Date Submitted: 5/2/07 Originator: L. M. Dittmer Phone: 372-9664	**WASTE SITE RECLASSIFICATION FORM** Operable Unit(s): 100-FR-1 Waste Site Code: 100-F-36 Type of Reclassification Action: Closed Out ☐ Interim Closed Out ☐ No Action ☒ RCRA Postclosure ☐ Rejected ☐ Consolidated ☐	Control Number: 2007-002

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 100-F-36 waste site is the location of the former 108-F Biological Laboratory. The building was closed in 1973, decontaminated, decommissioned, and eventually demolished in 1999. Sampling and evaluation of this site have been performed in accordance with remedial action objectives and goals established by the *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington* (Remaining Sites ROD), U.S. Environmental Protection Agency, Region 10, Seattle, Washington. The selected action involved (1) evaluating the site using available process information and confirmatory sample data, (2) demonstrating through confirmatory sampling that cleanup goals have been achieved, and (3) proposing the site for reclassification as No Action.

Basis for reclassification:

In accordance with this evaluation, the confirmatory sampling results support a reclassification of this site to No Action. The current site conditions achieve the remedial action objectives and the corresponding remedial action goals established in the Remaining Sites ROD. The results of confirmatory sampling show that residual contaminant concentrations do not preclude any future uses (as bounded by the rural-residential scenario) and allow for unrestricted use of shallow zone soils (i.e., surface to 4.6 m [15 ft] deep). The results also demonstrate that residual contaminant concentrations are protective of groundwater and the Columbia River. Remedial actions were not required for 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 *Remaining Sites Verification Package for the 100-F-36, 108-F Biological Laboratory and for the 116-F-15, 108-F Radiation Crib* (attached).

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	5/10/07 Date
N/A Ecology Project Manager (printed)	Signature	Date
R. A. Lobos EPA Project Manager (printed)	 Signature	5/24/07 Date

REMAINING SITES VERIFICATION PACKAGE FOR THE 100-F-36, 108-F BIOLOGICAL LABORATORY, AND FOR THE 116-F-15, 108-F RADIATION CRIB

Attachment to Waste Site Reclassification Form 2007-002 and 2007-003

RLK 12/3/08

May 2007

REMAINING SITES VERIFICATION PACKAGE FOR THE 100-F-36, 108-F BIOLOGICAL LABORATORY, AND FOR THE 116-F-15, 108-F RADIATION CRIB

EXECUTIVE SUMMARY

This remaining sites verification package documents completion of remedial action and sampling activities for the 100-F-36 and 116-F-15 waste sites. The 100-F-36 waste site is the former 108-F Biological Laboratory, and the 116-F-15 waste site is the former 108-F Radiation Crib that was located within the footprint of the 108-F Biological Laboratory. These sites are part of the 100-FR-1 Operable Unit in the 100-F Area of the Hanford Site.

The 108-F Building was originally built in 1944 to support treatment of cooling water for use in the 105-F Reactor. In 1949, the building was converted to a biological laboratory to test the effects of radiation and contamination on plant and animal life. The 108-F Radiation Crib was a concrete sump, or floor drain, located near the center of the first floor of the 108-F Building. In 1999, the 108-F Building was demolished and all building debris and the foundation were removed, and the site backfilled. The 108-F Radiation Crib was reported to also have been removed (BHI 2000a).

In February 2002, verification sampling was conducted at various french drains around the former 108-F Building, and the 116-F-15 sump was included in this sample campaign. During excavation to obtain appropriate samples, a piece of 15-cm (6-in.)-diameter cast-iron pipe was uncovered and found to contain lead and radiological contamination (BHI 2002). The excavation was closed without removing any material, and no samples were collected.

In 2004, an evaluation of the 100-F-36 and 116-F-15 waste sites was conducted using historical process information, geophysical surveys, decontamination and decommissioning reports, and screening results from the contaminated 15-cm (6-in.)-diameter cast-iron pipe. It was determined that the 116-F-15 waste site contained hazardous constituents at levels exceeding the remedial action goals (RAGs); therefore, remedial action was recommended (Feist 2004).

Remediation of the 116-F-15 waste site was performed on September 26, 2005, and consisted of the removal of approximately 86 metric tons (95 US tons) of material, including concrete debris, piping, and soil. The material was disposed of at the Environmental Restoration Disposal Facility.

Following the remediation of 116-F-15, confirmatory sampling at the 100-F-36 waste site was performed on December 5, 2006, and verification sampling of the 116-F-15 waste site was performed on December 12, 2006. The results indicated compliance with the remedial action objectives and goals for these sites. A summary of the cleanup evaluation for the soil results against the applicable criteria is presented in Table ES-1. The results of the sampling are used to make reclassification decisions for the 100-F-36 and 116-F-15 sites in accordance with the TPA-MP-14 (DOE-RL 2007) procedure.

Table ES-1. Summary of Remedial Action Objectives for the 100-F-36 and 116-F-15 Waste Sites. (2 Pages)

Regulatory Requirement	Remedial Action Goals	Results	Remedial Action Objectives Attained?
Direct Exposure Radionuclides	Attain 15 mrem/yr dose rate above background over 1,000 years.	No radionuclide COPCs were detected above dose equivalent lookup values. Except for europium-152, all radionuclide activities are less than background.	Yes
Direct Exposure Nonradionuclides	Attain individual COPC RAGs.	All individual COPC concentrations are below the direct exposure criteria.	Yes
Risk Requirements – Nonradionuclides	Attain a hazard quotient of <1 for all individual noncarcinogens.	All individual hazard quotients are <1.	Yes
	Attain a cumulative hazard quotient of <1 for noncarcinogens.	The cumulative hazard quotient for both sites (1.4×10^{-2}) is <1.	
	Attain an excess cancer risk of $<1 \times 10^{-6}$ for individual carcinogens.	The excess cancer risk values for individual carcinogens are $<1 \times 10^{-6}$.	
	Attain a total excess cancer risk of $<1 \times 10^{-5}$ for carcinogens.	The total excess cancer risk value for both sites (5.0×10^{-7}) is $<1 \times 10^{-5}$.	
Groundwater/River Protection – Radionuclides	Attain single COPC groundwater and river protection RAGs.	No radionuclide COPCs were detected above dose equivalent lookup values.	Yes
	Attain national primary drinking water regulations:[a] 4 mrem/yr (beta/gamma) dose rate to target receptor/organs.		
	Meet drinking water standards for alpha emitters: the more stringent of 15 pCi/L MCL or 1/25th of the derived concentration guide from DOE Order 5400.5.[b]		
	Meet total uranium standard of 21.2 pCi/L.[c]		

Table ES-1. Summary of Remedial Action Objectives for the 100-F-36 and 116-F-15 Waste Sites. (2 Pages)

Regulatory Requirement	Remedial Action Goals	Results	Remedial Action Objectives Attained?
Groundwater/River Protection – Nonradionuclides	Attain individual nonradionuclide groundwater and river cleanup requirements.	Verification sample results for lead and aroclor-1254 at the 116-F-15 site failed one or more parts of the WAC 173-340 3-part test. Additionally, aroclor-1260 exceeded groundwater and river protection RAGs. However, results of RESRAD modeling (BHI 2005) indicate these contaminants will not reach groundwater (and, thus, the Columbia River) within 1,000 years. Therefore, the residual concentrations achieve the RAOs for groundwater and river protection.[d]	Yes

[a] "National Primary Drinking Water Regulations" (40 *Code of Federal Regulations* 141).
[b] *Radiation Protection of the Public and Environment* (DOE Order 5400.5).
[c] Based on the isotopic distribution of uranium in the 100 Areas, the 30 µg/L MCL corresponds to 21.2 pCi/L. Concentration-to-activity calculations are documented in *Calculation of Total Uranium Activity Corresponding to a Maximum Contaminant Level for Total Uranium of 30 Micrograms per Liter in Groundwater* (BHI 2001).
[d] Based on the *100 Area Analogous Sites RESRAD Calculations* (BHI 2005), lead, aroclor-1254, and aroclor-1260 are not predicted to migrate more than 3 m (10 ft) vertically in 1,000 years. The vadose zone underlying the 116-F-15 excavation is approximately 10 m (33 ft) thick.

COPC = contaminant of potential concern
MCL = maximum contaminant level
RAG = remedial action goal
RAO = remedial action objective
RESRAD = RESidual RADioactivity (dose assessment model)
WAC = *Washington Administrative Code*

In accordance with this evaluation, the confirmatory and verification sampling results support a reclassification of these sites to No Action (100-F-36) and Interim Closed Out (116-F-15). The current site conditions achieve the remedial action objectives and the corresponding remedial action goals established in the *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington* (Remaining Sites ROD) (EPA 1999), and the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE-RL 2005b). The results of 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 deep zone soils; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are not required.

Soil cleanup levels were established in the Remaining Sites ROD (EPA 1999) based on a limited ecological risk assessment. Although not required by the Remaining Sites ROD, a comparison against ecological risk screening levels has been made for both 100-F-36 and 116-F-15

contaminants of potential concern and other constituents. Screening levels for constituents were not exceeded for either site, with the exception of boron, mercury, and vanadium. Exceedance of screening values does not necessarily indicate the existence of risk to ecological receptors. It is believed that the presence of these constituents does not pose a risk to ecological receptors because concentrations of vanadium and mercury are below site background levels and boron concentrations are consistent with those seen elsewhere at the Hanford Site (no established background value is available for boron). 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 the final closeout decision for this site.

REMAINING SITES VERIFICATION PACKAGE FOR THE 100-F-36, 108-F BIOLOGICAL LABORATORY, AND FOR THE 116-F-15, 108-F RADIATION CRIB

STATEMENT OF PROTECTIVENESS

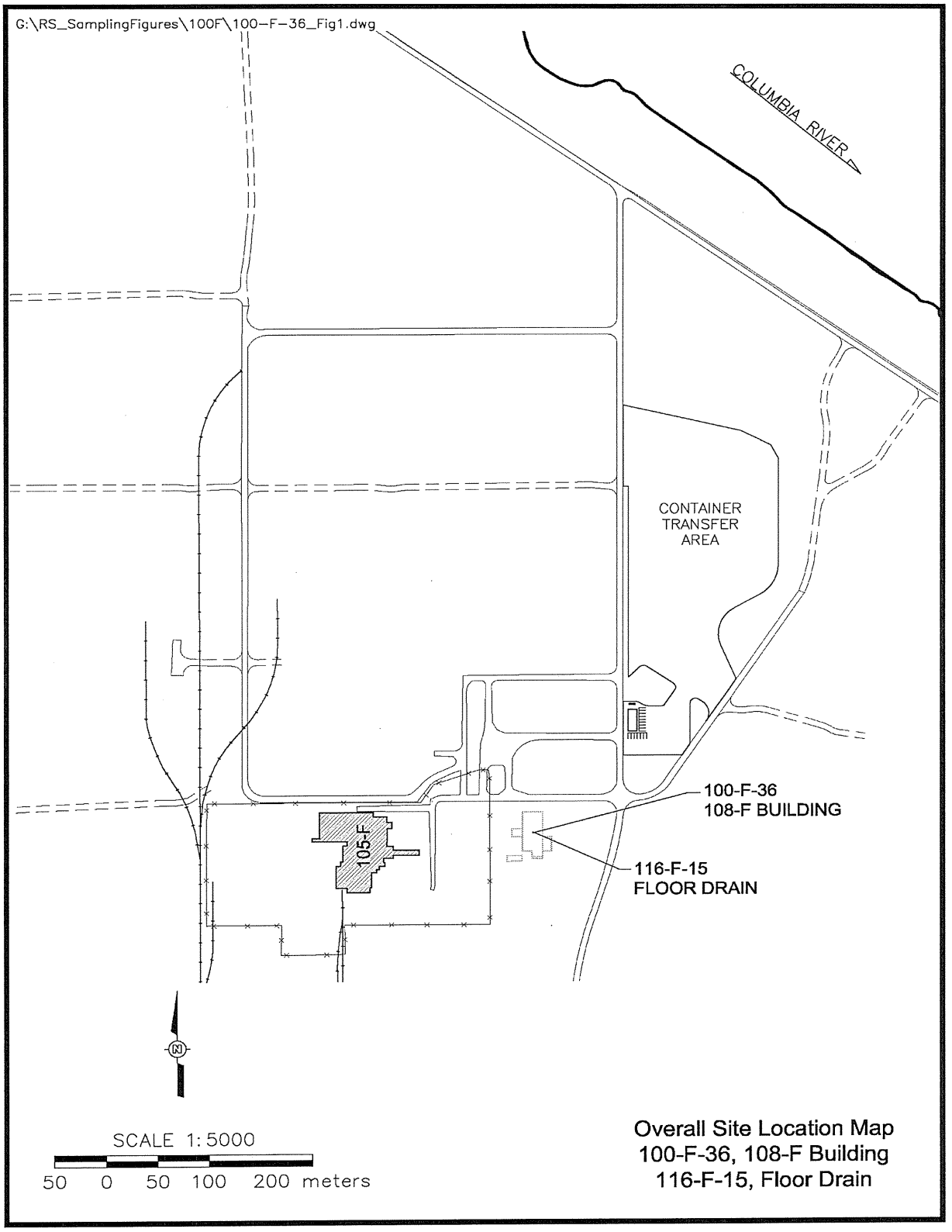
This report demonstrates that the 100-F-36, 108-F Biological Laboratory waste site meets the objectives for No Action, and the 116-F-15, 108-F Radiation Crib waste site meets the objectives for Interim Closure as established in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP) (DOE-RL 2005b) and the *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington* (Remaining Sites ROD) (EPA 1999). The results of 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 deep zone soils; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are not required.

Soil cleanup levels were established in the Remaining Sites ROD (EPA 1999) based on a limited ecological risk assessment. Although not required by the Remaining Sites ROD, a comparison against ecological risk screening levels has been made for both 100-F-36 and 116-F-15 contaminants of potential concern and other constituents. Screening levels were not exceeded for either site constituents, with the exception of boron, mercury, and vanadium. Exceedance of screening values does not necessarily indicate the existence of risk to ecological receptors. It is believed that the presence of these constituents does not pose a risk to ecological receptors because concentrations of vanadium and mercury are below site background levels and boron concentrations are consistent with those seen elsewhere at the Hanford Site (no established background value is available for boron). 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 the final closeout decision for this site.

GENERAL SITE INFORMATION AND BACKGROUND

The 100-F-36 and 116-F-15 waste sites are located in the 100-FR-1 Operable Unit of the Hanford Site approximately 100 m (330 ft) east of the 105-F Reactor Building (Figure 1). The 100-F-36 waste site is the location of the former 108-F Biological Laboratory, and the 116-F-15 waste site is the location of the former 108-F Radiation Crib, which was a floor drain (also called a sump or crib) located in the first floor of the 108-F Building. The following paragraphs summarize background information on both of these sites; see the Waste Information Data Summary (WIDS) database for additional information (WCH 2006b).

