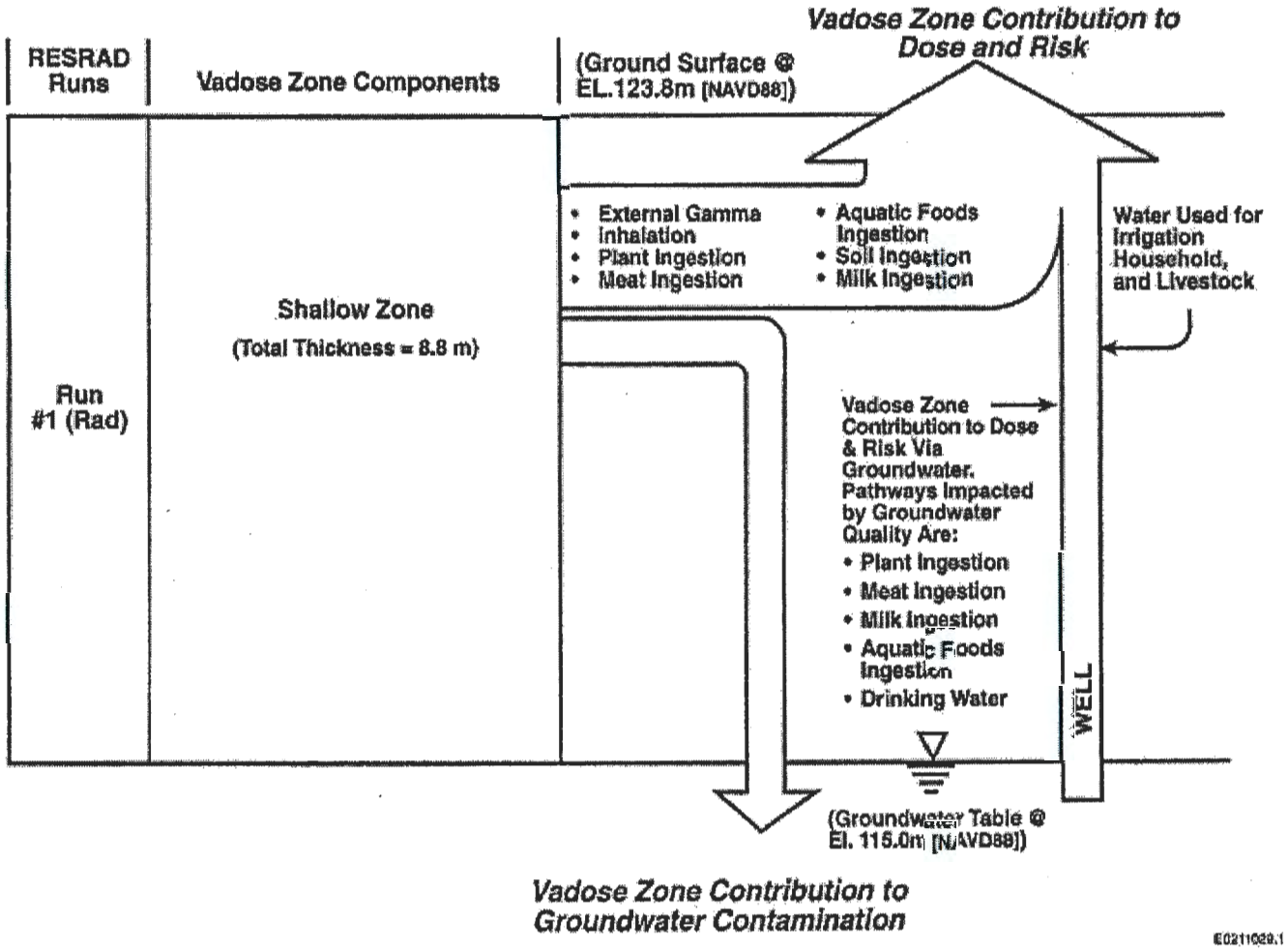
- None of the site COCs are projected to exceed remedial action goals (RAGs).

ATTACHMENTS:

1. Graphic showing 126-F-1 Cleanup Verification Model (1 page)
2. RESRAD Output: 126-F-1 Shallow Zone Rad (Run 1), Mixture Sums and Single Radionuclide Guidelines (20 pages)
3. RESRAD Output: 126-F-1 Shallow Zone Rad (Run 1), Concentration of Radionuclides (10 pages)
4. RESRAD Output: 126-F-1 Shallow Zone Rad (Run 1), Intake Quantities and Health Risk Factors (29 pages)
5. RESRAD Output: 126-F-1 Overburden Rad (Run 2), Mixture Sums and Single Radionuclide Guidelines (19 pages)
6. RESRAD Output: 126-F-1 Overburden Rad (Run 2), Concentration of Radionuclides (10 pages)
7. RESRAD Output: 126-F-1 Overburden Rad (Run 2), Intake Quantities and Health Risk Factors (20 pages)

ATTACHMENT 1

126-F-1 Northern Portion Cleanup Verification Model



Attachment 1 Sheet No. 1 of 1
Originator J. E. Thomson Date 11/27/02
Chk'd By S. W. Clark Date 11/26/02
Calc. No. 0100F-CA-V00146 Rev. No. 0

ATTACHMENT 2

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1RESRAD, Version 6.21      T« Limit = 0.5 year        11/07/2002  16:04  Page   1
 Summary : 126-F-1 Ash Pit (Northern Portion) Shallow Zone Rad
 File    : 126-F-1 North SZ Rad.RAD
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Time = 1.600E+01 14
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Attachment 2 Sheet No. 1 of 20
Originator J. E. Thomson Date 11/13/02
Chk'd By S. W. Clark Date 11/13/02
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ATTACHMENT 2

1RESRAD, Version 6.21 T« Limit = 0.5 year 11/07/2002 16:04 Page 2
Summary : 126-F-1 Ash Pit (Northern Portion) Shallow Zone Rad
File : 126-F-1 North SZ Rad.RAD

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

0 Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Co-60	2.190E-04	2.190E-04	DCF2(1)
B-1	Cs-137+D	3.190E-05	3.190E-05	DCF2(2)
B-1	Eu-152	2.210E-04	2.210E-04	DCF2(3)
B-1	Eu-154	2.860E-04	2.860E-04	DCF2(5)
B-1	Eu-155	4.140E-05	4.140E-05	DCF2(6)
B-1	Gd-152	2.430E-01	2.430E-01	DCF2(7)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Co-60	2.690E-05	2.690E-05	DCF3(1)
D-1	Cs-137+D	5.000E-05	5.000E-05	DCF3(2)
D-1	Eu-152	6.480E-06	6.480E-06	DCF3(3)
D-1	Eu-154	9.550E-06	9.550E-06	DCF3(5)
D-1	Eu-155	1.530E-06	1.530E-06	DCF3(6)
D-1	Gd-152	1.610E-04	1.610E-04	DCF3(7)
D-34	Food transfer factors:			
D-34	Co-60 , plant/soil concentration ratio, dimensionless	8.000E-02	8.000E-02	RTF(1,1)
D-34	Co-60 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-02	2.000E-02	RTF(1,2)
D-34	Co-60 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-03	2.000E-03	RTF(1,3)
D-34	Cs-137+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(2,1)
D-34	Cs-137+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.000E-02	3.000E-02	RTF(2,2)
D-34	Cs-137+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	8.000E-03	8.000E-03	RTF(2,3)
D-34	Eu-152 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(3,1)
D-34	Eu-152 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(3,2)
D-34	Eu-152 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(3,3)
D-34	Eu-154 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(5,1)
D-34	Eu-154 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(5,2)
D-34	Eu-154 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(5,3)
D-34	Eu-155 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(6,1)
D-34	Eu-155 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(6,2)
D-34	Eu-155 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(6,3)
D-34	Gd-152 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(7,1)
D-34	Gd-152 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(7,2)
D-34	Gd-152 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(7,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Co-60 , fish	3.000E+02	3.000E+02	BIOFAC(1,1)
D-5	Co-60 , crustacea and mollusks	2.000E+02	2.000E+02	BIOFAC(1,2)
D-5	Cs-137+D , fish	2.000E+03	2.000E+03	BIOFAC(2,1)
D-5	Cs-137+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(2,2)
D-5	Eu-152 , fish	5.000E+01	5.000E+01	BIOFAC(3,1)
D-5	Eu-152 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(3,2)