Figure 1. 100-F-36 and 116-F-15 Location Map.



100-F-36, 108-F Biological Laboratory Background

The 108-F Building was originally built as a chemical makeup facility in 1944 to support treatment of cooling water for use in the 105-F Reactor. In 1949, the building was converted to a biological laboratory to test the effects of radiation and contamination on plant and animal life.

In 1962, the laboratory was expanded by adding a three-story annex to the original four-story structure. The building contained 47 laboratories, a number of small offices, a conference room, an administrative section, lunch and locker rooms, and a heavily shielded, high-energy exposure cell. The biological laboratory activities at the 108-F Building were gradually phased out and transferred to other facilities, primarily in the 300 Area, and in 1973, the laboratory closed entirely (WCH 2006b).

Between 1977 and 1983, activities to remove highly contaminated and uncontaminated materials from inside the 108-F Building took place. A total of approximately 1,412 m^3 (4,722 ft^3) of contaminated material was removed and disposed of in the 200 West Area burial site. Approximately 304 m^3 (10,840 ft^3) of uncontaminated material was also removed from the facility and disposed of at the 183-F clearwells (126-F-2 waste site). Between 1984 and 1996, the 108-F Building was maintained in a safe condition through Surveillance and Maintenance programs. In 1996, the 108-F Building was transferred to the Decontamination and Decommissioning (D&D) program for demolition (WCH 2006b).

The 108-F Building was demolished in 1999. Approximately 80 m^3 (105 yd^3) of uncontaminated masonry block was removed from the facility and transported to the 116-B-14 sludge pit site for use as clean backfill. The masonry block was surveyed prior to demolition (Ceffalo 1999). All building debris and the foundation were removed, and the site backfilled. The soils underlying the footprint of the 108-F Building were not sampled at that time, due to future remedial actions planned in adjacent areas (BHI 2000a). Photographs of the 108-F Building demolition activities are located in Appendix A.

116-F-15, 108-F Radiation Crib Background

The 116-F-15, 108-F Radiation Crib was a 0.91- by 0.91-m (3- by 3-ft) concrete sump near the center of the former 108-F Building first floor. The sump system connected to a subgrade pipe trench that ran north and south along the first floor. The trench was approximately 0.9 m (3 ft) tall, 0.3 m (1 ft) wide, and 61 m (200 ft) long, and drained from both ends into the sump. Many laboratory floor and hood drains were connected to the trench and sump. A 15-cm (6-in.) earthenware pipeline exited the sump and the building to the south. The pipe trench and sump were reportedly removed during D&D activities of the 108-F Biological Laboratory (BHI 2000a); however, verification soil sampling was not performed at that time.

In February 2002, verification sampling was conducted at various french drains around the former 108-F Building, and the 116-F-15 sump was included in this sample campaign. During excavation of a test pit, a piece of 15-cm (6-in.)-diameter cast-iron pipe was uncovered at a depth of approximately 1 m (3 ft) and found to have lead contamination and elevated radiation readings (BHI 2002). The excavation was closed, and no samples were collected.

In 2004, an evaluation of the 100-F-36 and 116-F-15 waste sites was conducted using historical process information, geophysical surveys, D&D reports, and information concerning the discovery of the contaminated 15-cm (6-in.)-diameter cast-iron pipe. It was determined that the 116-F-15 waste site contained hazardous constituents at levels exceeding the remedial action goals (RAGs); therefore, remedial action was recommended (Feist 2004).

REMEDIAL ACTION SUMMARY

Remediation of the 116-F-15 waste site was performed on September 26, 2005, to locate and remove the piece of contaminated pipe that was found during the 2002 excavation activities (BHI 2002) and to verify that the sump was removed during the 1999 demolition of the 108-F Biological Laboratory. Remediation consisted of the removal of approximately 86 metric tons (95 US tons) of material, including concrete debris, piping, and soil, which was disposed of at the Environmental Restoration Disposal Facility (ERDF). The soil was excavated and field surveyed to a depth of approximately 2.6 m (8.5 ft). The contaminated cast-iron pipe found during the February 2002 excavation was not located during this remedial action. Therefore, an additional test pit was excavated on November 29, 2005, in an attempt to locate the contaminated 15-cm (6-in.)-diameter cast-iron pipe. The additional excavation was unsuccessful, and the excavated material was placed back in the pit. Additional efforts in July 2006 to locate the contaminated pipe using a metal detector were also unsuccessful. However, the contaminated 15-cm (6-in.)-diameter cast-iron pipe (100-F-26:4) was found during test pitting activities in December 2006. The contaminated pipe is associated with the 100-F-26:4 pipeline site and is not a part of the 116-F-15 sump as previously indicated. Remediation and sampling activities for the 100-F-26:4 pipelines site will be included in a future work instruction and verification package. The pre- and post-excavation topographic surveys for the 100-F-36 and 116-F-15 waste sites are provided in Figures 2 and 3, respectively. Figure 3 also shows the location of the exploratory test pit.

Following excavation, confirmatory sampling of the 100-F-36 waste site and verification sampling of the 116-F-15 waste site were performed as described in the following section.

CONFIRMATORY AND VERIFICATION SAMPLING ACTIVITIES

RAGs are the specific numeric goals against which the cleanup verification data are evaluated to demonstrate attainment of the remedial action objectives for these sites. Confirmatory sampling at the 100-F-36 waste site was performed on December 5, 2006, and verification sampling at the 116-F-15 waste site was performed on December 12, 2006, in accordance with the approved work instruction (WCH 2006b), to collect data to evaluate if the RAGs had been met. Based on evaluation of the resulting data, the residual contaminant concentrations meet the cleanup criteria specified in the RDR/RAWP (DOE-RL 2005b) and the Remaining Sites ROD (EPA 1999). The following subsections provide additional discussion of the information used to develop the confirmatory and verification sampling designs. The results of the sampling conducted for each site are also summarized to support closure of these sites.

Figure 2. Pre-Excavation Boundary of the 100-F-36 and 116-F-15 Waste Sites.

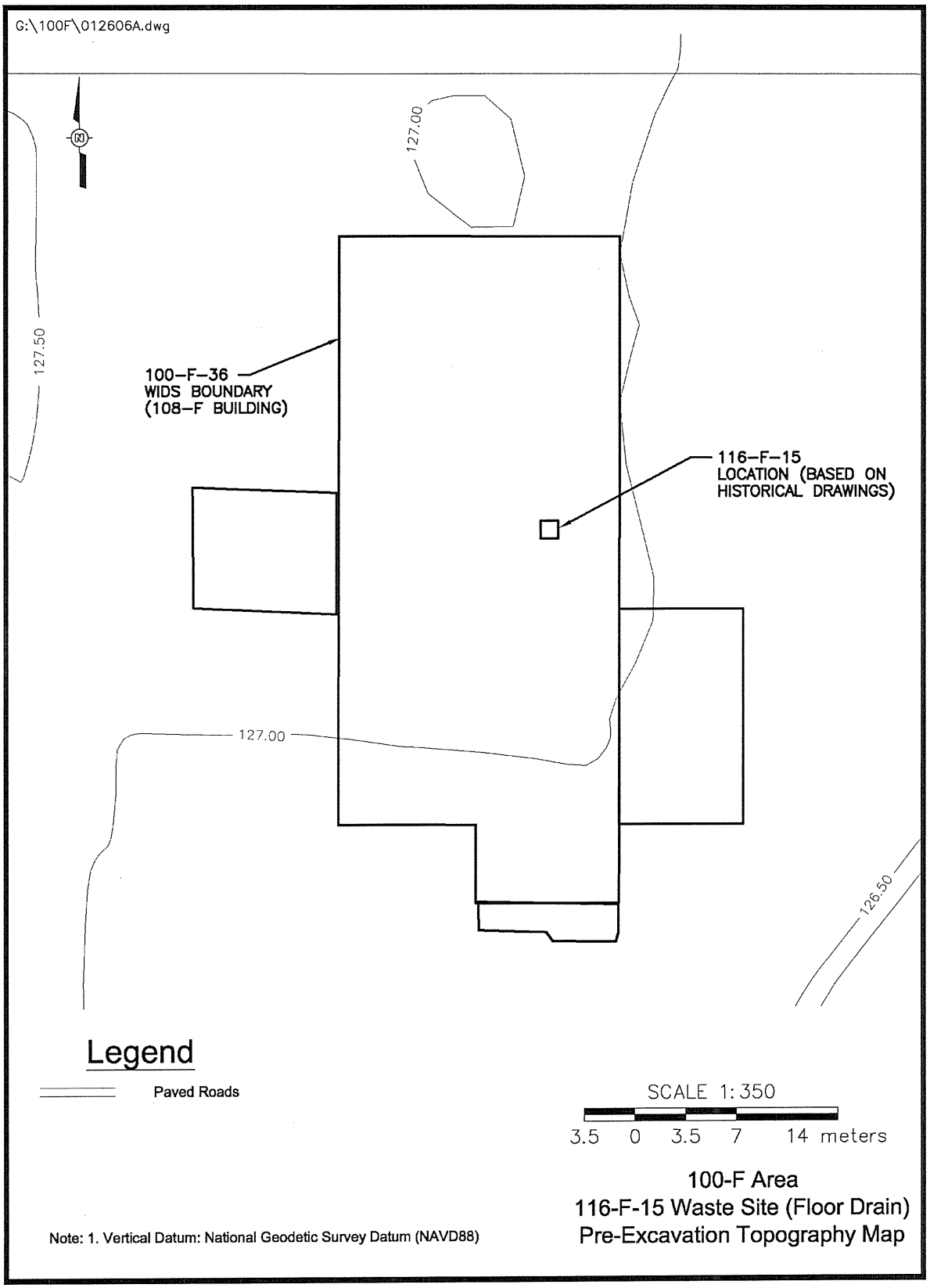
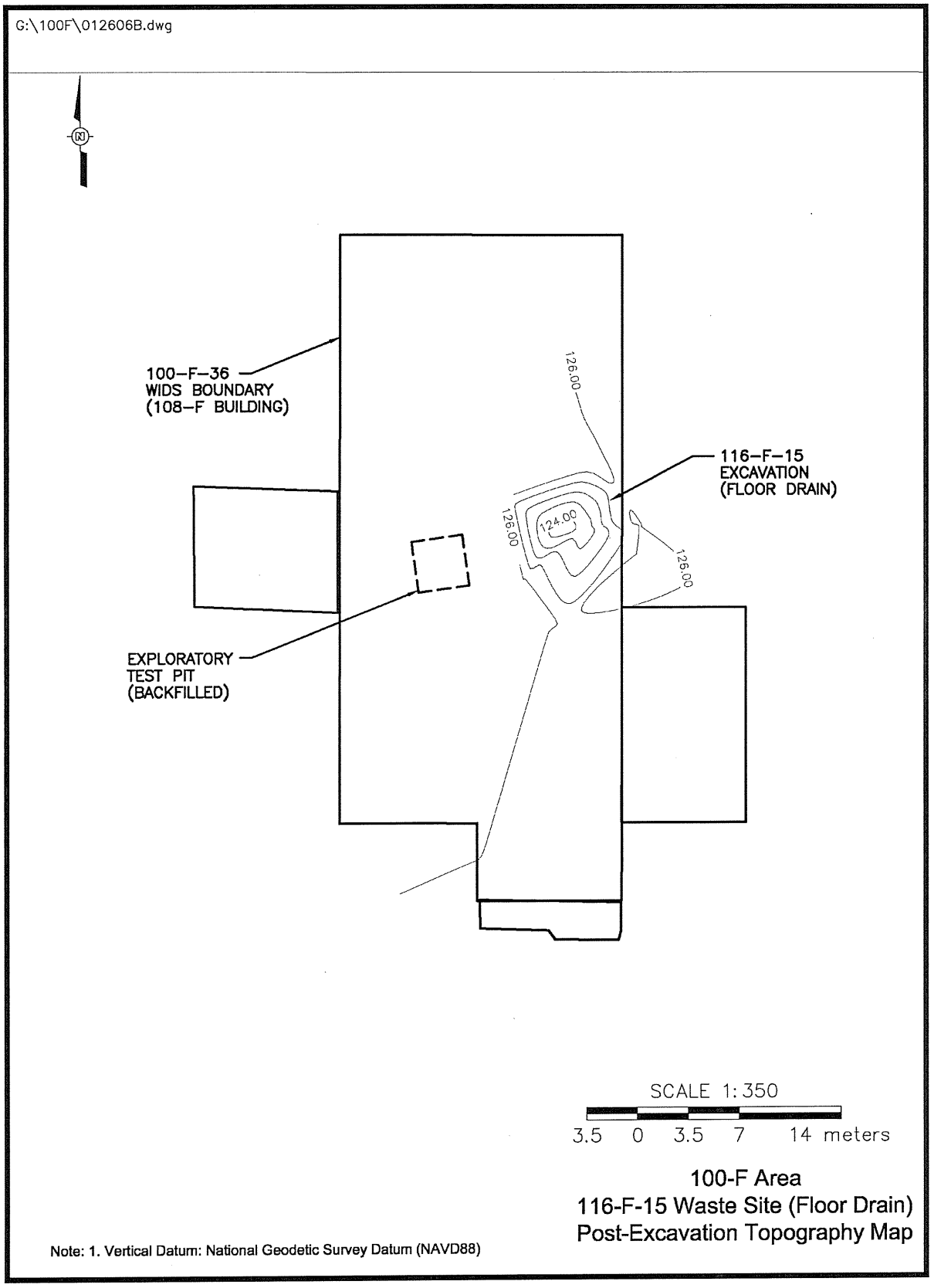


Figure 3. Post-Excavation Boundary of the 116-F-15 Waste Site.