Attachment 2 Sheet No. 2 of 20
Originator J. E. Thomson Date
Chk'd By S. W. Clark Date
Calc. No. 0100F-CA-V0146 Rev. No. 0

ATTACHMENT 2

1RESRAD, Version 6.21 T« Limit = 0.5 year 11/07/2002 16:04 Page 3
Summary : 126-F-1 Ash Pit (Northern Portion) Shallow Zone Rad
File : 126-F-1 North SZ Rad.RAD

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

Menu	Parameter	Current Value	Default	Parameter Name
D-5	Eu-154 , fish	5.000E+01	5.000E+01	BIOFAC(5,1)
D-5	Eu-154 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(5,2)
D-5	Eu-155 , fish	5.000E+01	5.000E+01	BIOFAC(6,1)
D-5	Eu-155 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(6,2)
D-5	Gd-152 , fish	2.500E+01	2.500E+01	BIOFAC(7,1)
D-5	Gd-152 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(7,2)

Attachment 2 Sheet No. 3 of 20
Originator J. E. Thomson Date
Chk'd By S. W. Clark Date
Calc. No. 0100F-CA-V0146 Rev. No. 0

ATTACHMENT 2

1RESRAD, Version 6.21 T« Limit = 0.5 year 11/07/2002 16:04 Page 4
Summary : 126-F-1 Ash Pit (Northern Portion) Shallow Zone Rad
File : 126-F-1 North SZ Rad.RAD

Site-Specific Parameter Summary

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	3.507E+04	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	8.800E+00	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	3.150E+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)	7.000E+00	1.000E+01	---	T(4)
R011	Times for calculations (yr)	1.600E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	4.300E+01	1.000E+02	---	T(6)
R011	Times for calculations (yr)	1.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	3.000E+02	1.000E+03	---	T(8)
R011	Times for calculations (yr)	1.000E+03	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Co-60	4.100E-02	0.000E+00	---	S1(1)
R012	Initial principal radionuclide (pCi/g): Cs-137	3.900E-01	0.000E+00	---	S1(2)
R012	Initial principal radionuclide (pCi/g): Eu-152	6.600E-01	0.000E+00	---	S1(3)
R012	Initial principal radionuclide (pCi/g): Eu-154	9.100E-02	0.000E+00	---	S1(5)
R012	Initial principal radionuclide (pCi/g): Eu-155	1.200E-01	0.000E+00	---	S1(6)
R012	Concentration in groundwater (pCi/L): Co-60	not used	0.000E+00	---	W1(1)
R012	Concentration in groundwater (pCi/L): Cs-137	not used	0.000E+00	---	W1(2)
R012	Concentration in groundwater (pCi/L): Eu-152	not used	0.000E+00	---	W1(3)
R012	Concentration in groundwater (pCi/L): Eu-154	not used	0.000E+00	---	W1(5)
R012	Concentration in groundwater (pCi/L): Eu-155	not used	0.000E+00	---	W1(6)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.600E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone field capacity	1.500E-01	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	2.500E+02	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	4.050E+00	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	3.400E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	9.100E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1.600E-01	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	7.600E-01	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1.000E+06	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	1.000E-03	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	1.600E+00	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	4.000E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	2.500E-01	2.000E-01	---	EPSZ
R014	Saturated zone field capacity	1.500E-01	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	5.530E+03	1.000E+02	---	HCSZ

Attachment 2 Sheet No. 4 of 20
Originator J. E. Thomson Date
Chk'd By S. W. Clark Date
Calc. No. 0100F-CA-V0146 Rev. No. 0

ATTACHMENT 2

1RESRAD, Version 6.21 T« Limit = 0.5 year 11/07/2002 16:04 Page 5
Summary : 126-F-1 Ash Pit (Northern Portion) Shallow Zone Rad
File : 126-F-1 North SZ Rad.RAD

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
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
R015	Number of unsaturated zone strata	0	1	---	NS
R016	Distribution coefficients for Co-60				
R016	Contaminated zone (cm**3/g)	5.000E+01	1.000E+03	---	DCNUCC(1)
R016	Saturated zone (cm**3/g)	5.000E+01	1.000E+03	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.132E-04	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for Cs-137				
R016	Contaminated zone (cm**3/g)	5.000E+01	1.000E+03	---	DCNUCC(2)
R016	Saturated zone (cm**3/g)	5.000E+01	1.000E+03	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.132E-04	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for Eu-152				
R016	Contaminated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCC(3)
R016	Saturated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.836E-05	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for Eu-154				
R016	Contaminated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCC(5)
R016	Saturated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCS(5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.836E-05	ALEACH(5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)
R016	Distribution coefficients for Eu-155				
R016	Contaminated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCC(6)
R016	Saturated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCS(6)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.836E-05	ALEACH(6)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(6)
R016	Distribution coefficients for daughter Gd-152				
R016	Contaminated zone (cm**3/g)	-1.000E+00	-1.000E+00	8.249E+02	DCNUCC(7)
R016	Saturated zone (cm**3/g)	-1.000E+00	-1.000E+00	8.249E+02	DCNUCS(7)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	6.880E-06	ALEACH(7)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(7)
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

Attachment 2 Sheet No. 5 of 20
Originator J. E. Thomson Date
Chk'd By S. W. Clark Date
Calc. No. 0100F-CA-V0146 Rev. No. 0

ATTACHMENT 2

1RESRAD, Version 6.21 T½ Limit = 0.5 year 11/07/2002 16:04 Page 6
Summary : 126-F-1 Ash Pit (Northern Portion) Shallow Zone Rad
File : 126-F-1 North SZ Rad.RAD

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Fraction of time spent indoors	6.000E-01	5.000E-01	---	FINO
R017	Fraction of time spent outdoors (on site)	2.000E-01	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)
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

Attachment 2 Sheet No. 6 of 20
Originator J. E. Thomson Date
Chk'd By S. W. Clark Date
Calc. No. 0100F-CA-V0146 Rev. No. 0

ATTACHMENT 2

1RESRAD, Version 6.21 T½ Limit = 0.5 year 11/07/2002 16:04 Page 7
Summary : 126-F-1 Ash Pit (Northern Portion) Shallow Zone Rad
File : 126-F-1 North SZ Rad.RAD