Contaminants of Potential Concern

Contaminants of potential concern (COPCs) were identified in *Remedial Design Report/ Remedial Action Work Plan for the 100 Area* (DOE-RL 2005b). Because the 116-F-15 waste site is located within the boundary of the 100-F-36 waste site, the COPC lists were combined and each confirmatory and verification sample analyzed for all constituents. The combined list of COPCs is as follows:

- Cobalt-60
- Cesium-137
- Europium-152
- Europium-154
- Europium-155
- Plutonium-238
- Plutonium-239/240
- Strontium-90
- Uranium-238
- Inductively coupled plasma metals
- Mercury
- Hexavalent chromium
- Polychlorinated biphenyls
- Asbestos

Sample Design Selection and Basis

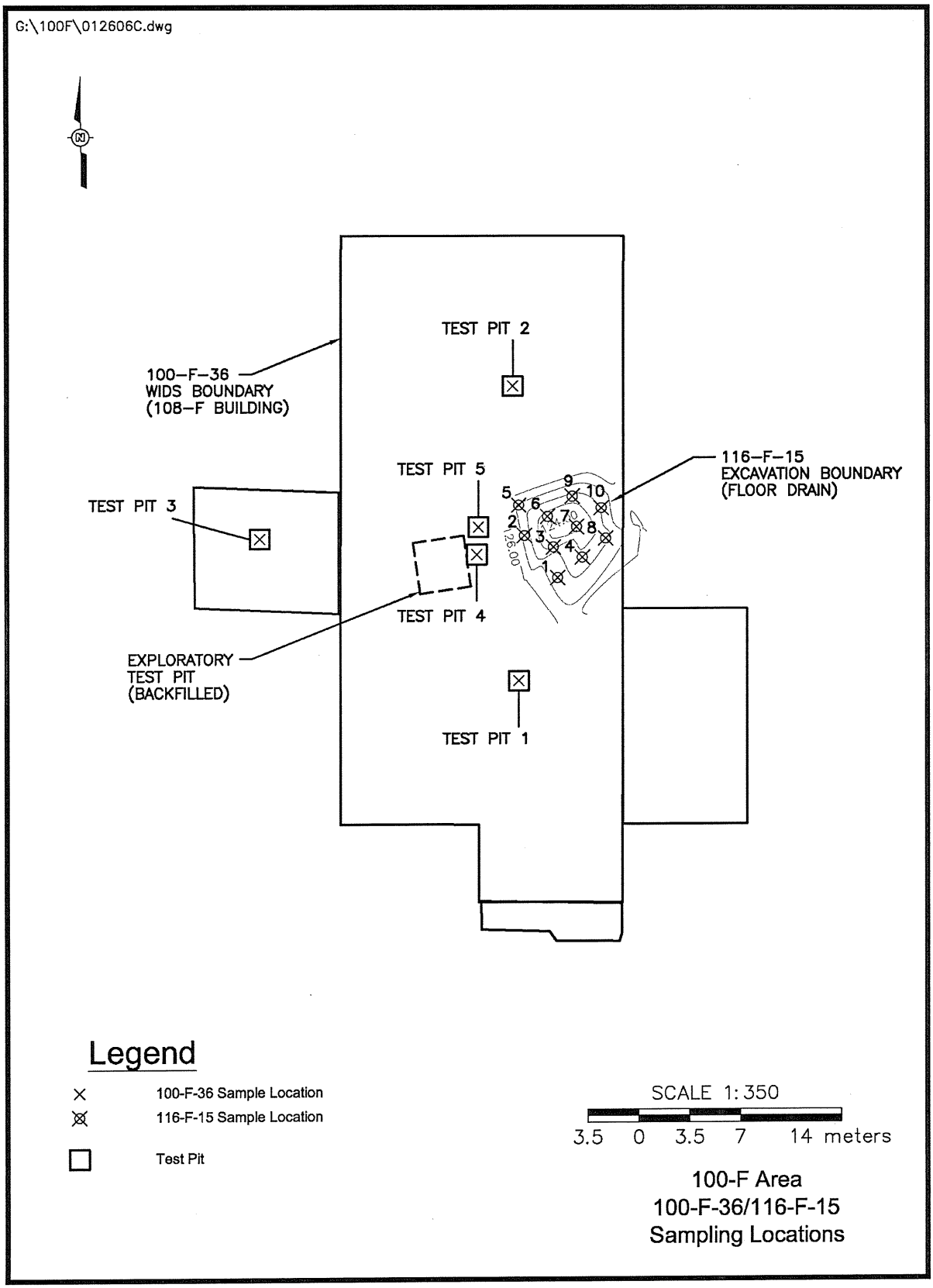
This section describes the basis for selection of an appropriate sample design and determination of the number of samples that were collected for each site.

Inadequate information was available to determine worst-case sample locations within each site to support development of a focused sampling approach. Therefore, a statistical sampling design was used for each site. For statistical sampling, the decision rule for demonstrating compliance with the cleanup criteria required comparison of the true population mean, as estimated by the 95% confidence limit on the sample mean, with the cleanup level. The Washington State Department of Ecology (Ecology) publication *Guidance on Sampling and Data Analysis Methods* (Ecology 1995) recommends that systematic sampling with sample locations distributed over the entire study area be used. This sampling approach is known by Ecology as "area-wide sampling." Visual Sample Plan[1] (VSP) was used as a tool to develop the statistical sampling designs for both waste sites. The footprint of the 108-F decommissioned facility and the post-excavation survey for the 116-F-15 waste site were delineated in VSP and used as the basis for location of a random-start systematic grid for soil sample collection at these sites. A triangular grid was selected based on studies that indicate triangular grids are superior to square grids (Gilbert 1987).

A total of three statistical sample locations within the footprint of the 100-F-36 waste site (test pits 1, 2, and 3) and ten statistical sample locations within the 116-F-15 waste site were determined using VSP and are shown in Figure 4. In addition, two focused samples were added to the design, shown on Figure 4 as test pits 4 and 5, to locate the contaminated 15-cm (6-in.)-diameter cast-iron pipe found in February 2002. Additional details concerning the use of VSP to develop statistical sampling designs and derive the number of samples to collect is provided in the work instruction (WCH 2006b).

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

Figure 4. Sample Locations at the 100-F-36 and 116-F-15 Waste Sites.



The test pits and soil sample locations were surveyed and staked prior to sample collection. All sampling was performed in accordance with ENV-1, *Environmental Monitoring & Management*, to fulfill the requirements of the *100 Area Remedial Action Sampling and Analysis Plan* (SAP) (DOE-RL 2005a). Excavation and confirmatory sampling of the test pits at the 100-F-36 waste site was conducted on December 5, 2006, and verification sampling at the 116-F-15 waste site was conducted on December 12, 2006. One duplicate sample and one equipment blank were collected during each sampling event for quality control purposes. Field screening for volatile organic compounds was conducted during excavation and sampling, but no elevated organic vapor readings were detected; therefore, volatile organic analysis was not required. Total petroleum hydrocarbon and polycyclic aromatic hydrocarbon analyses were not performed because no stained soil or evidence of burned areas were observed during excavation.

All five test pits at the 100-F-36 waste site were excavated to native soil and samples were collected. During excavation of test pit 4, the contaminated 15-cm (6-in.)-diameter cast-iron pipe (100-F-26:4) was located. Field radiological survey measurements indicated that fixed contamination inside the pipe and focused samples were collected. The results of pipe samples exceeded cleanup criteria indicating removal of the pipe was required. As indicated in the work instruction (WCH 2006b), this pipe was determined to be associated with the 100-F-26:4 subsite. Remediation and sampling activities for the 100-F-26:4 pipeline will be included in a future work instruction and verification package. During excavation of test pit 3, the 100-F-26:4 pipeline was encountered again, and a focused sample of the contents was collected. Focused samples were also collected of the native soil in test pits 4 and 5. Various photographs of test pit excavation and sampling activities at the 100-F-36 waste site are located in Appendix A.

Sampling at the 116-F-15 site consisted of a soil grab sample from each of the ten staked locations. A summary of the samples collected and laboratory analyses performed for each site is provided in Tables 1 and 2.

Table 1. Confirmatory Sample Summary for the 100-F-36 Waste Site. (2 Pages)

Sample Location	Sample Media	Sample Number	Coordinate Locations	Approximate Depth (m bgs)	Sample Analyses
Statistical Sampling					
Test pit 1	Native soil	J13VH9	N 147605.0 E 580602.8	2.1 m (7 ft)	ICP metals, PCBs, hexavalent chromium, mercury, GEA, isotopic plutonium, strontium-90, isotopic uranium
		J13J44			Asbestos
Test pit 2	Native soil	J13VJ3	N 147625.3 E 580602.4	2.1 m (7 ft)	ICP metals, PCBs, hexavalent chromium, mercury, GEA, isotopic plutonium, strontium-90, isotopic uranium
		J13J48			Asbestos

Table 1. Confirmatory Sample Summary for the 100-F-36 Waste Site. (2 Pages)

Sample Location	Sample Media	Sample Number	Coordinate Locations	Approximate Depth (m bgs)	Sample Analyses
Statistical Sampling					
Test pit 3	Native soil	J13VJ6	N 147614.8 E 580585.0	2.1 m (7 ft)	ICP metals, PCBs, hexavalent chromium, mercury, GEA, isotopic plutonium, strontium-90, isotopic uranium
		J13J51			Asbestos
Duplicate (test pit 2)	Native soil	J13VJ4	N 147625.3 E 580602.4	2.1 m (7 ft)	ICP metals, PCBs, hexavalent chromium, mercury, GEA, isotopic plutonium, strontium-90, isotopic uranium
		J13J49			Asbestos
Focused Sampling					
Test pit 3	Vitrified clay pipe	J13VJ5	N 147615.5 E 580584.9	2.1 m (7 ft)	ICP metals, PCBs, hexavalent chromium, mercury, GEA, isotopic plutonium, strontium-90, isotopic uranium
		J13J49			Asbestos
Test pit 4	Native soil	J13VJ1	N 147612.7 E 580599.9	1.8 m (6 ft)	ICP metals, PCBs, hexavalent chromium, mercury, GEA, isotopic plutonium, strontium-90, isotopic uranium
		J13J46			Asbestos
	Cast-iron pipe	J13VJ0[a]	N 147614.6 E 580599.8	1.8 m (6 ft)	ICP metals, PCBs, hexavalent chromium, mercury, GEA, isotopic plutonium, strontium-90, isotopic uranium
		J13J45[a]			Asbestos
Test pit 5	Native soil	J13VJ2	N 147616.6 E 580600.0	1.8 m (6 ft)	ICP metals, PCBs, hexavalent chromium, mercury, GEA, isotopic plutonium, strontium-90, isotopic uranium
		J13J47			Asbestos
Other Sampling					
Equipment blank	Silica sand	J13J52	N/A	N/A	ICP metals and mercury

Source: *100-F Area Remedial Sampling,* Logbook EFL-1174-2 (WCH 2006a).
[a] Results of this sample associated with the 100-F-26:4 site.
bgs = below ground surface
GEA = gamma energy analysis
ICP = inductively coupled plasma
N/A = not applicable
PCB = polychlorinated biphenyl

Table 2. Verification Sample Summary for the 116-F-15 Waste Site.

Sample Location	Sample Media	Sample Coordinates	HEIS Number	Sample Analysis
1	Soil	N 147612.1 E 580605.5	J13W02	ICP metals, PCBs, hexavalent chromium, mercury, GEA, isotopic plutonium, strontium-90, isotopic uranium
			J13W13	Asbestos
2	Soil	N 147615.0 E 580603.2	J13W04	ICP metals, PCBs, hexavalent chromium, mercury, GEA, isotopic plutonium, strontium-90, isotopic uranium
			J13W15	Asbestos
3	Soil	N 147614.2 E 580605.2	J13W05	ICP metals, PCBs, hexavalent chromium, mercury, GEA, isotopic plutonium, strontium-90, isotopic uranium
			J13W16	Asbestos
4	Soil	N 147613.5 E 580607.2	J13W06	ICP metals, PCBs, hexavalent chromium, mercury, GEA, isotopic plutonium, strontium-90, isotopic uranium
			J13W17	Asbestos
5	Soil	N 147617.1 E 580602.8	J13W07	ICP metals, PCBs, hexavalent chromium, mercury, GEA, isotopic plutonium, strontium-90, isotopic uranium
			J13W18	Asbestos
6	Soil	N 147616.3 E 580604.8	J13W08	ICP metals, PCBs, hexavalent chromium, mercury, GEA, isotopic plutonium, strontium-90, isotopic uranium
			J13W19	Asbestos
7	Soil	N 147615.6 E 580606.8	J13W09	ICP metals, PCBs, hexavalent chromium, mercury, GEA, isotopic plutonium, strontium-90, isotopic uranium
			J13W20	Asbestos
8	Soil	N 147614.8 E 580608.8	J13W10	ICP metals, PCBs, hexavalent chromium, mercury, GEA, isotopic plutonium, strontium-90, isotopic uranium
			J13W21	Asbestos
9	Soil	N 147617.7 E 580606.5	J13W11	ICP metals, PCBs, hexavalent chromium, mercury, GEA, isotopic plutonium, strontium-90, isotopic uranium
			J13W22	Asbestos
10	Soil	N 147616.9 E 580608.5	J13W12	ICP metals, PCBs, hexavalent chromium, mercury, GEA, isotopic plutonium, strontium-90, isotopic uranium
			J13W23	Asbestos
Duplicate at location 1	Soil	N 147612.1 E 580605.5	J13W03	ICP metals, PCBs, hexavalent chromium, mercury, GEA, isotopic plutonium, strontium-90, isotopic uranium
			J13W14	Asbestos
Equipment blank	Silica sand	N/A	J13J53	ICP metals and mercury

Source: *100-F Area Remedial Sampling,* Logbook EFL-1174-2 (WCH 2006a).
GEA = gamma energy analysis
ICP = inductively coupled plasma
N/A = not applicable
PCB = polychlorinated biphenyl

Sampling Results

All samples were analyzed using U.S. Environmental Protection Agency-approved analytical methods. The 95% UCL on the true population mean for residual concentrations of COPCs was calculated for both sites as specified by the RDR/RAWP (DOE-RL 2005b), with calculations provided in Appendix B. When a nonradionuclide COPC was detected in fewer than 50% of the samples collected, and for focused sampling, the maximum detected value was used for comparison with the RAGs instead of the calculating the 95% UCL value. If no detection for a given COPC was reported in the data set, no statistical evaluation or calculations were performed for that COPC.

Comparisons of the quantified COPC results with the RAGs for both the 100-F-36 and 116-F-15 sites are summarized in Tables 3a, 3b, and 3c. Table 3a presents the statistical contaminant concentrations from test pits 1, 2, and 3 sampling of the 100-F-36 waste site. Table 3b presents the results from the 100-F-36 focused sampling of test pits 4 and 5, as well as the pipe from test pit 3. Table 3c presents the results from the 116-F-15 verification sampling. Contaminants that were not detected by laboratory analysis are excluded from these tables. Calculated cleanup levels are not presented in the *Cleanup Levels and Risk Calculations (CLARC) Database* (Ecology 2005) under WAC 173-340-740(3) for aluminum, calcium, iron, magnesium, potassium, silicon, and sodium; therefore, these constituents are not considered site COPCs and are also not included in these tables. Potassium-40, radium-226, radium-228, thorium-228, and thorium-232 were detected in samples collected at these sites, but are excluded from these tables because these isotopes are not related to the operational history. The laboratory-reported data results for all constituents are stored in the Environmental Restoration (ENRE) project-specific database prior to archival in the Hanford Environmental Information System (HEIS) and are included in Appendix B.