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R019	Livestock water intake for meat (L/day)	5.000E+01	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	1.600E+02	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	5.000E-01	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	1.000E-04	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	9.000E-01	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	1.000E+00	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	1.000E+00	1.000E+00	---	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	7.000E-01	7.000E-01	---	YV(1)
R19B	Wet weight crop yield for Leafy (kg/m**2)	1.500E+00	1.500E+00	---	YV(2)
R19B	Wet weight crop yield for Fodder (kg/m**2)	1.100E+00	1.100E+00	---	YV(3)
R19B	Growing Season for Non-Leafy (years)	1.700E-01	1.700E-01	---	TE(1)
R19B	Growing Season for Leafy (years)	2.500E-01	2.500E-01	---	TE(2)
R19B	Growing Season for Fodder (years)	8.000E-02	8.000E-02	---	TE(3)
R19B	Translocation Factor for Non-Leafy	1.000E-01	1.000E-01	---	TIV(1)
R19B	Translocation Factor for Leafy	1.000E+00	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	1.000E+00	1.000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RDRY(1)
R19B	Dry Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	2.000E+01	2.000E+01	---	WLAM
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
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)

Attachment 2 Sheet No. 7 of 20
Originator J. E. Thomson Date
Chk'd By S. W. Clark Date
Calc. No. 0100F-CA-V0146 Rev. No. 0

ATTACHMENT 2

1RESRAD, Version 6.21 T∝ Limit = 0.5 year 11/07/2002 16:04 Page 8
Summary : 126-F-1 Ash Pit (Northern Portion) Shallow Zone Rad
File : 126-F-1 North SZ Rad.RAD

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)
TITL	Number of graphical time points	32	---	---	NPTS
TITL	Maximum number of integration points for dose	17	---	---	LYMAX
TITL	Maximum number of integration points for risk	257	---	---	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

Attachment 2 Sheet No. 8 of 20
Originator J. E. Thomson Date
Chk'd By S. W. Clark Date
Calc. No. 0100F-CA-V0146 Rev. No. 0

ATTACHMENT 2

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1RESRAD, Version 6.21      T« Limit = 0.5 year        11/07/2002  16:04  Page   9
 Summary : 126-F-1 Ash Pit (Northern Portion) Shallow Zone Rad
 File    : 126-F-1 North SZ Rad.RAD

     Contaminated Zone Dimensions          Initial Soil Concentrations, pCi/g
     XXXXXXXXXXXXXXXXXXXXXXXXXXXX          XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
        Area:  35068.00 square meters              Co-60      4.100E-02
   Thickness:      8.80 meters                     Cs-137     3.900E-01
 .Cover Depth:     0.00 meters                     Eu-152     6.600E-01
                                                   Eu-154     9.100E-02
                                                   Eu-155     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)
                  XXXXXXXXXXXXXXXXXXXX
```

CALCULATION COVER SHEET

Project Title 126-F-1 Cleanup Verification **Job No.** 14655
Area 100-F Area
Discipline Environmental ***Calc. No.** 0100F-CA-V0102
Subject 126-F-1 (Southern Portion) RESRAD Calculation
Computer Program RESRAD **Program No.** Version 6.3

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

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

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover – 1 pg Summary – 4 pg Attm. 1 – 1 pg Attm. 2 – 20 pg Attm. 3 – 22 pg Attm. 4 – 11 pg Total – 59 pages	T. M. Routt *Approved 09/05/01*	S. W. Clark *Approved 09/05/01*	K. E. Cook *Approved 09/05/01*	M. A. Buckmaster *Approved 09/10/01*	*Approved 09/10/01*
1	Cover – 1 pg Summary – ~~3~~ pg Attm. 1 - 1 pg Attm. 2 - 20 pg Attm. 3 - 21 pg Attm. 4 - 10 pg Total – ~~194~~ pages mie 2/21/07 57	S. W. Clark S.W. Clark 2/12/07	M. W. Perrott M.W. Perrott 2/13/07	N/A	S. W. Callison SW Callison 2-20-07	2-20-07

SUMMARY OF REVISION

1	This calculation brief was revised to account for radioactive decay since the original calculation (Rev. 0) was performed in 2001. For convenience the entire calculation brief including the cover sheet has been replaced.

WCH-DE-018 (9/01/2006) *Obtain Calc. No. from R&DC and Form from Intranet

Washington Closure Hanford CALCULATION SHEET

Originator:	S. W. Clark SWC	Date:	2/12/07	Calc. No.:	0100F-CA-V0102	Rev.:	0
Project:	126-F-1 Cleanup Verification	Job No:	14655	Checked:	M. W. Perrott MWPerrott	Date:	2/12/07
Subject:	126-F-1 (Southern Portion) RESRAD Calculation					Sheet No. 1 of 4	

PURPOSE:

Calculate the soil and groundwater concentrations, dose, and risk contributions from remaining radionuclide contaminants in vadose zone soil at the southern portion of the 126-F-1 Powerhouse Ash Pit over a period of 1,000 years.

GIVEN/REFERENCES:

1) Cleanup verification data from *126-F-1 (Southern Portion) Cleanup Verification 95% UCL Calculation*, Calculation No. 0100F-CA-V0100, 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. 5, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
3) Radioactive and nonradioactive contaminants of potential concern (COPCs) from the *100 Area Remedial Action Sampling and Analysis Plan*, DOE/RL-96-22, Rev. 2, U.S. Department of Energy, Richland Operations Office, Richland, Washington. For the purpose of these RESRAD calculations, the radioactive COCs were cesium-137, cobalt-60, europium-152, europium-154, and europium-155. There were no nonradionuclide COCs.
4) RESidual RADioactivity (RESRAD) computer code, version 6.3, to calculate compliance with residual radioactivity guidelines, developed for the U.S. Department of Energy by the Environmental Assessment Division of Argonne National Laboratory, Argonne, Illinois.
5) Sample design data from the *Sampling and Analysis Instruction for Confirmatory Sampling of the Southern Half of the 126-F-1 Ash Pit*, BHI-01522, Rev. 1, Bechtel Hanford, Inc., Richland, Washington.
6) 100-F Remedial Action Sampling Logbook EL-1535-1.

SOLUTION:

1) A single RESRAD run was performed for the entire vadose zone soil horizon, applying shallow zone cleanup verification criteria. Table 1 shows the elevations (NAVD88), thickness, and areal dimensions of the soil horizon. Attachment 1 shows dimensions of the soil horizon and contaminant pathways considered for dose, risk, and groundwater protection modeling. Input factors for each run are shown in the "Summary" section of the RESRAD "Mixture Sums and Single Radionuclide Guidelines" printouts in the Attachments to this Calculation Summary.

Washington Closure Hanford CALCULATION SHEET

Originator:	S. W. Clark	Date:	2/12/07	Calc. No.:	0100F-CA-V0102	Rev.:	0
Project:	126-F-1 Cleanup Verification	Job No:	14655	Checked:	M. W. Perrott	Date:	2/13/07
Subject:	126-F-1 (Southern Portion) RESRAD Calculation					Sheet No. 2 of 4	

Table 1. Waste Site Dimensions for RESRAD Modeling

Parameter	Units	Contaminated Zone Dimensions
Cover Depth	m	0
Area of Contaminated Zone (CZ)	m^2	72,840
Length Parallel to Aquifer Flow	m	353
Elevation: Surface	m	122.0
Elevation: Groundwater	m	115.0
Thickness: Contaminated Zone	m	7.0

2) The cleanup verification data set for the southern portion of the 126-F-1 Powerhouse Ash Pit is presented in Table 2. The year where the peak dose (or concentration) occurs from each individual radionuclide contaminant of concern (COC) and layer is determined by a preliminary run. This year is then added for all horizons for the 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 2007) for all COCs. RESRAD evaluations were performed for the southern portion of the 126-F-1 Powerhouse Ash Pit assuming that the residual contamination levels from the shallow zone sample data sets extend to groundwater, 7 m (23 ft) below the ground surface (Attachment 1). For the water pathways (i.e. drinking water and food ingestion) the peak year was year 7 for cobalt-60, year 19 for europium-152, year 12 for europium-154, and year 10 for europium-155. The 7, 10, 12, and 19-year time periods were added to all RESRAD runs.

Table 2. Cleanup Verification Data Set [a]

Contaminants of Concern	Radionuclide Activity When Sampled (5/21/2001), (pCi/g)	Radionuclide Activity Decayed to 2/8/2007, (pCi/g)
Cesium-137	0(<BG)	0(<BG)
Cobalt-60	0.26	0.12
Europium-152	3.5	2.6
Europium-154	0.42	0.27
Europium-155	0.061	0.027

[a] Soil concentration values from *126-F-1 (Southern Portion) Cleanup Verification 95% UCL Calculation*, Calculation No. 0100F-CA-V0102, Rev. 0, Bechtel Hanford, Inc., Richland, Washington are reduced by radioactive decay calculations from original sample values on 5/21/2001 to present values (2/8/2007).

METHODOLOGY:

1) Runs of RESRAD version 6.3 were completed for the southern portion of the 126-F-1 Powerhouse Ash Pit using the radionuclide concentrations shown in Table 2. RESRAD numerical output reports for dose, risk, and concentration are presented in the Attachments to this calculation summary.