Table 3a. Comparison of Maximum or Statistical Contaminant Concentrations to Action Levels for the 100-F-36 Confirmatory Sampling. (2 Pages)

COPC	Statistical Result (pCi/g)	Generic Site Lookup Values[a] (pCi/g)			Does the Statistical Result Exceed Lookup Values?	Does the Statistical Result Pass RESRAD Modeling?
		Shallow Zone Lookup Value[b]	Groundwater Protection Lookup Value	River Protection Lookup Value		
Uranium-233/234	0.716 (<BG)	1.1[c]	1.1[c]	1.1[c]	No	--
Uranium-238	0.963 (<BG)	1.1[c]	1.1[c]	1.1[c]	No	--
COPC	**Maximum or Statistical Result (mg/kg)**	**Remedial Action Goals[a] (mg/kg)**			**Does the Maximum or Statistical Result Exceed RAGs?**	**Does the Maximum or Statistical Result Pass RESRAD Modeling?**
		Direct Exposure	Soil Cleanup Level for Groundwater Protection	Soil Cleanup Level for River Protection		
Arsenic	1.7 (<BG)	20	20	20	No	--
Barium	32.5 (<BG)	5,600[d]	132[e,f]	224[g]	No	--

Table 3a. Comparison of Maximum or Statistical Contaminant Concentrations to Action Levels for the 100-F-36 Confirmatory Sampling. (2 Pages)

COPC	Maximum or Statistical Result (mg/kg)	Remedial Action Goals[a] (mg/kg)			Does the Maximum or Statistical Result Exceed RAGs?	Does the Maximum or Statistical Result Pass RESRAD Modeling?
		Direct Exposure	Soil Cleanup Level for Groundwater Protection	Soil Cleanup Level for River Protection		
Beryllium	0.19 (<BG)	10.4[h]	1.51[f]	1.51[f]	No	--
Chromium (total)	6.6 (<BG)	80,000[d]	18.5[f]	18.5[f]	No	--
Chromium (hexavalent)[i]	0.32	2.1[g]	4.8	2	No	--
Cobalt	3.7 (<BG)	1,600	32	--[j]	No	--
Copper	10.0 (<BG)	2,960	59.2	22.0[f]	No	--
Lead	2.1 (<BG)	353	10.2[f]	10.2[f]	No	--
Manganese	194 (<BG)	11,200	512[f]	512[f]	No	--
Nickel	8.0 (<BG)	1,600	19.1[f]	27.4	No	--
Vanadium	27.3 (<BG)	560	85.1[f]	--[j]	No	--
Zinc	25.2 (<BG)	24,000	480	67.8[f]	No	--

[a] Lookup values and RAGs obtained from the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP) (DOE-RL 2005b) or calculated per WAC-173-340-720, 173-340-730, and 173-340-740, Method B, 1996, unless otherwise noted.

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

[c] The calculated value is below the Hanford-specific statistical soil background activity. The value presented is the Hanford-specific statistical soil background activity.

[d] Noncarcinogenic cleanup level calculated from WAC 173-340-740(3), 1996 (Method B for soils) (as presented in the RDR/RAWP [DOE-RL 2005b]). Updated oral reference dose values (as provided in the Integrated Risk Information System [EPA 2006]) yield Method B direct exposure RAG values of 16,000 mg/kg and 120,000 mg/kg for barium and chromium, respectively.

[e] Barium soil cleanup level for groundwater protection calculated from WAC 173-340-740(3)(a)(ii)(A), 1996 ("100 times rule") and WAC 173-340-720(3), 1996 (Method B for groundwater) is 112 mg/kg (as presented in the RDR/RAWP [DOE-RL 2005b]). The updated oral reference dose value (as provided in the Integrated Risk Information System) yields a Method B groundwater cleanup criteria of 7 mg/L, as compared to the more restrictive maximum contaminant level of 2 mg/L (40 *Code of Federal Regulations* 141). Per WAC 173-340-740(3)(a)(ii)(A), 1996 ("100 times rule"), the most restrictive updated soil cleanup level for groundwater protection would be 200 mg/kg.

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

[g] Barium soil cleanup level for river protection calculated from WAC 173-340-740(3)(a)(ii)(A), 1996 ("100 times rule"), a dilution attenuation factor of 2, and WAC 173-340-720(3), 1996 (Method B for groundwater) is 224 mg/kg (as presented in the RDR/RAWP [DOE-RL 2005b]). No surface water bioconcentration factor is available for barium and no ambient water quality criteria value exists; therefore no WAC 173-340-730(3), 1996 (Method B for surface waters) value can be determined.

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

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

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

-- = not applicable
BG = background
COPC = contaminant of potential concern
RAG = remedial action goal
RDR/RAWP = remedial design report/remedial action work plan
RESRAD = RESidual RADioactivity (dose assessment model)
WAC = *Washington Administrative Code*

Table 3b. Comparison of Maximum Contaminant Concentrations to Action Levels for the 100-F-36 Focused Sampling. (2 Pages)

COPC	Result (pCi/g)	Generic Site Lookup Values[a] (pCi/g)			Does the Result Exceed Lookup Values?	Does the Result Pass RESRAD Modeling?
		Shallow Zone Lookup Value[b]	Groundwater Protection Lookup Value	River Protection Lookup Value		
Uranium-233/234	0.569 (<BG)	1.1[c]	1.1[c]	1.1[c]	No	--
Uranium-238	0.727 (<BG)	1.1[c]	1.1[c]	1.1[c]	No	--
COPC	**Result (mg/kg)**	**Remedial Action Goals[a] (mg/kg)**			**Does the Result Exceed RAGs?**	**Does the Result Pass RESRAD Modeling?**
		Direct Exposure	Soil Cleanup Level for Groundwater Protection	Soil Cleanup Level for River Protection		
Arsenic	3.0 (<BG)	20	20	20	No	--
Barium	86.1 (<BG)	5,600[d]	132[e,f]	224[g]	No	--
Beryllium	0.35 (<BG)	10.4[g]	1.51[f]	1.51[f]	No	--
Boron[i]	1.2	16,000	320	--[j]	No	--
Chromium (total)	10.6 (<BG)	80,000[d]	18.5[f]	18.5[f]	No	--
Chromium (hexavalent)[i]	0.87	2.1[h]	4.8	2	No	--
Cobalt	6.9 (<BG)	1,600	32	--[j]	No	--
Copper	12.1 (<BG)	2,960	59.2	22.0[f]	No	--
Lead	5.5 (<BG)	353	10.2[f]	10.2[f]	No	--
Manganese	356 (<BG)	11,200	512[f]	512[f]	No	--
Mercury	0.05 (<BG)	24	0.33[f]	0.33[f]	No	--
Nickel	9.0 (<BG)	1,600	19.1[f]	27.4	No	--
Vanadium	44.8 (<BG)	560	85.1[f]	--[j]	No	--

Table 3b. Comparison of Maximum Contaminant Concentrations to Action Levels for the 100-F-36 Focused Sampling. (2 Pages)

COPC	Result (mg/kg)	Remedial Action Goals[a] (mg/kg)			Does the Result Exceed RAGs?	Does the Result Pass RESRAD Modeling?
		Direct Exposure	Soil Cleanup Level for Groundwater Protection	Soil Cleanup Level for River Protection		
Zinc	41.0 (<BG)	24,000	480	67.8[f]	No	--

[a] Lookup values and RAGs obtained from the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP) (DOE-RL 2005b) or calculated per WAC-173-340-720, 173-340-730, and 173-340-740, Method B, 1996, unless otherwise noted.

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

[c] The calculated value is below the Hanford-specific statistical soil background activity. The value presented is the Hanford-specific statistical soil background activity.

[d] Noncarcinogenic cleanup level calculated from WAC 173-340-740(3), 1996 (Method B for soils) (as presented in the RDR/RAWP [DOE-RL 2005b]). Updated oral reference dose values (as provided in the Integrated Risk Information System [EPA 2006]) yield Method B direct exposure RAG values of 16,000 mg/kg and 120,000 mg/kg for barium and chromium, respectively.

[e] Barium soil cleanup level for groundwater protection calculated from WAC 173-340-740(3)(a)(ii)(A), 1996 ("100 times rule") and WAC 173-340-720(3), 1996 (Method B for groundwater) is 112 mg/kg (as presented in the RDR/RAWP [DOE-RL 2005b]). The updated oral reference dose value (as provided in the Integrated Risk Information System) yields a Method B groundwater cleanup criteria of 7 mg/L, as compared to the more restrictive maximum contaminant level of 2 mg/L (40 *Code of Federal Regulations* 141). Per WAC 173-340-740(3)(a)(ii)(A), 1996 ("100 times rule"), the most restrictive updated soil cleanup level for groundwater protection would be 200 mg/kg.

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

[g] Barium soil cleanup level for river protection calculated from WAC 173-340-740(3)(a)(ii)(A), 1996 ("100 times rule"), a dilution attenuation factor of 2, and WAC 173-340-720(3), 1996 (Method B for groundwater) is 224 mg/kg (as presented in the RDR/RAWP [DOE-RL 2005b]). No surface water bioconcentration factor is available for barium and no ambient water quality criteria value exists; therefore no WAC 173-340-730(3), 1996 (Method B for surface waters) value can be determined.

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

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

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

-- = not applicable
BG = background
COPC = contaminant of potential concern
RAG = remedial action goal
RDR/RAWP = remedial design report/remedial action work plan
RESRAD = RESidual RADioactivity (dose assessment model)
WAC = *Washington Administrative Code*

Table 3c. Comparison of Maximum or Statistical Contaminant Concentrations to Action Levels for the 116-F-15 Verification Sampling. (2 Pages)

COPC	Statistical Result (pCi/g)	Generic Site Lookup Values[a] (pCi/g)			Does the Statistical Result Exceed Lookup Values?	Does the Statistical Result Pass RESRAD Modeling?
		Shallow Zone Lookup Value[b]	Groundwater Protection Lookup Value	River Protection Lookup Value		
Cesium-137	0.100 (<BG)	6.2	1,465	1,465	No	--
Europium-152	0.06	3.3	--[a]	--[a]	No	--
Uranium-233/234	0.590 (<BG)	1.1[c]	1.1[c]	1.1[c]	No	--
Uranium-238	0.546 (<BG)	1.1[c]	1.1[c]	1.1[c]	No	--
COPC	**Maximum or Statistical Result (mg/kg)**	**Remedial Action Goals[a] (mg/kg)**			**Does the Maximum or Statistical Result Exceed RAGs?**	**Does the Maximum or Statistical Result Pass RESRAD Modeling?**
		Direct Exposure	Soil Cleanup Level for Groundwater Protection	Soil Cleanup Level for River Protection		
Arsenic	2.7 (<BG)	20	20	20	No	--
Barium	74.0 (<BG)	5,600[d]	132[e,f]	224[g]	No	--
Beryllium	0.13 (<BG)	10.4[h]	1.51[f]	1.51[f]	No	--
Boron[i]	4.4	16,000	320	--[j]	No	--
Cadmium[k]	0.11 (<BG)	13.9	0.81[f]	0.81[f]	No	--
Chromium (total)	13 (<BG)	80,000[d]	18.5[f]	18.5[f]	No	--
Chromium (hexavalent)[i]	0.6	2.1[h]	4.8	2	No	--
Cobalt	5.5 (<BG)	1,600	32	--[j]	No	--
Copper	14.0 (<BG)	2,960	59.2	22.0[f]	No	--
Lead	9.8 (<BG)	353	10.2[f]	10.2[f]	No	--
Manganese	244 (<BG)	11,200	512[f]	512[f]	No	--
Mercury	0.19 (<BG)	24	0.33[f]	0.33[f]	No	--
Molybdenum[i]	0.66	400	8	--[j]	No	--
Nickel	11 (<BG)	1,600	19.1[f]	27.4	No	--
Vanadium	38.3 (<BG)	560	85.1[f]	--[j]	No	--
Zinc	38.5 (<BG)	24,000	480	67.8[f]	No	--
Aroclor-1254	0.014	0.5	0.017[l]	0.017[l]	No	--

Table 3c. Comparison of Maximum or Statistical Contaminant Concentrations to Action Levels for the 116-F-15 Verification Sampling. (2 Pages)

COPC	Maximum or Statistical Result (mg/kg)	Remedial Action Goals[a] (mg/kg)			Does the Maximum or Statistical Result Exceed RAGs?	Does the Maximum or Statistical Result Pass RESRAD Modeling?
		Direct Exposure	Soil Cleanup Level for Groundwater Protection	Soil Cleanup Level for River Protection		
Aroclor-1260	0.027	0.5	0.017[l]	0.017[l]	Yes	Yes[m]

[a] Lookup values and RAGs obtained from the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP) (DOE-RL 2005b) or calculated per WAC-173-340-720, 173-340-730, and 173-340-740, Method B, 1996, unless otherwise noted.

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

[c] The calculated value is below the Hanford-specific statistical soil background activity. The value presented is the Hanford-specific statistical soil background activity.

[d] Noncarcinogenic cleanup level calculated from WAC 173-340-740(3), 1996 (Method B for soils) (as presented in the RDR/RAWP [DOE-RL 2005b]). Updated oral reference dose values (as provided in the Integrated Risk Information System [EPA 2006]) yield Method B direct exposure RAG values of 16,000 mg/kg and 120,000 mg/kg for barium and chromium, respectively.

[e] Barium soil cleanup level for groundwater protection calculated from WAC 173-340-740(3)(a)(ii)(A), 1996 ("100 times rule") and WAC 173-340-720(3), 1996 (Method B for groundwater) is 112 mg/kg (as presented in the RDR/RAWP [DOE-RL 2005b]). The updated oral reference dose value (as provided in the Integrated Risk Information System) yields a Method B groundwater cleanup criteria of 7 mg/L, as compared to the more restrictive maximum contaminant level of 2 mg/L (40 *Code of Federal Regulations* 141). Per WAC 173-340-740(3)(a)(ii)(A), 1996 ("100 times rule"), the most restrictive updated soil cleanup level for groundwater protection would be 200 mg/kg.

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

[g] Barium soil cleanup level for river protection calculated from WAC 173-340-740(3)(a)(ii)(A), 1996 ("100 times rule"), a dilution attenuation factor of 2, and WAC 173-340-720(3), 1996 (Method B for groundwater) is 224 mg/kg (as presented in the RDR/RAWP [DOE-RL 2005b]). No surface water bioconcentration factor is available for barium and no ambient water quality criteria value exists; therefore no WAC 173-340-730(3), 1996 (Method B for surface waters) value can be determined.

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

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

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

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

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

[m] Based on the K_d value for aroclor-1260 (530 mL/g) and the discussion of the contaminant depth/K_d value model presented in the *100 Area Analogous Sites RESRAD Calculations* (BHI 2005), this constituent is not expected to migrate further than 3 m (10 ft) vertically in 1,000 years, and residual concentrations will be protective of groundwater and the Columbia River.

-- = not applicable
BG = background
COPC = contaminant of potential concern
RAG = remedial action goal
RDR/RAWP = remedial design report/remedial action work plan
RESRAD = RESidual RADioactivity (dose assessment model)
RDL = required detection limit
WAC = *Washington Administrative Code*

DATA EVALUATION

This section describes the evaluation of the sampling data in terms of comparison to the RAGs, as listed in Tables 3a, 3b, and 3c, the nonradionuclide risk requirements, and the WAC 173-340-740(7)(e) three-part test.

Evaluation of the results listed in Tables 3a and 3b from confirmatory sampling at the 100-F-36 waste site indicates that all COPCs were quantified below RAGs and lookup values. Therefore, residual concentrations of site COPCs are protective in relation to the requirements for direct exposure, groundwater protection, and river protection.

Evaluation of the results listed in Table 3c from verification sampling at the 116-F-15 waste site indicates that all COPCs were quantified below RAGs and lookup values, with the exception of aroclor-1260. Residual concentrations of aroclor-1260 in the 116-F-15 excavation (0.027 mg/kg) exceed soil RAGs for groundwater and river protection (0.017 mg/kg). Data were not collected on the vertical extent of contamination for this area, but, given the distribution coefficient (K_d) for aroclor-1260 (530 mL/g), this contaminant would not be expected to migrate more than 3 m (10 ft) vertically in 1,000 years (BHI 2005). The vadose zone beneath the 116-F-15 excavation is approximately 10 m (33 ft) thick. Therefore, residual concentrations of site COPCs are protective in relation to the requirements for direct exposure, groundwater protection, and river protection.

Assessment of the risk requirements for the 100-F-36 and 116-F-15 waste sites is determined by calculation of the hazard quotient and excess cancer risk values for nonradionuclides. These calculations are located in Appendix C. The requirements include an individual hazard quotient of less than 1.0, a cumulative hazard quotient of less than 1.0, an individual contaminant carcinogenic risk of less than 1×10^{-6}, and a cumulative carcinogenic risk of less than 1×10^{-5}. These risk values were not calculated for constituents that were not detected or were detected at concentrations below Hanford Site or Washington State background values. The results (Appendix C) indicated that all individual hazard quotients for noncarcinogenic constituents were less than 1.0. The cumulative hazard quotient for the noncarcinogenic constituents is 1.4×10^{-2}. All individual carcinogen risk values for carcinogenic constituents were less than 1×10^{-6}. The cumulative carcinogenic risk value is 5.0×10^{-7}. Therefore, nonradionuclide risk requirements are met.

When using a statistical sampling approach, a RAG requirement for nonradionuclides is the WAC 173-340-740(7)(e) three-part test. This test consists of the following criteria: (1) the statistical value must be less than the most stringent cleanup level, (2) the percentage of samples exceeding the cleanup criteria must be less than 10%, and (3) no single detection can exceed two times the cleanup criteria. The application of the three-part test for the 100-F-36 and 116-F-15 waste sites is included in the statistical calculations (Appendix B). Where statistical values default to maximum values due to data censorship, or when all values in a data set are below background values, as is the case for the 100-F-36 waste site, the three-part test is not required. For the 116-F-15 site, all residual COPC concentrations pass the three-part test, except lead and aroclor-1254, which fail the three-part test when compared to soils RAGs for the protection of groundwater and the Columbia River. However, lead and aroclor-1254 are not predicted to reach groundwater (and, thus, the Columbia River) based on RESRAD modeling (BHI 2005). Data were not collected on the vertical extent of contamination for this area, but, given the distribution coefficients (K_d) for lead (30 mL/g) and aroclor-1254 (75.6 mL/g), these contaminants would not be expected to migrate more than 3 m (10 ft) vertically in 1,000 years (BHI 2005). The vadose zone beneath the 116-F-15 excavation is approximately 10 m (33 ft) thick. Residual concentrations are, therefore, protective of groundwater and the Columbia River.

DATA QUALITY ASSESSMENT

A data quality assessment (DQA) review was performed to compare the confirmatory and verification sampling approaches and resulting analytical data with the sampling and data requirements specified by the project objectives and performance specifications. This review involves evaluation of the data to determine if they are of the right type, quality, and quantity to support the intended use (i.e., closeout decisions). The assessment review completes the data life cycle (i.e., planning, implementation, and assessment) that was initiated by the data quality objectives process (EPA 2000).

This DQA review was performed in accordance with ENV-1, *Environmental Monitoring & Management*. Specific data quality objectives for these sites are found in the SAP (DOE-RL 2005a). To ensure quality data sets, the SAP data assurance requirements, as well as the validation procedures for chemical and radiochemical analysis (BHI 2000b, 2000c), are followed where appropriate. Further details of both the confirmatory and verification DQAs are described below.

Confirmatory Sampling Data Quality Assessment

Confirmatory samples collected at the 100-F-36 waste site were analyzed using analytical methods approved by the Environmental Protection Agency. A review of the sample design (WCH 2006b), the field logbook (WCH 2006a), and applicable analytical data packages was performed as part of this DQA. All samples were collected in accordance with the sample design. Confirmatory samples collected at this site were provided by the laboratories in two sample delivery groups (SDGs), SDG K0635 and SDG 06I-6671-01, and are described below.

SDG K0635

This SDG comprises nine samples from the 100-F-36 test pits (J13VH9, J13VJ0, J13VJ1, J13VJ2, J13VJ3, J13VJ4, J13VJ5, J13VJ6, and J13J52). One of the samples, J13VJ0, is associated with a contaminated pipe section found while excavating test pit 4. This pipe is associated with the 100-F-26:4 site, therefore, the data are not considered further within this DQA. One field duplicate pair is included in this SDG (J13VJ3/J13VJ4) and one equipment blank (J13J52). These samples were analyzed for inductively coupled plasma (ICP) metals, mercury, hexavalent chromium, polychlorinated biphenyls (PCBs), and by alpha spectroscopy, beta counting, gamma spectroscopy, and liquid scintillation counting. SDG K0635 was submitted for formal third-party validation. No major deficiencies were found and minor deficiencies are noted below.

ICP Metals Analysis

In the ICP metals analysis, the matrix spike (MS) recoveries for four ICP metals (aluminum, iron, antimony, and silicon) are out of acceptance criteria. For aluminum and iron, the spiking concentration was insignificant compared to the native concentration in the sample from which the MS was prepared. For these analytes, the deficiency in the MS is a reflection of the

analytical variability of the native concentration rather than a measure of the recovery from the sample. To confirm quantitation, post-digestion spikes and serial dilutions were prepared for all four analytes with results in the range of 94.3% to 103.0%. The analytes antimony and silicon did not have mismatched spike and native concentrations in the original MS. The original MS recoveries for antimony and silicon were 71.3% and 54.6%, respectively. The antimony and silicon data for SDG K0635 may be considered estimated. The data are useable for decision-making purposes.

The analytes sodium and zinc were reported in the method blank (MB) at concentrations that were below the contract required quantitation limits but not less than 1/5th of some of the concentrations reported in the field samples (i.e., the field sample concentrations were low enough that the MB concentration is of similar magnitude). Third-party validation qualified the analytical data for sodium and zinc in sample J13J52 (equipment blank) as estimated nondetections with "UJ" flags.

One field (equipment) blank (J13J52) was submitted for analysis. Aluminum, barium, beryllium, iron, potassium, magnesium, manganese, lead, and silicon were detected in the equipment blank at concentrations insignificant to the applicable RAGs. Under the Washington Closure Hanford (WCH) statement of work to the laboratory, no qualification is required.

All selenium laboratory detection levels exceeded the required quantitation limit (RQL). However, the detection limits were such that had selenium been present at concentrations above the applicable RAGs, selenium would have been detected and reported. Under the WCH statement of work to the laboratory, no qualification is required.

Also in the ICP metals analysis, the laboratory control sample (LCS) recovery for silicon was below the acceptance criteria at 6.8%. Silicon was qualified by third-party validation as estimates with "J" flags for all samples in SDG K0635. Estimated, or "J"-flagged, data are considered acceptable for the intended use of the data.

Hexavalent Chromium Analysis

In the hexavalent chromium analysis, the samples were not properly preserved at a cooler temperature of 1.7 degrees Celsius. Third-party validation qualified all the analytical data for hexavalent chromium in SDG K0635 as estimates with "J" flags. The data are useable for decision-making purposes.

PCB Analysis

In the PCB analysis, the samples were not properly preserved at a cooler temperature of 1.7 degrees Celsius. Third-party validation qualified all the PCB analytical data in SDG K0635 as estimates with "J" flags. The data are useable for decision-making purposes.

Radionuclide Analysis

For the radionuclide analysis, 14 analytes exceeded the RQL. However, the detection limits were such that had the analytes been present at concentrations above the applicable RAGs, they would have been detected and reported. Under the WCH statement of work to the laboratory, no qualification is required. These small exceedances were also not qualified by third-party validation.

The tracer recovery for uranium-233/234 and uranium-238 in sample J13VJ6 was outside the quality control limits at 111%. Third-party validation qualified the analytical data for uranium-233/234 and uranium-238 in sample J13VJ6 as estimates with "J" flags. The data are useable for decision-making purposes.

The relative percent difference (RPD) for uranium-233/234 for the laboratory duplicate samples were outside the acceptance criteria of 30% with an RPD of 60%. The primary and duplicate samples are both detected just above the detection limit. When one of the two samples is undetected, or when the duplicate pair is near the detection limit, analysis of RPDs is not considered useful in the precision determination. The data are useable for decision-making purposes.

SDG 06I-6671-01

This SDG comprises eight field samples from the 100-F-36 test pits (J13J44, J13J45, J13J46, J13J47, J13J48, J13J49, J13J50, and J13J51). One of the samples, J13J45, is associated with a contaminated pipe section found while excavating test pit 4. This pipe is associated with the 100-F-26:4 site, therefore, the data are not considered within this DQA. One field duplicate pair is included in this SDG (J13J48/J13J49). These samples were analyzed for bulk asbestos. No major or minor deficiencies were found.

Confirmatory Sampling Field Quality Assurance/Quality Control

Field quality assurance/quality control (QA/QC) measures are used to assess potential sources of error and cross contamination of samples that could bias results. The field QA/QC samples for the 100-F-36 waste site (WCH 2006a) are summarized in Table 4 and the sample results are presented in Appendix B.

Table 4. Field Quality Control Samples for the 100-F-36 Waste Site.

SDG	Main	Duplicate
K0635	J13VJ3	J13VJ4
06I-6671-01	J13J48	J13J49

Field duplicate samples are collected to provide a relative measure of the degree of local heterogeneity in the sampling medium, unlike laboratory duplicates that are used to evaluate precision in the analytical process. The field duplicates are evaluated by computing the RPD of the duplicate samples for each COPC. The RPD evaluation for radionuclides and nonradionuclides is described below.

- **Radionuclides.** For SDG K0635, the third-party validation calculated the field duplicates RPD for potassium-40 at 44%, radium-226 at 39%, radium-228 at 44%, thorium-228 at 65%, and thorium-232 at 44%. These RPD results exceed the criteria (30%); however, there is no requirement to qualify the data and no qualifier flags were assigned. As elevated RPDs are attributed to heterogeneity naturally occurring in the soil matrix, the data are found to be useable for decision-making purposes.

- **Nonradionuclides.** None of the RPDs calculated for nonradionuclides in field duplicates are above the acceptance criteria (30%). The data are useable for decision-making purposes.

A secondary check of the data variability is used when one or both of the samples being evaluated (main and duplicate) is less than five times the target detection limit (TDL), including undetected analytes. In these cases, a control limit of ±2 times the TDL is used (Appendix B) to indicate that a visual check of the data is required by the reviewer. For the SDG K0635 duplicate sample, the radium-226 and radium-228 results required this check. These results are attributed to heterogeneities in the sample matrix from which the samples were collected. A visual inspection of all of the data was also performed. No additional major or minor deficiencies were noted. The data are useable for decision-making purposes.

Confirmatory Sampling Data Quality Assessment Summary

Limited, random, or sample matrix-specific influenced batch QC issues, such as those discussed above, are a potential issue for any analysis. The number and types seen in these data sets are within expectations for the matrix types and analyses performed. The DQA review of the 100-F-36 confirmatory sampling data found that the analytical results are accurate within the standard errors associated with the analytical methods, sampling, and sample handling. It is, therefore, concluded that the reviewed data are of the right type, quality, and quantity to support the intended use. Detection limits, precision, accuracy, and sampling data group completeness were assessed to determine if any analytical results should be rejected as a result of QA and QC deficiencies. The analytical data were found to be acceptable for decision-making purposes.

The confirmatory sample analytical data are stored in the ENRE project-specific database prior to being submitted for inclusion in the HEIS database. The confirmatory sample analytical data are also presented in Appendix B.

Verification Sampling Data Quality Assessment

Verification samples collected at the 116-F-15 waste site were analyzed using analytical methods approved by the Environmental Protection Agency. A review of the sample design (WCH 2006b), the field logbook (WCH 2006a), and applicable analytical data packages was

performed as part of this DQA. All samples were collected in accordance with the sample design. Verification samples collected at this site were provided by the laboratories in two SDGs, SDG K0645 and SDG 06I-6735-01, and are described below.

SDG K0645

This SDG comprises 12 samples from the 116-F-15 excavation (J13W02 through J13W12, and J13J53). One field duplicate pair is included in this SDG (J13W02/J13W03) and one equipment blank (J13J53). These samples were analyzed for ICP metals, mercury, hexavalent chromium, PCBs, and by alpha spectroscopy, beta counting, gamma spectroscopy, and liquid scintillation counting. SDG K0645 was submitted for formal third-party validation. No major deficiencies were found and minor deficiencies are noted below.

ICP Metals Analysis

In the ICP metals analysis, the MS recoveries for six ICP metals (aluminum, barium, calcium, iron, antimony, and silicon) are out of acceptance criteria. For aluminum, iron, and silicon, the spiking concentration was insignificant compared to the native concentration in the sample from which the MS was prepared. For these analytes, the deficiency in the MS is a reflection of the analytical variability of the native concentration rather than a measure of the recovery from the sample. To confirm quantitation, post-digestion spikes and serial dilutions were prepared for all six analytes with acceptable results. The analytes barium, calcium, and antimony did not have mismatched spike and native concentrations in the original MS. These three analytes were qualified by third-party validation as estimates with "J" flags for all samples in SDG K0645. The original MS recoveries for barium, calcium, and antimony were 44.2%, 22.6%, and 48%, respectively. Estimated, or "J"-flagged, data are considered acceptable for the intended use of the data. The data are useable for decision-making purposes.