Washington Closure Hanford CALCULATION SHEET

Originator:	S. W. Clark	Date:	2/13/07	Calc. No.:	0100F-CA-V0102	Rev.:	0
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RESULTS:

1) Radionuclide "All Pathways" Dose Rate

The "all pathways" (maximum) dose rates are shown in Table 3. The maximum all pathways dose rate from the southern portion of the 126-F-1 Powerhouse Ash Pit is 14.3 mrem/yr at year zero (2007).

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

Vadose Zone Horizon	"All Pathways" Dose Contributions in mrem/yr at Each Time Slice (yr)								
	0	1	7	10	11	12	19	300	1000
Shallow Zone	1.43E+01	1.35E+01	9.41E+00	7.91E+00	7.47E+00	7.05E+00	4.76E+00	1.95E-06	4.94E-15

2) Radionuclide Excess Lifetime Cancer Risk

The radionuclide excess lifetime cancer risk (ELCR) results are shown in Table 4. The maximum ELCR for the southern portion of the 126-F-1 Powerhouse Ash Pit is 1.58×10^{-4} at year zero (2007).

Table 4. Radionuclide Excess Lifetime Cancer Risk

Vadose Zone Horizon	Excess Cancer Risk at Each Time Slice (yr)								
	0	1	7	10	11	12	19	300	1000
Shallow Zone	1.58E-04	1.49E-04	1.06E-04	8.98E-05	8.49E-05	8.04E-05	5.48E-05	2.30E-11	3.24E-20

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 calculated in a separate calculation brief. Only concentrations are presented here.

Table 5. RESRAD Predicted Groundwater (Well Water) Concentrations

Radio-nuclides	Groundwater Concentrations in pCi/L at Each Time Slice (yr)									RAGs, pCi/L
	0	1	7	10	11	12	19	300	1000	
Co-60	0	7.26E-04	2.31E-03	2.22E-03	2.14E-03	2.05E-03	1.29E-03	1.75E-18	0	100
Eu-152	0	1.07E-03	5.48E-03	6.70E-03	6.99E-03	7.24E-03	7.96E-03	5.53E-08	2.69E-23	200
Eu-154	0	1.08E-04	4.72E-04	5.32E-04	5.41E-04	5.45E-04	4.97E-04	1.87E-12	4.53E-36	60
Eu-155	0	1.02E-05	3.08E-05	2.89E-05	2.77E-05	2.62E-05	1.56E-05	2.12E-21	0	600

RAGs = Remedial action goals from the 100 Area RDR/RAWP

CONCLUSIONS:

- The "all pathways" (maximum) dose rates are shown in Table 3. The maximum all pathways dose rate from the southern portion of the 126-F-1 Powerhouse Ash Pit is 14.3 mrem/yr at year zero (2007).

Washington Closure Hanford CALCULATION SHEET

Originator:	S. W. Clark	Date:	2/12/07	Calc. No.:	0100F-CA-V0102	Rev.:	0
Project:	126-F-1 Cleanup Verification	Job No:	14655	Checked:	M. W. Perrott	Date:	2/13/07
Subject:	126-F-1 (Southern Portion) RESRAD Calculation					Sheet No.	4 of 4

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

- The radionuclide excess lifetime cancer risk (ELCR) results are shown in Table 4. The maximum ELCR for the southern portion of the 126-F-1 Powerhouse Ash Pit is 1.58×10^{-4} at year zero (2007).

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

- The primary radionuclide contributing to the direct exposure pathway is europium-152.

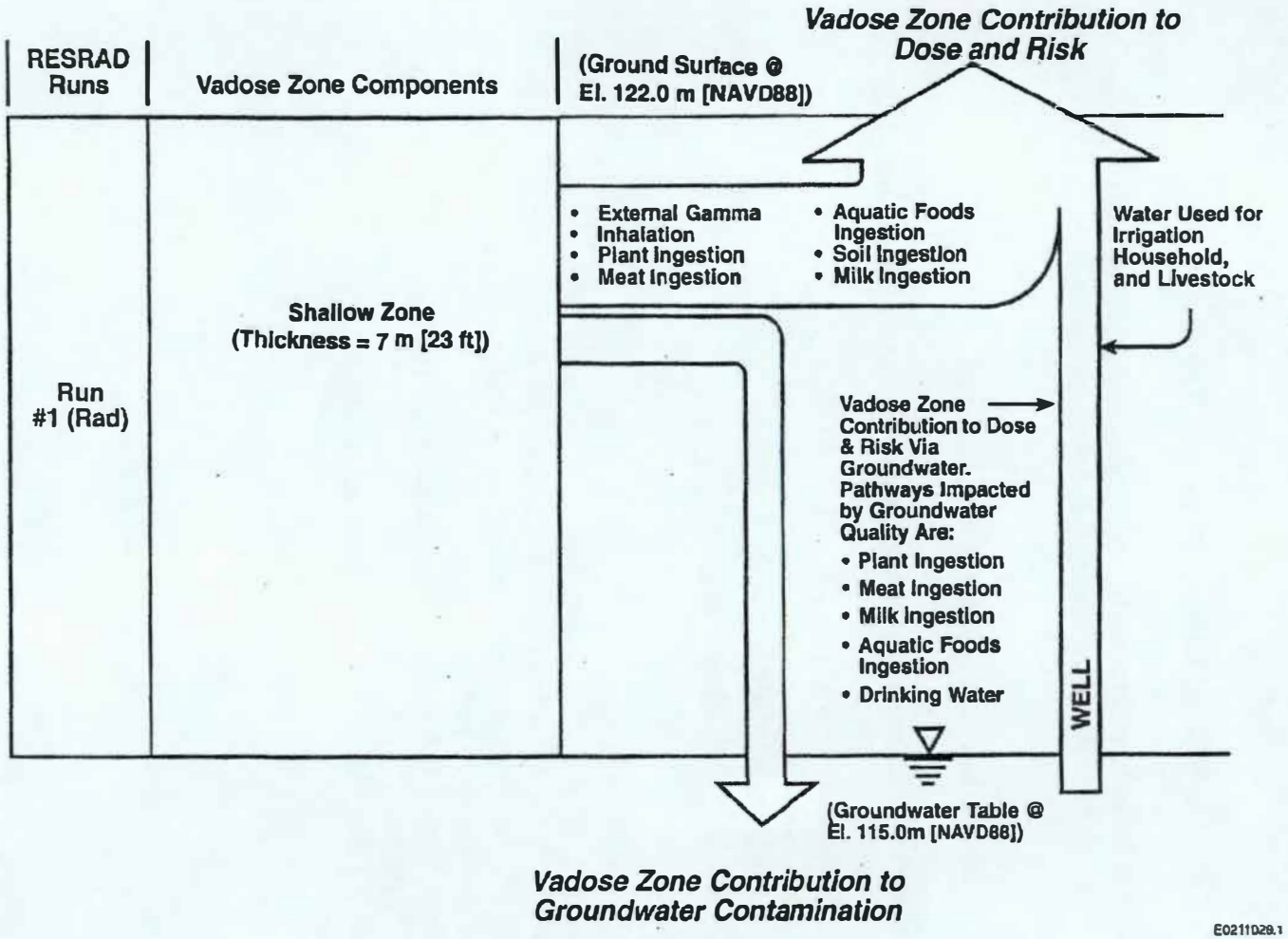
- Among the radionuclide contaminants of concern, cobalt-60, europium-152, europium-154, and europium-155 are calculated to reach groundwater in the 1,000 years of the RESRAD model run. These radionuclides are predicted to reach groundwater at concentrations greatly below the RAGs for drinking water consumption.

ATTACHMENTS:

1. Graphic showing 126-F-1 Ash Pit Southern Portion Cleanup Verification Model (1 page)
2. RESRAD Output: 126-F-1 Ash Pit Southern Portion Radionuclides – Mixture Sums and Single Radionuclide Guidelines (20 pages)
3. RESRAD Output: 126-F-1 Ash Pit Southern Portion Radionuclides – Intake Quantities and Health Risk Factors (21 pages)
4. RESRAD Output: 126-F-1 Ash Pit Southern Portion Radionuclides – Concentration of Radionuclides, (10 Pages)

ATTACHMENT 1

126-F-1 Ash Pit Southern Portion Cleanup Verification Model



Attachment 1 Sheet No. 1 o
Originators: S. W. Clark Date 2/2/
Chk'd By M. W. Perrott Date
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ATTACHMENT 2

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

0 Menu	Parameter	Current Value	Base Case*	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Co-60	2.190E-04	2.190E-04	DCF2(1)
B-1	Eu-152	2.210E-04	2.210E-04	DCF2(2)
B-1	Eu-154	2.860E-04	2.860E-04	DCF2(4)
B-1	Eu-155	4.140E-05	4.140E-05	DCF2(5)
B-1	Gd-152	2.430E-01	2.430E-01	DCF2(6)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Co-60	2.690E-05	2.690E-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	Eu-155	1.530E-06	1.530E-06	DCF3(5)
D-1	Gd-152	1.610E-04	1.610E-04	DCF3(6)
D-34	Food transfer factors:			
D-34	Co-60 , plant/soil concentration ratio, dimensionless	8.000E-02	8.000E-02	RTF(1,1)
D-34	Co-60 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-02	2.000E-02	RTF(1,2)
D-34	Co-60 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-03	2.000E-03	RTF(1,3)
D-34	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)	5.000E-05	5.000E-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)	5.000E-05	5.000E-05	RTF(4,3)
D-34	Eu-155 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(5,1)
D-34	Eu-155 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(5,2)
D-34	Eu-155 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-05	5.000E-05	RTF(5,3)
D-34	Gd-152 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(6,1)
D-34	Gd-152 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(6,2)
D-34	Gd-152 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(6,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Co-60 , fish	3.000E+02	3.000E+02	BIOFAC(1,1)
D-5	Co-60 , crustacea and mollusks	2.000E+02	2.000E+02	BIOFAC(1,2)
D-5	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	Eu-155 , fish	5.000E+01	5.000E+01	BIOFAC(5,1)
D-5	Eu-155 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(5,2)

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Summary : 126-F-1 Southern Portion Radionuclides Decayed to 2007
File : 126-F-1_Decayed_To_2007.RAD

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

0 Menu	Parameter	Current Value	Base Case*	Parameter Name
D-5	Gd-152 , fish	2.500E+01	2.500E+01	BIOFAC(6,1)
D-5	Gd-152 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(6,2)

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

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Summary : 126-F-1 Southern Portion Radionuclides Decayed to 2007
File : 126-F-1_Decayed_To_2007.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)	7.284E+04	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	7.000E+00	2.000E+00	---	THICKO
R011	Length parallel to aquifer flow (m)	3.530E+02	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	1.500E+01	3.000E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	7.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	1.100E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.200E+01	1.000E+02	---	T(6)
R011	Times for calculations (yr)	1.900E+01	3.000E+02	---	T(7)
R011	Times for calculations (yr)	3.000E+02	1.000E+03	---	T(8)
R011	Times for calculations (yr)	1.000E+03	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Co-60	1.200E-01	0.000E+00	---	S1(1)
R012	Initial principal radionuclide (pCi/g): Eu-152	2.600E+00	0.000E+00	---	S1(2)
R012	Initial principal radionuclide (pCi/g): Eu-154	2.700E-01	0.000E+00	---	S1(4)
R012	Initial principal radionuclide (pCi/g): Eu-155	2.700E-02	0.000E+00	---	S1(5)
R012	Concentration in groundwater (pCi/L): Co-60	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)
R012	Concentration in groundwater (pCi/L): Eu-155	not used	0.000E+00	---	W1(5)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.600E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone field capacity	1.500E-01	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	2.500E+02	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	4.050E+00	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	3.400E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	9.100E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1.600E-01	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	7.600E-01	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1.000E+06	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	1.000E-03	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	1.600E+00	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	4.000E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	2.500E-01	2.000E-01	---	EPSZ
R014	Saturated zone field capacity	1.500E-01	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	5.530E+03	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	1.250E-03	2.000E-02	---	HGWT
R014	Saturated zone b parameter	not used	5.300E+00	---	BSZ

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Summary : 126-F-1 Southern Portion Radionuclides Decayed to 2007
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Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R014	Water table drop rate (m/yr)	0.000E+00	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	4.600E+00	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	2.500E+02	2.500E+02	---	UW
R015	Number of unsaturated zone strata	0	1	---	NS
R016	Distribution coefficients for Co-60				
R016	Contaminated zone (cm**3/g)	5.000E+01	1.000E+03	---	DCNUCC(1)
R016	Saturated zone (cm**3/g)	5.000E+01	1.000E+03	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.424E-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	Saturated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.566E-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	3.566E-05	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)
R016	Distribution coefficients for Eu-155				
R016	Contaminated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCC(5)
R016	Saturated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCS(5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.566E-05	ALEACH(5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)
R016	Distribution coefficients for daughter Gd-152				
R016	Contaminated zone (cm**3/g)	-1.000E+00	-1.000E+00	8.249E+02	DCNUCC(6)
R016	Saturated zone (cm**3/g)	-1.000E+00	-1.000E+00	8.249E+02	DCNUCS(6)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	8.650E-06	ALEACH(6)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(6)
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 : 126-F-1 Southern Portion Radionuclides Decayed to 2007
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Site-Specific Parameter Summary (continued)

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

Attachment 2 Sheet No. 6 of 20
Originators: S. W. Clark Date
Chk'd By M. W. Perrott Date
Calc. No. 0100B-CA-V0102 Rev. No. 1

ATTACHMENT 2

1RESRAD, Version 6.3 T« Limit = 180 days 02/12/2007 09:15 Page 7
Summary : 126-F-1 Southern Portion Radionuclides Decayed to 2007
File : 126-F-1_Decayed_To_2007.RAD

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	0.000E+00	---	CO2F
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV

Attachment 2 Sheet No. 7 of 20
Originators: S. W. Clark Date
Chk'd By M. W. Perrott Date
Calc. No. 0100B-CA-V0102 Rev. No. 1

ATTACHMENT 2

1RESRAD, Version 6.3 T« Limit = 180 days 02/12/2007 09:15 Page 8
Summary : 126-F-1 Southern Portion Radionuclides Decayed to 2007
File : 126-F-1_Decayed_To_2007.RAD

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)
TITL	Number of graphical time points	64	---	---	NPTS
TITL	Maximum number of integration points for dose	5	---	---	LYMAX
TITL	Maximum number of integration points for risk	17	---	---	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

Attachment 2 Sheet No. 8 of 20
Originators: S. W. Clark Date
Chk'd By M. W. Perrott Date
Calc. No. 0100B-CA-V0102 Rev. No. 1

ATTACHMENT 2

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1RESRAD, Version 6.3      T« Limit = 180 days       02/12/2007  09:15  Page   9
 Summary : 126-F-1 Southern Portion Radionuclides Decayed to 2007
 File    : 126-F-1_Decayed_To_2007.RAD

     Contaminated Zone Dimensions          Initial Soil Concentrations, pCi/g
     ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ          ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
       Area:  72840.00 square meters              Co-60      1.200E-01
  Thickness:      7.00 meters                     Eu-152     2.600E+00
 Cover Depth:     0.00 meters                     Eu-154     2.700E-01
                                                  Eu-155     2.700E-02
0
                                   Total Dose TDOSE(t), mrem/yr
                              Basic Radiation Dose Limit = 1.500E+01 mrem/yr
                   Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)
                   ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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CALCULATION COVER SHEET

Project Title:	126-F-1 Ash Pit (Northern Portion)	**Job No.**	22192
Area	100-F Area		
Discipline	Environmental	***Calc. No.**	0100F-CA-V0145
Subject	126-F-1 Ash Pit (Northern Portion) Comparison to Drinking Water Standards		
Computer Program	Excel	**Program No.**	Excel 97

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