The analytes boron, calcium, sodium, and zinc were reported in the MB at concentrations that were below the contract required quantitation limits but not less than 1/5th of some of the concentrations reported in the field samples (i.e., the field sample concentrations were low enough that the MB concentration is of similar magnitude). Third-party validation qualified the analytical data for calcium, sodium, and zinc in sample J13J53 (equipment blank), and for boron in samples J13W04 and J13W08, as estimated nondetections with "UJ" flags.

One field (equipment) blank (J13J53) was submitted for analysis. Aluminum, barium, chromium, copper, iron, potassium, magnesium, manganese, molybdenum, lead, silicon, and vanadium were detected in the equipment blank at concentrations insignificant to the applicable RAGs.. Under the WCH statement of work to the laboratory, no qualification is required.

All selenium laboratory detection levels exceeded the RQL. However, the detection limits were such that had selenium been present at concentrations above the applicable RAGs, selenium would have been detected and reported. Under the WCH statement of work to the laboratory, no qualification is required.

Also in the ICP metals analysis, the LCS recovery for silicon was below the acceptance criteria at 8.4%. Silicon was qualified by third-party validation as estimates with "J" flags for all samples in SDG K0645. The data are useable for decision-making purposes.

The RPDs calculated for boron and barium in the laboratory duplicate pair (J13W02/J13W03) are above the acceptance criteria at 161.3% and 90.2%, respectively. Boron and barium were qualified by third-party validation as estimates with "J" flags for all samples in SDG K0645. The data are useable for decision-making purposes.

Hexavalent Chromium Analysis

No major or minor deficiencies were found. The data are useable for decision-making purposes.

PCB Analysis

No major or minor deficiencies were found. The data are useable for decision-making purposes.

Radionuclide Analysis

For the radionuclide analysis, 19 analytes exceeded the RQL. However, the detection limits were such that had the analytes been present at concentrations above the applicable RAGs, they would have been detected and reported. Under the WCH statement of work to the laboratory, no qualification is required. These small exceedances were also not qualified by third-party validation.

The RPD for uranium-233/234 for the laboratory duplicate samples were outside the acceptance criteria of 30% with an RPD of 38%. The primary and duplicate samples are both detected just above the detection limit. When one of the two samples is undetected, or when the duplicate pair is near the detection limit, analysis of RPDs is not considered useful in the precision determination. The data are useable for decision-making purposes.

SDG 06I-6735-01

This SDG comprises 11 field samples from the 116-F-15 excavation (J13W13 through J13W23). One field duplicate pair is included in this SDG (J13W13/J13W14). These samples were analyzed for bulk asbestos. No major or minor deficiencies were found.

Verification Sampling Field Quality Assurance/Quality Control

Field QA/QC measures are used to assess potential sources of error and cross contamination of samples that could bias results. The field QA/QC samples for the 116-F-15 waste site (WCH 2006a) are summarized in Table 5 and the sample results are presented in Appendix B.

Table 5. Field Quality Control Samples for the 116-F-15 Waste Site.

SDG	Main	Duplicate
K0645	J13W02	J13W03
06I-6735-01	J13W13	J13W14

Field duplicate samples are collected to provide a relative measure of the degree of local heterogeneity in the sampling medium, unlike laboratory duplicates that are used to evaluate precision in the analytical process. The field duplicates are evaluated by computing the RPD of the duplicate samples for each COPC. The RPD evaluation for radionuclides and nonradionuclides is described below.

- **Radionuclides.** For SDG K0645, the third-party validation calculated the field duplicates RPD for potassium-40 at 131%, cesium-137 at 140%, radium-226 at 117%, radium-228 at 128%, thorium-228 at 140%, and thorium-232 at 127%. These RPD results exceed the criteria (30%); however, there is no requirement to qualify the data and no qualifier flags were assigned. As elevated RPDs are attributed to heterogeneity naturally occurring in the soil matrix, the data are found to be useable for decision-making purposes.

- **Nonradionuclides.** For SDG K0645, the third-party validation calculated the field duplicates RPD for boron at 132%, barium at 173%, calcium at 38%, and silicon at 48%. The RPD calculation presented in Appendix B reports the field duplicates RPD for barium at 83.5% and the field duplicates RPD for calcium at 37%. These RPDs exceed the criteria (30%); however, there is no requirement to qualify the data and no qualifier flags were assigned. As elevated RPDs are attributed to heterogeneity naturally occurring in the soil matrix, the data are found to be useable for decision-making purposes.

A secondary check of the data variability is used when one or both of the samples being evaluated (main and duplicate) is less than five times the TDL, including undetected analytes. In these cases, a control limit of ±2 times the TDL is used (Appendix B) to indicate that a visual check of the data is required by the reviewer. For the SDG K0645 duplicate sample, the cesium-137, radium-226, radium-228, boron, and sodium results required this check. These results are attributed to heterogeneities in the sample matrix from which the samples were collected. A visual inspection of all of the data was also performed. No additional major or minor deficiencies were noted. The data are useable for decision-making purposes.

Verification Sampling Data Quality Assessment Summary

Limited, random, or sample matrix-specific influenced batch QC issues, such as those discussed above, are a potential issue for any analysis. The number and types seen in these data sets are within expectations for the matrix types and analyses performed. The DQA review of the 116-F-15 verification sampling data found that the analytical results are accurate within the standard errors associated with the analytical methods, sampling, and sample handling. It is, therefore, concluded that the reviewed data are of the right type, quality, and quantity to support the

intended use. Detection limits, precision, accuracy, and sampling data group completeness were assessed to determine if any analytical results should be rejected as a result of QA and QC deficiencies. The analytical data were found acceptable for decision-making purposes.

The verification sample analytical data are stored in the ENRE project-specific database prior to being submitted for inclusion in the HEIS database. The verification sample analytical data are also presented in Appendix B.

SUMMARY FOR NO ACTION AND INTERIM CLOSURE

The 100-F-36 and 116-F-15 waste sites have been evaluated and remediated in accordance with the Remaining Sites ROD (EPA 1999) and the RDR/RAWP (DOE-RL 2005b). Because the 116-F-15 waste site contained hazardous constituents at levels exceeding the RAGs, remedial action was performed. Following remediation, sampling of the sites was conducted. The confirmatory sample results for the 100-F-36 waste site were shown to meet the cleanup objectives for direct exposure, groundwater protection, and river protection. In accordance with this evaluation, the confirmatory sampling results support a reclassification of the 100-F-36 site to No Action. Verification sampling of the 116-F-15 waste site was performed to verify the completeness of remediation. The analytical results were shown to meet the cleanup objectives for direct exposure, groundwater protection, and river protection. In accordance with this evaluation, the verification sampling results support a reclassification of the 116-F-15 site to Interim Closed Out. Remedial actions were not required for deep zone soils; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are not required.

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APPENDIX A

PHOTOGRAPHS OF 108-F BUILDING DEMOLITION AND SAMPLING ACTIVITIES

Photograph A-1. 108-F Biological Laboratory Prior to Demolition (Circa 1983).

Photograph A-2. Heavy Equipment Removing Concrete Wall on West Side of 108-F Biological Laboratory as Water is Sprayed to Control Dust (1999).

Photograph A-3. Demolition of North Side of 108-F Biological Laboratory (1999).

Photograph A-4. Demolition of Southern Half of 108-F Biological Laboratory (1999).

Photograph A-5. 108-F Biological Laboratory Site After Demolition Complete (1999).

Photograph A-6. Excavation of Test Pit 1 for Sampling (December 2006).

Photograph A-7. Excavation of Test Pit 3 In Progress (December 2006).

Photograph A-8. Sampling of Vitrified Clay Pipe from Test Pit 3 (December 2006).

APPENDIX B

95% UCL CALCULATIONS AND VERIFICATION SAMPLING RESULTS

APPENDIX B

95% UCL CALCULATIONS AND VERIFICATION SAMPLING RESULTS

The calculations in this appendix are kept in the active Washington Closure Hanford project files and are available upon request. When the project is completed, the files will be stored in a U.S. Department of Energy, Richland Operations Office, repository. These calculations have been prepared in accordance with ENG-1, *Engineering Services*, ENG-1-4.5, "Project Calculations," Washington Closure Hanford, Richland, Washington. The following calculations are provided in this appendix:

100-F-36 Cleanup Verification 95% UCL Calculations, 0100F-CA-V0276, Rev. 0, Washington Closure Hanford, Richland, Washington.

116-F-15 Cleanup Verification 95% UCL Calculations, 0100F-CA-V0277, Rev. 0, Washington Closure Hanford, Richland, Washington.

DISCLAIMER FOR CALCULATIONS

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

CALCULATION COVER SHEET

Project Title:	Field Remediation	**Job No.**	14655
Area	100-F		
Discipline	Environmental	***Calc. No.**	0100F-CA-V0276
Subject	100-F-36 Cleanup Verification 95% UCL Calculations		
Computer Program	Excel	**Program No.**	Excel 2003

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

Committed Calculatio ☒ **Preliminary** ☐ **Superseded** ☐ **Voided** ☐

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover = 1 Sheets = 9 Attm. 1 = 5 Total = 15	K.A. Anselm 4/17/07 K. A. Anselm	J.M. Capron 4/23/07 J. M. Capron	T.M. Blakley 4/24/07 T. M. Blakley	S.W. Callison 4-24-07 S. W. Callison	4-24-07

SUMMARY OF REVISIONS

WCH-DE-018 (09/01/2006) * Obtain Calc No. from Document Control and Form from Intranet

CALCULATION SHEET

Washington Closure Hanford

Originator K. A. Anselm Kaa	**Date** 04/17/07	**Calc. No.** 0100F-CA-V0276	**Rev. No.** 0
Project Field Remediation	**Job No.** 14655	**Checked** J. M. Capron JMC	**Date** 4/23/07
Subject 100-F-36 Cleanup Verification 95% UCL Calculations			**Sheet No.** 1 of 9

Summary

Purpose:

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

Table of Contents:

Given/References:

1) Sample Results (Attachment 1). Attachment 1 also includes the results of the focused sampling performed at this site; however, only the statistical sampling results (test pits 1, 2, and 3) are used for calculating the 95% UCL values in this calculation. The focused sampling results (test pits 4 and 5, and test pit 3 pipe) are addressed in the remaining sites verification package (RSVP) for this site.
2) Background values and remedial action goals (RAGs) are from DOE-RL (2005b) and Ecology (2005).
3) DOE-RL, 2005a, *100 Area Remedial Action Sampling and Analysis Plan* (SAP), DOE/RL-96-22, Rev. 4, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
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9) WAC 173-340, 1996, "Model Toxic Control Act - Cleanup," *Washington Administrative Code.*

Solution:

Calculation methodology is described in Ecology publication #92-54 (Ecology 1992, 1993), below, and in the RDR/RAWP (DOE-RL 2005b). Use data from attached worksheets to perform the 95% UCL calculation for each COPC, the WAC 173-340-740(7)(e) 3-part test for nonradionuclides, and the RPD calculations for primary-duplicate sample pairs, as required. The hazard quotient and carcinogenic risk calculations are located in a separate calculation brief and are inlcuded as an appendix to the RSVP.

Calculation Description:

The subject calculations were performed on data from soil samples from the subject waste site. The data were entered into an EXCEL 2003 spreadsheet and calculations performed by using the built-in spreadsheet functions and/or creating formulae within the cells. The statistical evaluation of data for use in accordance with the RDR/RAWP (DOE-RL 2005b) is documented by this calculation. Duplicate RPD results are used in evaluation of data quality within the RSVP for this site.

CALCULATION SHEET

Washington Closure Hanford

Originator K. A. Anselm KAA	**Date** 04/17/07	**Calc. No.** 0100F-CA-V0276	**Rev. No.** 0
Project Field Remediation	**Job No.** 14655	**Checked** J. M. Capron JMC	**Date** 4/23/07
Subject 100-F-36 Cleanup Verification 95% UCL Calculations			**Sheet No.** 2 of 9

Summary (continued)

Methodology:

For nonradioactive analytes with ≤50% of the data below detection limits, and all detected radionuclide analytes, the statistical value calculated to evaluate the effectiveness of cleanup is the 95% UCL. For nonradioactive analytes with >50% of the data below detection limits, as determined by direct inspection of the sample results (Attachment 1), the maximum detected value for the data set is used instead of the 95% UCL, and no further calculations are performed for those data sets. The 95% UCL is also not calculated for data sets with no reported detections. Calculated cleanup levels are not available in Ecology (2005) under WAC 173-340-740(3) for aluminum, calcium, iron, magnesium, potassium, silicon, and sodium; therefore, these constituents are not considered site COPCs and are also not included in these tables. Potassium-40, radium-226, radium-228, thorium-228, and thorium-232 were detected in samples collected at these sites, but are excluded from these tables because these isotopes are not related to the operational history of the site.

All nonradionuclide data reported as being undetected are set to ½ the detection limit value for calculation of the statistics (Ecology 1993). For radionuclide data, calculation of the statistics was done on the reported value. In cases where the laboratory does not report a value below the minimum detectable activity (MDA), half of the MDA is used in the calculation. For the statistical evaluation of duplicate sample pairs, the samples are averaged before being included in the data set, after adjustments for censored data as described above.

For nonradionuclides, the WAC 173-340 statistical guidance suggests that a test for distributional form be performed on the data and the 95% UCL calculated on the appropriate distribution using Ecology software. For all nonradionuclide and radionuclide data sets for the subject site, the 95% UCL value was approximated using the z-statistic without further distributional testing.

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

The WAC 173-340-740(7)(e) 3-part test is not performed for COPCs where the statistical value defaults to the maximum value in the data set. Instead, direct comparison of the maximum value against site RAGs (within the RSVP) is used as the compliance basis.

The RPD values are evaluated for analytes detected in a primary-duplicate or primary-split sample pair for the purposes of data quality assessment within the RSVP (where direct evaluation of the attached data showed that a given analyte was undetected in both the primary and duplicate sample, no further calculations were performed). The RPD is calculated when both the primary value and the duplicate value for a given analyte are above detection limits and are greater than 5 times the target detection limit (TDL). The TDL is a laboratory detection limit pre-determined for each analytical method and is listed in Table II-1 of the SAP (DOE-RL 2005a). The RPD calculations use the following formula:

$$RPD = [\,|M-S|/((M+S)/2)]*100$$

where, M = main sample value S = split (or duplicate) sample value

When an analyte is detected in the primary or duplicate sample, but was quantified at less than 5 times the TDL in one or both samples, an additional parameter is evaluated. In this case, if the difference between the primary and duplicate results exceeds a control limit of 2 times the TDL, further assessment regarding the usability of the data is performed. This assessment is provided in the data quality assessment section of the RSVP.

CALCULATION SHEET

Washington Closure Hanford

Originator K. A. Anselm KAA **Date** 04/17/07 **Calc. No.** 0100F-CA-V0276 **Rev. No.** 0
Project Field Remediation **Job No.** 14655 **Checked** J. M. Capron JMC **Date** 4/23/07
Subject 100-F-36 Cleanup Verification 95% UCL Calculations **Sheet No.** 3 of 9

Summary (continued)

Methodology (continued):
For quality assurance/quality control (QA/QC) split and duplicate RPD calculations, a value less than 30% indicates the data compare favorably. For regulatory splits, a threshold of 35% is used (EPA 1994). If the RPD is greater than 30% (or 35% for regulatory split data), further investigation regarding the usability of the data is performed. No split samples were collected at this site. Additional discussion is provided in the data quality assessment section of the applicable RSVP, as necessary.

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

Statistical Sampling Results Summary[a]

Analyte	95% UCL[b]	Maximum Value[c]	Units
Uranium-233/234	0 (< BG)		pCi/g
Uranium-238	0 (< BG)		pCi/g
Arsenic	1.7		mg/kg
Barium	32.5		mg/kg
Beryllium	0.19		mg/kg
Chromium	6.6		mg/kg
Cobalt	3.7		mg/kg
Copper	10.0		mg/kg
Hexavalent chromium		0.32	mg/kg
Lead	2.1		mg/kg
Manganese	194		mg/kg
Nickel	8.0		mg/kg
Vanadium	27.3		mg/kg
Zinc	25.2		mg/kg

[a]No detections were reported in any data set for COPCs not listed in this table.
[b]For nonradionuclides, where ≤ 50% of a data set is below detection limits, the 95% UCL value is used for a given analyte.
[c]For nonradionuclides, where > 50% of a data set is below detection limits, the statistical value defaults to the maximum detected value in the data set (Attachment 1).

WAC 173-340 3-Part Test for Most Stringent RAG:

95% UCL > Cleanup Limit?	NA
> 10% above Cleanup Limit?	NA
Any sample > 2x Cleanup Limit?	NA

All detected results were below background levels.

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Washington Closure Hanford

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Summary (continued)

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

Analyte	Duplicate Analysis[b]
Potassium-40	44%
Aluminum	17%
Barium	3.2%
Calcium	6.6%
Chromium	21%
Copper	5.0%
Iron	14%
Magnesium	12%
Manganese	9.5%
Silicon	6.2%
Vanadium	22%
Zinc	9.6%

[a]Relative percent difference evaluation was not required for analytes not included in this table.

[b]The significance of relative percent difference values is discussed within the RSVP for this site.

Focused Sampling Results Summary[a]

Analyte	Maximum Value	Units
Uranium-233/234	0.569 (< BG)	pCi/g
Uranium-238	0.727 (< BG)	pCi/g
Arsenic	3.0 (< BG)	mg/kg
Barium	86.1 (< BG)	mg/kg
Beryllium	0.35 (< BG)	mg/kg
Boron	1.2	mg/kg
Chromium	10.6 (< BG)	mg/kg
Cobalt	6.9 (< BG)	mg/kg

Analyte	Maximum Value	Units
Copper	12.1 (< BG)	mg/kg
Hexavalent chromium	0.87	mg/kg
Lead	5.5 (< BG)	mg/kg
Manganese	356 (< BG)	mg/kg
Mercury	0.05 (< BG)	mg/kg
Nickel	9.0 (< BG)	mg/kg
Vanadium	44.8 (< BG)	mg/kg
Zinc	41.0 (< BG)	mg/kg

[a]No detections were reported in any data set for COPCs not listed in this table.

Abbreviations/Acronyms:

The following abbreviations and/or acronyms are used in this calcuation:

BG = background
C = method blank contamination (inorganic constituents)
COPC = contaminant of potential concern
GEA = gamma energy analysis
GW = groundwater
J = estimate
MDA = minimum detectable activity
MTCA = *Model Toxics Control Act*
NA = not applicable
PQL = practical quantitation limit
Q = qualifier
QA/QC = quality assurance/quality control
RAG = remedial action goal
RDL = required detection limit
RDR/RAWP = remedial design report/remedial action work plan
RPD = relative percent difference
RSVP = remaining sites verification package
SAP = sampling and analysis plan
TDL = target detection limit
U = undetected
UCL = upper confidence limit
WAC = *Washington Administrative Code*

CALCULATION SHEET

Washington Closure Hanford

Originator K. A. Anselm KAA
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Sampling Data

Sampling Area	HEIS Number	Sample Date	Uranium-233/234 pCi/g	Q	MDA	Uranium-238 pCi/g	Q	MDA	Arsenic mg/kg	Q	PQL	Barium mg/kg	Q	PQL	Beryllium mg/kg	Q	PQL
Test pit 2 soil	J13VJ3	12/05/06	0.665		0.12	0.616		0.12	1.6		0.86	25.5		0.03	0.16		0.03
Duplicate of J13VJ3	J13VJ4	12/05/06	0.661		0.13	0.529		0.13	1.8		0.88	24.7		0.03	0.19		0.03
Test pit 1 soil	J13VH9	12/05/06	0.486		0.13	0.625		0.13	1.7		0.87	33.5		0.03	0.19		0.03
Test pit 3 soil	J13VJ6	12/05/06	0.687	J	0.14	1.01	J	0.14	1.5		0.88	25.3		0.03	0.15		0.03

Statistical Computation Input Data

Sampling Area	HEIS Number	Sample Date	Uranium-233/234 pCi/g	Uranium-238 pCi/g	Arsenic mg/kg	Barium mg/kg	Beryllium mg/kg
Test pit 2 soil	J13VJ3/J13VJ4	12/05/06	0.663	0.573	1.7	25.1	0.18
Test pit 1 soil	J13VH9	12/05/06	0.486	0.625	1.7	33.5	0.19
Test pit 3 soil	J13VJ6	12/05/06	0.687	1.01	1.5	25.3	0.15

Statistical Computations

	Uranium-233/234	Uranium-238	Arsenic	Barium	Beryllium
95% UCL value based on	Use z-statistic.	Use z-statistic.	Use z-statistic.	Use z-statistic.	Use z-statistic.
N	3	3	3	3	3
% < Detection limit	0%	0%	0%	0%	0%
Mean	0.612	0.736	1.6	28.0	0.17
Standard deviation	0.110	0.239	0.12	4.79	0.02
Z-statistic	1.645	1.645	1.645	1.645	1.645
95% UCL on mean	0.716	0.963	1.7	32.5	0.19
Maximum detected value	0.687	1.01	1.8	33.5	0.19
Background	1.1	1.1	6.5	132	1.51
Statistical value above background*	0 (< BG)	0 (< BG)	1.7	32.5	0.19
Most Stringent Cleanup Limit for nonradionuclide and RAG type			20 Direct Exposure/GW & River Protection	132 BG/GW Protection	1.51 BG/GW & River Protection
WAC 173-340 3-PART TEST					
95% UCL > Cleanup Limit?			NA	NA	NA
> 10% above Cleanup Limit?			NA	NA	NA
Any sample > 2X Cleanup Limit?			NA	NA	NA
WAC 173-340 Compliance? YES			Because all values are below background (6.5 mg/kg), the WAC 173-340 3-part test is not required.	Because all values are below background (132 mg/kg), the WAC 173-340 3-part test is not required.	Because all values are below background (1.51 mg/kg), the WAC 173-340 3-part test is not required.

* Background is not subtracted for nonradionuclides; consideration of background is provided for comparison purposes.

CALCULATION SHEET

Washington Closure Hanford

Originator K. A. Anselm | Caa | Date 04/17/07 | Calc. No. 0100F-CA-V0276 | Rev. No. 0

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Sampling Data (cont.)

Sampling Area	HEIS Number	Sample Date	Chromium			Cobalt			Copper			Lead			Manganese		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
Test pit 2 soil	J13VJ3	12/05/06	5.6		0.33	3.3		0.14	10.2		0.20	1.8		0.45	170		0.11
Duplicate of J13VJ3	J13VJ4	12/05/06	6.9		0.34	3.8		0.14	9.7		0.20	1.8		0.45	187		0.11
Test pit 1 soil	J13VH9	12/05/06	6.6		0.34	3.7		0.14	9.9		0.20	2.0		0.45	195		0.11
Test pit 3 soil	J13VJ6	12/05/06	6.3		0.34	3.7		0.14	10.0		0.20	2.1		0.46	184		0.11

Statistical Computation Input Data

Sampling Area	HEIS Number	Sample Date	Chromium mg/kg			Cobalt mg/kg			Copper mg/kg			Lead mg/kg			Manganese mg/kg		
Test pit 2 soil	J13VJ3/J13VJ4	12/05/06	6.3			3.6			10.0			1.8			179		
Test pit 1 soil	J13VH9	12/05/06	6.6			3.7			9.9			2.0			195		
Test pit 3 soil	J13VJ6	12/05/06	6.3			3.7			10.0			2.1			184		

Statistical Computations

	Chromium			Cobalt			Copper			Lead			Manganese		
95% UCL value based on	Use z-statistic.			Use z-statistic.			Use z-statistic.			Use z-statistic.			Use z-statistic.		
N	3			3			3			3			3		
% < Detection limit	0%			0%			0%			0%			0%		
Mean	6.4			3.7			10.0			2.0			186		
Standard deviation	0.19			0.09			0.050			0.15			8.40		
Z-statistic	1.645			1.645			1.645			1.645			1.645		
95% UCL on mean	6.6			3.7			10.0			2.1			194		
Maximum detected value	6.9			3.8			10.2			2.0			195		
Statistical value	6.6			3.7			10.0			2.1			194		
Most Stringent Cleanup Limit for nonradionuclide and RAG type	18.5		BG/GW & River Protection	32		GW Protection	22.0		BG/River Protection	10.2		BG/GW & River Protection	512		BG/GW Protection
WAC 173-340 3-PART TEST															
95% UCL > Cleanup Limit?	NA			NA			NA			NA			NA		
> 10% above Cleanup Limit?	NA			NA			NA			NA			NA		
Any sample > 2X Cleanup Limit?	NA			NA			NA			NA			NA		
WAC 173-340 Compliance? YES	Because all values are below background (18.5 mg/kg), the WAC 173-340 3-part test is not required.			Because all values are below background (15.7 mg/kg), the WAC 173-340 3-part test is not required.			Because all values are below background (22.0 mg/kg), the WAC 173-340 3-part test is not required.			Because all values are below background (10.2 mg/kg), the WAC 173-340 3-part test is not required.			Because all values are below background (512 mg/kg), the WAC 173-340 3-part test is not required.		

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Originator K. A. Anselm KAA Date 04/17/07
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Sampling Data (cont.)

Sample Location	Sample Number	Sample Date	Nickel mg/kg	Nickel Q	Nickel PQL	Vanadium mg/kg	Vanadium Q	Vanadium PQL	Zinc mg/kg	Zinc Q	Zinc PQL
Test pit 2 soil	J13VJ3	12/05/06	7.9		0.61	22.2		0.17	21.7	C	0.11
Duplicate of J13VJ3	J13VJ4	12/05/06	8.1		0.62	27.7		0.17	23.9	C	0.11
Test pit 1 soil	J13VH9	12/05/06	7.5		0.62	24.8		0.17	25.3	C	0.11
Test pit 3 soil	J13VJ6	12/05/06	7.7		0.63	27.6		0.17	24.0	C	0.11

Statistical Computation Input Data

Sample Location	Sample Number	Sample Date	Nickel mg/kg	Vanadium mg/kg	Zinc mg/kg
Test pit 2 soil	J13VJ3/J13VJ4	12/05/06	8.0	25.0	22.8
Test pit 1 soil	J13VH9	12/05/06	7.5	24.8	25.3
Test pit 3 soil	J13VJ6	12/05/06	7.7	27.6	24.0

Statistical Computations

	Nickel	Vanadium	Zinc
95% UCL value based on	Use z-statistic.	Use z-statistic.	Use z-statistic.
N	3	3	3
% < Detection limit	0%	0%	0%
Mean	7.7	25.8	24.0
Standard deviation	0.25	1.58	1.25
Z-statistic	1.645	1.645	1.645
95% UCL on mean	8.0	27.3	25.2
Maximum detected value	8.1	27.7	25.3
Statistical value	8.0	27.3	25.2
Most Stringent Cleanup Limit for nonradionuclide and RAG type	19.1 BG/GW Protection	85.1 BG/GW Protection	67.8 BG/River Protection
WAC 173-340 3-PART TEST			
95% UCL > Cleanup Limit?	NA	NA	NA
> 10% above Cleanup Limit?	NA	NA	NA
Any sample > 2X Cleanup Limit?	NA	NA	NA
WAC 173-340 Compliance? YES	Because all values are below background (19.1 mg/kg), the WAC 173-340 3-part test is not required.	Because all values are below background (85.1 mg/kg), the WAC 173-340 3-part test is not required.	Because all values are below background (67.8 mg/kg), the WAC 173-340 3-part test is not required.