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover - 1 Calculations - 3 Total - 4	J.E. Thomson 11/12/02 J. E. Thomson	S.W. Clark 11/12/02 S. W. Clark	KEC 11/13/02 K.E. Cook	12/01/02 M. A. Buckmaster	12/01/02

SUMMARY OF REVISIONS

*Obtain Calc. No. from DIS

November 1998

DE01437.03

Bechtel Hanford, Inc. **CALCULATION SHEET**

Originator	J. E. Thomson	**Date**	11/18/02	**Calc. No.**	0100F-CA-V0145	**Rev. No.**	0
Project	126-F-1 Ash Pit (Northern Portion)	**Job No.**	22192	**Checked**	S. W. Clark	**Date**	11/12/03
Subject	126-F-1 Ash Pit (Northern Portion) Comparison to Drinking Water Standards					**Sheet No.**	1 of 3

Purpose:
Compare RESRAD derived groundwater radionuclide concentrations to maximum contamination levels (MCLs) (summarized in DOE 2001, the Remedial Design Report/Remedial Action Work Plan for the 100 Area (RDR/RAWP), DOE/RL-96-17, Rev. 3, Table 2-3). Compare beta/gamma emitter dose contribution to the maximum allowable dose of 4 mrem/yr (40 CFR Part 141, Subpart B, 141.16), as calculated using NBS Handbook 69 individual organ-dose calculation methodology and EPA-570/9-76-003 total organ-dose calculation methodology.

Table of Contents:
1. Calculation Summary
2. Comparison to MCLs
4. Cumulative Dose Comparison

Given/References:
1) RESRAD derived groundwater radionuclide concentrations from Calc. No. 0100F-CA-V0145, Rev. 0, *126-F-1 Ash Pit (Northern Portion) RESRAD Calculation.*
2) Radionuclide concentrations in water corresponding to 4 mrem/year (C_4 mrem/yr) from Calc. No. 0100X-CA-V0128 or as determined from references in item 5.
3) MCLs summarized in Table 2-3 of: DOE, 2001, *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP), DOE/RL-96-17, Rev. 3, U.S. Department of Energy, Richland Operations office, Richland, WA.
4) Maximum allowable dose (beta/gamma emitters) from: 40 CFR 141, "National Primary Drinking Water Regulation," *Code of Federal Regulations*, as amended.
5) Individual organ-dose calculation methodology from: NBS Handbook 69, *Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air or Water for Occupational Exposure*, as amended, U.S. Department of Commerce, Washington D.C., and EPA-570/9-76-003. *National Interim Primary Drinking Water Regulations*. 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 COCs (daughter products are not considered) over time from the RESRAD groundwater (GW) concentration file.
2. If the site conceptual model breaks the contamination into multiple layers with differing concentrations, then the GW concentrations from the various model runs are added (for each time interval) to provide the concentration data for comparison to the individual MCLs and the dose calculation for the beta and gamma emitters.
3. Compare the summed concentrations for each radionuclide to the GW 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, Co-60) at time t is calculated separately using the activity corresponding to a 4 mrem/year dose (C_4) 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.

$$Dose_{organ\ x\ (t)} = [ConcA_{(t)}/C_4^{A}{}_{(x)} + ConcB_{(t)}/C_4^{B}{}_{(x)} + \ldots] \times (4\ mrem/yr)$$

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
$C_4^{A}{}_{(x)}$ 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 $x \leq 4$ mrem/yr, then the standard is met.

Conclusions:
The summed concentrations for each radionuclide are less than the GW MCL given in the RDR/RAWP.

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 (using EPA-570/9-76-003 total dose calculation methodology).

Bechtel Hanford, Inc. **CALCULATION SHEET**

Originator	J. E. Thomson	**Date** 11/12/02	**Calc. No.** 0100F-CA-V0145	**Rev. No.**	0
Project	126-F-1 Ash Pit (Northern Portion)	**Job** 22192	**Checked** S. W. Clark	**Date**	11/13/05
Subject	126-F-1 Ash Pit (Northern Portion) Comparison to Drinking Water Standards			**Sheet No.**	2 of 3

Comparison of the summed concentrations for each radionuclide to the GW MCL given in the RDR/RAWP
Data derived from RESRAD modeling, units are pCi/L.

	Radionuclide	Time (years) 0	1	3	7	16	43	100	300	1000	MCL	Exceed MCL?	Peak Conc.	Year of Peak
1														
2														
3	Co-60	0.0E+00	9.2E-05	2.1E-04	2.9E-04	2.1E-04	1.6E-05	2.0E-08	2.3E-19	0.0E+00	100	No	2.9E-04	7
4														
5	Cs-137	0.0E+00	9.7E-04	2.8E-03	6.0E-03	1.1E-02	1.6E-02	9.9E-03	2.9E-04	8.9E-11	200	No	1.6E-02	43
6														
7	Eu-152	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	200	No	0.0E+00	0
8														
9	Eu-154	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	60	No	0.0E+00	0
10														
11	Eu-155	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	600	No	0.0E+00	0

Bechtel Hanford, Inc. **CALCULATION SHEET**

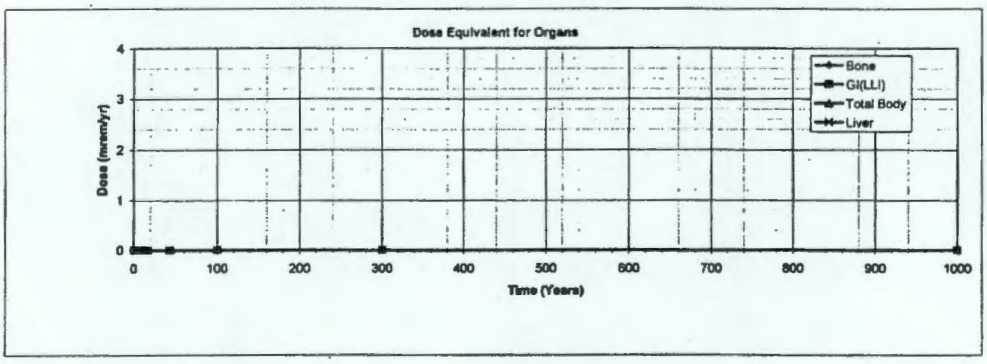
Originator	J. E. Thomson	Date 11/12/02	Calc. No.	0100F-CA-V0145	Rev. No. 0
Project	126-F-1 Ash Pit (Northern Portion)	Job 22192	Checked	S. W. Clark	Date 11/12/02
Subject	126-F-1 Ash Pit (Northern Portion) Comparison to Drinking Water Standards				Sheet No. 4 of 3

Comparison of the summed concentrations for each radionuclide to the GW MCL given in the RDR/RAWP
Data derived from RESRAD modeling, units are pCi/L. C_4 values from Calculation 0100X-CA-V0025.

Radionuclide	Time (years) 0	1	3	7	16	43	100	300	1000	Organ	C_4	Exceeds 4 mrem/yr?	Peak Conc.	Year of Peak Conc.
Co-60	0.0E+00	9.2E-05	2.1E-04	2.9E-04	2.1E-04	1.6E-05	2.0E-08	2.3E-19	0.0E+00	Total Body	900	No	2.9E-04	7
										GI (LLI)	100	No		
										Liver	3000	No		
Cs-137	0.0E+00	9.7E-04	2.8E-03	6.0E-03	1.1E-02	1.6E-02	9.9E-03	2.9E-04	8.9E-11	GI(LLI)	2000	No	1.6E-02	43
										Total Body	200	No		
										Liver	60	No		
										Bone	29.1	No		
Eu-152	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	Bone	30000	No	0.0E+00	NA
										GI(LLI)	200	No		
										Total Body	200000	No		
										Liver	100000	No		
Eu-154	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	Bone	5000	No	0.0E+00	NA
										GI(LLI)	60	No		
										Total Body	70000	No		
										Liver	600000	No		
Eu-155	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	Bone	100000	No	0.0E+00	NA
										GI(LLI)	600	No		
										Total Body	900000	No		
										Liver	600000	No		

Cumulative dose for each organ (with time)

Organ	Time (years) 0	1	3	7	16	43	100	300	1000	Exceeds 4 mrem/yr?	Peak Dose	Year of Peak Dose
Bone	0	1.3E-04	3.9E-04	8.4E-04	1.5E-03	2.2E-03	1.4E-03	4.0E-05	1.2E-11	No	2.2E-03	43
GI(LLI)	0	5.6E-06	1.4E-05	2.4E-05	3.0E-05	3.3E-05	2.0E-05	5.8E-07	1.8E-13	No	3.3E-05	43
Total Body	0	2.0E-05	5.7E-05	1.2E-04	2.2E-04	3.2E-04	2.0E-04	5.8E-06	1.8E-12	No	3.2E-04	43
Liver	0	6.5E-05	1.9E-04	4.0E-04	7.3E-04	1.1E-03	6.6E-04	1.9E-05	5.9E-12	No	1.1E-03	43



CALCULATION COVER SHEET

Project Title:	100-F Remedial Action	**Job No.**	14655
Area	100-F Area		
Discipline	Environmental	***Calc. No.**	0100F-CA-V0101
Subject	126-F-1 (Southern Portion) Comparison to Drinking Water Standards		
Computer Program	Excel	**Program No.**	Excel 97

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

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover - 1 Calculations - 3 Total - 4	T. M. Routt *Approved* *9/5/2001*	S. W. Clark *Approved* *9/5/2001*	K.E. Cook *Approved* *9/5/2001*	M. A. Buckmaster *Approved* *9/10/2001*	*Approved* *9/10/2001*
1	Cover - 1 Calculations - 3 Total - 4	S. W. Clark 2/12/07	M. W. Perrott 2/14/07	N/A	S. W. Callison 2-20-07	2-20-07

SUMMARY OF REVISIONS

1	This calculation brief was revised to account for revisions to the RESRAD Calculation Brief (Calc. No. 0100F-CA-V0102). For convenience the entire calculation brief including the cover sheet has been replaced.

WCH-DE-018 (9/01/2006) *Obtain Calc. No. from R&DC and Form from Internet

Washington Closure Hanford **CALCULATION SHEET**

Originator	S. W. Clark	**Date** 2/12/07	**Calc. No.** 0100F-CA-V0101	**Rev. No.**	1
Project	100-F Remedial Action	**Job No.** 14655	**Checked** M. W. Perrott	**Date**	2/01/07
Subject	126-F-1 (Southern Portion) Comparison to Drinking Water Standards			**Sheet No.**	1 of 3

Purpose:
Compare RESRAD derived groundwater radionuclide concentrations to MCLs (summarized in DOE 2000, the RDR/RAWP, DOE/RL-96-17, Rev. 5, Table 2-3). Compare alpha emitter dose contribution to the maximum allowable gross particle activity of 15 pCi/L
(40 CFR Part 141, Subpart B, 141.15). Compare beta/gamma emitter dose contribution to the maximum allowable dose of 4 mrem/yr (40 CFR Part 141, Subpart B, 141.16), as calculated using NBS Handbook 69 individual organ-dose calculation methodology and EPA-570/9-76-003 total organ-dose calculation methodology.

Table of Contents:
1. Calculation Summary
2. Comparison to MCLs
3. Cumulative Dose Comparison

Given/References:
1) RESRAD derived groundwater radionuclide concentrations from Calc. No. 0100F-CA-V0102, Rev. 1, *126-F-1 (Southern Portion) RESRAD Calculation.*

2) Remedial action goals for groundwater and MCLs summarized in Table 2-3 of the Remedial Design Report/Remedial Action Work Plan for the 100 Area (RDR/RAWP), DOE/RL-96-17, Rev. 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 calculation methodology from: NBS Handbook 69, *Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air or Water for Occupational Exposure*, as amended, U.S. Department of Commerce, Washington D.C., and EPA-570/9-76-003, *National Interim Primary Drinking Water Regulations*, 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 COCs (daughter products are not considered) over time from the RESRAD groundwater (GW) concentration file.

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

3. Compare the summed concentrations for each radionuclide to the GW MCL given in the RDR/RAWP, Table 2-3.

4. The cumulative dose for each organ for all beta and gamma emitting COCs (Co-60, Eu-152, Eu-154, Eu-155) at time **t** is calculated separately using the activity corresponding to a 4 mrem/year dose (C_4) 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.

$$Dose_{organ\ x\ (t)} = [ConcA_{(t)}/C_4{}^{A}{}_{(x)} + ConcB_{(t)}/C_4{}^{B}{}_{(x)} + ...] \times (4\ mrem/yr)$$

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
$C_4{}^{A}{}_{(x)}$ 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** $\leq$ 4 mrem/yr, then the standard is met.

Conclusions:
The summed concentrations for each radionuclide are less than the GW MCL given in the RDR/RAWP.

Alpha emitters are not a COC for this site.

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 (using EPA-570/9-76-003 total dose calculation methodology).

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Project 100-F Remedial Action Job 14655 Checked M. W. Perrott Date 2/12/07
Subject 126-F-1 (Southern Portion) Comparison to Drinking Water Standards Sheet No. 2 of 3

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

Radionuclide	Time (years)									MCL	Exceeds MCL?	Peak Conc.	Year of Peak Conc.
	0	1	7	10	11	12	19	300	1000				
Co-60	0	7.26E-04	2.31E-03	2.22E-03	2.14E-03	2.05E-03	1.29E-03	1.75E-18	0	100	No	2.31E-03	7
Eu-152	0	1.07E-03	5.48E-03	6.70E-03	6.99E-03	7.24E-03	7.96E-03	5.53E-08	2.69E-23	200	No	7.96E-03	19
Eu-154	0	1.08E-04	4.72E-04	5.32E-04	5.41E-04	5.45E-04	4.97E-04	1.87E-12	4.53E-36	60	No	5.45E-04	12
Eu-155	0	1.02E-05	3.08E-05	2.89E-05	2.77E-05	2.62E-05	1.56E-05	2.12E-21	0	600	No	3.08E-05	7

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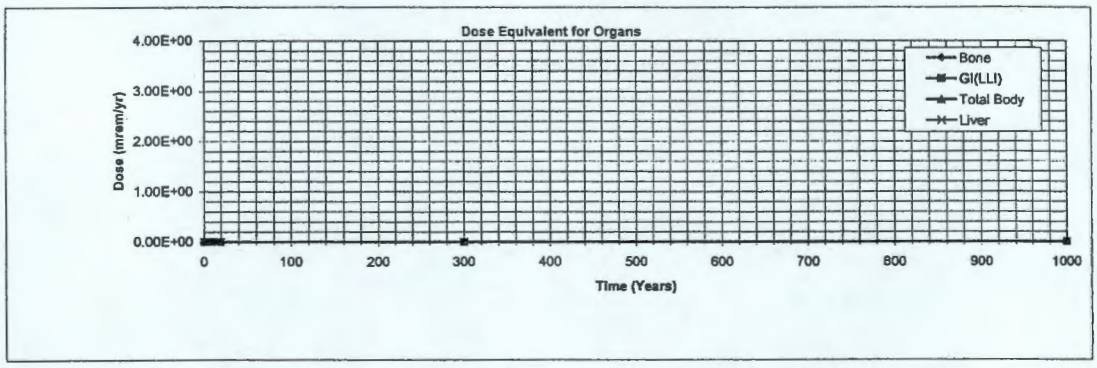
Subject	126-F-1 (Southern Portion) Comparison to Drinking Water Standards				Sheet No. 3 of 3

Comparison of the summed concentrations for each radionuclide to the GW MCL given in the RDR/RAWP
Data derived from RESRAD modeling, units are pCi/L. C_4 values from Calculation 0100X-CA-V0025.

Radionuclide	Time (years) 0	1	7	10	11	12	19	300	1000	Organ	C_4	Exceeds 4 mrem/yr?	Peak Conc.	Year of Peak Conc.
Co-60	0.00E+00	7.26E-04	2.31E-03	2.22E-03	2.14E-03	2.05E-03	1.29E-03	1.75E-18	0.00E+00	GI(LLI)	100	No	2.31E-03	7
										Total Body	900	No		
										Liver	3000	No		
Eu-152	0.00E+00	1.07E-03	5.48E-03	6.70E-03	6.99E-03	7.24E-03	7.96E-03	5.53E-08	2.69E-23	Bone	30000	No	7.96E-03	19
										GI(LLI)	200	No		
										Total Body	200000	No		
										Liver	100000	No		
Eu-154	0.00E+00	1.08E-04	4.72E-04	5.32E-04	5.41E-04	5.45E-04	4.97E-04	1.87E-12	4.53E-36	Bone	5000	No	5.45E-04	12
										GI(LLI)	60	No		
										Total Body	70000	No		
										Liver	60000	No		
Eu-155	0.00E+00	1.02E-05	3.08E-05	2.89E-05	2.77E-05	2.62E-05	1.56E-05	2.12E-21	0.00E+00	Bone	100000	No	3.08E-05	7
										GI(LLI)	600	No		
										Total Body	900000	No		
										Liver	600000	No		

Cumulative dose for each organ (with time)

Organ	Time (years) 0	1	7	10	11	12	19	300	1000	Exceeds 4 mrem/yr?	Peak Dose	Year of Peak Dose
Bone	0.00E+00	2.29E-07	1.11E-06	1.32E-06	1.37E-06	1.40E-06	1.46E-06	7.37E-12	3.59E-27	No	1.46E-06	19
GI(LLI)	0.00E+00	5.77E-05	2.34E-04	2.58E-04	2.62E-04	2.63E-04	2.44E-04	1.11E-09	5.38E-25	No	2.63E-04	12
Total Body	0.00E+00	3.25E-06	1.04E-05	1.00E-05	9.68E-06	9.29E-06	5.92E-06	1.11E-12	5.38E-28	No	1.04E-05	7
Liver	0.00E+00	1.02E-06	3.33E-06	3.26E-06	3.17E-06	3.06E-06	2.07E-06	2.21E-12	1.08E-27	No	3.33E-06	7



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