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Duplicate Analysis

Sample Location	Sample Number	Sample Date	Uranium-233/234			Uranium-238			Arsenic			Barium			Beryllium		
			pCi/g	Q	MDA	pCi/g	Q	MDA	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
Test pit 2 soil	J13VJ3	12/05/06	0.665		0.12	0.616		0.12	1.6		0.86	25.5		0.03	0.16		0.03
Duplicate of J13VJ3	J13VJ4	12/05/06	0.661		0.13	0.529		0.13	1.8		0.88	24.7		0.03	0.19		0.03

Analysis:

TDL		1	1	10	2	0.5
Duplicate Analysis	Both > MDA/PQL?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	No - evaluate difference	No - evaluate difference	No - evaluate difference	Yes (calc RPD)	No - evaluate difference
	RPD				3.2%	
	Difference >2xTDL?	No - acceptable	No - acceptable	No - acceptable	Not applicable	No - acceptable

Duplicate Analysis (continued)

Sample Location	Sample Number	Sample Date	Chromium			Cobalt			Copper			Lead			Manganese		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
Test pit 2 soil	J13VJ3	12/05/06	5.6		0.33	3.3		0.14	10.2		0.20	1.8		0.45	170		0.11
Duplicate of J13VJ3	J13VJ4	12/05/06	6.9		0.34	3.8		0.14	9.7		0.20	1.8		0.45	187		0.11

Analysis:

TDL		1	2	1	5	5
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	Yes (calc RPD)	No - evaluate difference	Yes (calc RPD)	No - evaluate difference	Yes (calc RPD)
	RPD	21%		5.0%		9.5%
	Difference >2xTDL?	Not applicable	No - acceptable	Not applicable	No - acceptable	Not applicable

Duplicate Analysis (continued)

Sample Location	Sample Number	Sample Date	Nickel			Vanadium			Zinc		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
Test pit 2 soil	J13VJ3	12/05/06	7.9		0.61	22.2		0.17	21.7	C	0.11
Duplicate of J13VJ3	J13VJ4	12/05/06	8.1		0.62	27.7		0.17	23.9	C	0.11

Analysis:

TDL		4	2.5	1
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	No - evaluate difference	Yes (calc RPD)	Yes (calc RPD)
	RPD		22%	9.6%
	Difference >2xTDL?	No - acceptable	Not applicable	Not applicable

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Washington Closure Hanford

Originator K. A. Anselm KAA — Date 04/17/07 — Calc. No. 0100F-CA-V0276 — Rev. No. 0

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Duplicate Analysis (continued)

Sample Location	Sample Number	Sample Date	Potassium-40			Radium-226			Radium-228			Thorium-228 GEA			Thorium-232 GEA		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
Test pit 2 soil	J13VJ3	12/05/06	18.2		0.34	0.486		0.060	0.751		0.13	0.621		0.041	0.751		0.13
Duplicate of J13VJ3	J13VJ4	12/05/06	28.4		0.63	0.724		0.10	1.17		0.25	1.22		0.094	1.17		0.25

Analysis:

TDL		0.5	0.1	0.2	1	1
Duplicate Analysis	Both > MDA/PQL?	**Yes (continue)**	Yes (continue)	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**
	Both >5xTDL?	**Yes (calc RPD)**	No - evaluate difference	No - evaluate difference	No - evaluate difference	No - evaluate difference
	RPD	*44%*				
	Difference >2xTDL?	Not applicable	Yes - assess further	Yes - assess further	No - acceptable	No - acceptable

Duplicate Analysis (continued)

Sample Location	Sample Number	Sample Date	Aluminum			Calcium			Iron			Magnesium			Potassium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
Test pit 2 soil	J13VJ3	12/05/06	3090		5.9	4840		3.5	9220		6.8	2690		1.3	393		5.9
Duplicate of J13VJ3	J13VJ4	12/05/06	3660		6.0	4530		3.5	10600		6.9	3020		1.3	429		6.0

Analysis:

TDL		5	100	5	75	400
Duplicate Analysis	Both > PQL?	**Yes (continue)**	Yes (continue)	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**
	Both >5xTDL?	**Yes (calc RPD)**	Yes (calc RPD)	**Yes (calc RPD)**	**Yes (calc RPD)**	No - evaluate difference
	RPD	17%	6.6%	14%	12%	
	Difference >2xTDL?	Not applicable	Not applicable	Not applicable	Not applicable	No - acceptable

Duplicate Analysis (continued)

Sample Location	Sample Number	Sample Date	Silicon			Sodium		
			mg/kg	Q	PQL	mg/kg	Q	PQL
Test pit 2 soil	J13VJ3	12/05/06	328		1.8	95.4		0.70
Duplicate of J13VJ3	J13VJ4	12/05/06	349		1.8	104		0.71

Analysis:

TDL		2	50
Duplicate Analysis	Both > PQL?	**Yes (continue)**	Yes (continue)
	Both >5xTDL?	**Yes (calc RPD)**	No - evaluate difference
	RPD	6.2%	
	Difference >2xTDL?	Not applicable	No - acceptable

Attachment 1. 100-F-36 Sampling Results.

Sample Location	Sample Number	Sample Date	Americium-241 GEA			Cesium-137			Cobalt-60			Europium-152			Europium-154			Europium-155		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
Test pit 2 soil	J13VJ3	12/05/06	0.18	U	0.18	0.029	U	0.029	0.034	U	0.034	0.077	U	0.077	0.10	U	0.10	0.11	U	0.11
Duplicate of J13VJ3	J13VJ4	12/05/06	0.62	U	0.62	0.054	U	0.054	0.064	U	0.064	0.18	U	0.18	0.23	U	0.23	0.20	U	0.20
Test pit 1 soil	J13VH9	12/05/06	0.048	U	0.048	0.069	U	0.069	0.044	U	0.044	0.10	U	0.10	0.15	U	0.15	0.081	U	0.081
Test pit 3 soil	J13VJ6	12/05/06	0.037	U	0.037	0.020	U	0.020	0.027	U	0.027	0.056	U	0.056	0.091	U	0.091	0.055	U	0.055
Test pit 4 soil	J13VJ1	12/05/06	0.26	U	0.26	0.043	U	0.043	0.033	U	0.033	0.083	U	0.083	0.11	U	0.11	0.11	U	0.11
Test pit 5 soil	J13VJ2	12/05/06	0.048	U	0.048	0.038	U	0.038	0.037	U	0.037	0.093	U	0.093	0.14	U	0.14	0.077	U	0.077
Test pit 3 pipe	J13VJ5	12/05/06	0.13	U	0.13	0.019	U	0.019	0.022	U	0.022	0.057	U	0.057	0.067	U	0.067	0.11	U	0.11

Sample Location	Sample Number	Sample Date	Nickel-63			Plutonium-238			Plutonium-239/240			Potassium-40			Radium-226			Radium-228		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
Test pit 2 soil	J13VJ3	12/05/06	-0.692	U	3.4	0.048	U	0.15	0	U	0.12	18.2		0.34	0.486		0.060	0.751		0.13
Duplicate of J13VJ3	J13VJ4	12/05/06	-1.01	U	3.4	0	U	0.19	0	U	0.15	28.4		0.63	0.724		0.10	1.17		0.25
Test pit 1 soil	J13VH9	12/05/06	-1.92	U	3.4	-0.021	U	0.16	0	U	0.16	22.9		0.47	0.708		0.083	0.876		0.21
Test pit 3 soil	J13VJ6	12/05/06	-1.04	U	3.4	0.020	U	0.16	0.020	U	0.16	14.6		0.26	0.463		0.044	0.728		0.11
Test pit 4 soil	J13VJ1	12/05/06	-1.51	U	3.4	0.017	U	0.19	0.017	U	0.13	12.7		0.43	0.495		0.070	0.757		0.14
Test pit 5 soil	J13VJ2	12/05/06	-0.948	U	3.5	0.016	U	0.18	0	U	0.12	20.9		0.35	0.892		0.075	1.23		0.20
Test pit 3 pipe	J13VJ5	12/05/06	-0.079	U	3.3	0	U	0.18	0	U	0.18	15.2		0.21	0.526		0.040	0.854		0.088

Notes: The following abbreviations apply to all Attachment 1 tables. Data qualified with C and/or J are considered acceptable values.

C = blank contamination (inorganic constituents)
GEA = gamma energy analysis
J = estimate
MDA = minimum detectable activity
PQL = practical quantitation limit
Q = qualifier
U = undetected

Attachment	1	Sheet No.	1 of 5
Originator	K. A. Anselm KAA	Date	04/17/07
Checked	J. M. Capron JMC	Date	4/23/07
Calc. No.	0100F-CA-V0276	Rev. No.	0

Attachment 1. 100-F-36 Sampling Results.

Sample Location	Sample Number	Sample Date	Silver-108m			Thorium-228 GEA			Thorium-232 GEA			Total beta radiostrontium			Uranium-233/234			Uranium-235		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
Test pit 2 soil	J13VJ3	12/05/06	0.023	U	0.023	0.621		0.041	0.751		0.13	0.001	U	0.25	0.665		0.12	0	U	0.15
Duplicate of J13VJ3	J13VJ4	12/05/06	0.044	U	0.044	1.22		0.094	1.17		0.25	-0.012	U	0.28	0.661		0.13	0.020	U	0.15
Test pit 1 soil	J13VH9	12/05/06	0.031	U	0.031	0.598		0.042	0.876		0.21	-0.150	U	0.26	0.486		0.13	0.063	U	0.16
Test pit 3 soil	J13VJ6	12/05/06	0.015	U	0.015	0.601		0.026	0.728		0.11	-0.079	U	0.26	0.687	J	0.14	0.066	U	0.17
Test pit 4 soil	J13VJ1	12/05/06	0.023	U	0.023	0.588		0.048	0.757		0.14	0.057	U	0.25	0.550		0.13	0	U	0.16
Test pit 5 soil	J13VJ2	12/05/06	0.027	U	0.027	1.01		0.042	1.23		0.20	-0.005	U	0.25	0.569		0.12	0.020	U	0.15
Test pit 3 pipe	J13VJ5	12/05/06	0.015	U	0.015	0.752		0.029	0.854		0.088	-0.008	U	0.30	0.537		0.13	0.042	U	0.16

Sample Location	Sample Number	Sample Date	Uranium-235 GEA			Uranium-238			Uranium-238 GEA		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
Test pit 2 soil	J13VJ3	12/05/06	0.14	U	0.14	0.616		0.12	3.6	U	3.6
Duplicate of J13VJ3	J13VJ4	12/05/06	0.27	U	0.27	0.529		0.13	7.7	U	7.7
Test pit 1 soil	J13VH9	12/05/06	0.13	U	0.13	0.625		0.13	5.6	U	5.6
Test pit 3 soil	J13VJ6	12/05/06	0.089	U	0.089	1.01	J	0.14	2.8	U	2.8
Test pit 4 soil	J13VJ1	12/05/06	0.16	U	0.16	0.378		0.13	4.8	U	4.8
Test pit 5 soil	J13VJ2	12/05/06	0.12	U	0.12	0.716		0.12	5.0	U	5.0
Test pit 3 pipe	J13VJ5	12/05/06	0.10	U	0.10	0.727		0.13	2.3	U	2.3

Attachment	1	Sheet No.	2 of 5
Originator	K. A. Anselm	Date	04/17/07
Checked	J. M. Capron	Date	
Calc. No.	0100F-CA-V0276	Rev. No.	0

Attachment 1. 100-F-36 Sampling Results.

Sample Location	Sample Number	Sample Date	Aluminum			Antimony			Arsenic			Barium			Beryllium			Boron		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
Test pit 2 soil	J13VJ3	12/05/06	3090		5.9	0.70	U	0.70	1.6		0.86	25.5		0.03	0.16		0.03	0.53	U	0.53
Duplicate of J13VJ3	J13VJ4	12/05/06	3660		6.0	0.71	U	0.71	1.8		0.88	24.7		0.03	0.19		0.03	0.54	U	0.54
Test pit 1 soil	J13VH9	12/05/06	3460		5.9	0.70	U	0.70	1.7		0.87	33.5		0.03	0.19		0.03	0.54	U	0.54
Test pit 3 soil	J13VJ6	12/05/06	3470		6.0	0.71	U	0.71	1.5		0.88	25.3		0.03	0.15		0.03	0.54	U	0.54
Equipment Blank	J13J52	12/05/06	57.0		1.9	0.23	U	0.23	0.28	U	0.28	1.4		0.009	0.01		0.009	0.17	U	0.17
Test pit 4 soil	J13VJ1	12/05/06	4470		6.0	0.72	U	0.72	2.0		0.89	86.1		0.03	0.25		0.03	1.2		0.54
Test pit 5 soil	J13VJ2	12/05/06	5050		6.3	0.75	U	0.75	3.0		0.93	71.4		0.03	0.35		0.03	0.57	U	0.57
Test pit 3 pipe	J13VJ5	12/05/06	5110		6.5	0.77	U	0.77	2.2		0.95	61.3		0.03	0.30		0.03	0.79		0.58

Sample Location	Sample Number	Sample Date	Cadmium			Calcium			Chromium			Cobalt			Copper			Hexavalent Chromium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
Test pit 2 soil	J13VJ3	12/05/06	0.08	U	0.08	4840	C	3.5	5.6		0.33	3.3		0.14	10.2		0.20	0.20	UJ	0.20
Duplicate of J13VJ3	J13VJ4	12/05/06	0.08	U	0.08	4530	C	3.5	6.9		0.34	3.8		0.14	9.7		0.20	0.20	UJ	0.20
Test pit 1 soil	J13VH9	12/05/06	0.08	U	0.08	5260	C	3.5	6.6		0.34	3.7		0.14	9.9		0.20	0.32	J	0.20
Test pit 3 soil	J13VJ6	12/05/06	0.09	U	0.09	5660	C	3.6	6.3		0.34	3.7		0.14	10.0		0.20	0.20	UJ	0.20
Equipment Blank	J13J52	12/05/06	0.03	U	0.03	30.3	C	1.1	0.11	U	0.11	0.05	U	0.05	0.06	U	0.06			
Test pit 4 soil	J13VJ1	12/05/06	0.09	U	0.09	5370	C	3.6	8.8		0.34	5.3		0.14	11.6		0.20	0.87	J	0.21
Test pit 5 soil	J13VJ2	12/05/06	0.09	U	0.09	3350	C	3.7	7.5		0.36	6.9		0.15	12.1		0.21	0.23	J	0.22
Test pit 3 pipe	J13VJ5	12/05/06	0.09	U	0.09	4320	C	3.8	10.6		0.37	5.7		0.15	10.6		0.22	0.22	UJ	0.22

Sample Location	Sample Number	Sample Date	Iron			Lead			Magnesium			Manganese			Mercury			Molybdenum		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
Test pit 2 soil	J13VJ3	12/05/06	9220		6.8	1.8		0.45	2690	C	1.3	170		0.11	0.01	U	0.01	0.45	U	0.45
Duplicate of J13VJ3	J13VJ4	12/05/06	10600		6.9	1.8		0.45	3020	C	1.3	187		0.11	0.02	U	0.02	0.45	U	0.45
Test pit 1 soil	J13VH9	12/05/06	10300		6.9	2.0		0.45	2830	C	1.3	195		0.11	0.02	U	0.02	0.45	U	0.45
Test pit 3 soil	J13VJ6	12/05/06	10800		7.0	2.1		0.46	3000	C	1.3	184		0.11	0.01	U	0.01	0.46	U	0.46
Equipment Blank	J13J52	12/05/06	138		2.2	0.22		0.15	11.9	C	0.42	4.4		0.04	0.02	U	0.02	0.15	U	0.15
Test pit 4 soil	J13VJ1	12/05/06	14500		7.0	5.5		0.46	3360	C	1.3	258		0.11	0.02	U	0.02	0.46	U	0.46
Test pit 5 soil	J13VJ2	12/05/06	18900		7.3	4.5		0.48	3640	C	1.4	356		0.12	0.02	U	0.02	0.48	U	0.48
Test pit 3 pipe	J13VJ5	12/05/06	15500		7.5	4.0		0.49	3280	C	1.4	309		0.12	0.05		0.02	0.49	U	0.49

Attachment	1	Sheet No.	3 of 5
Originator	K. A. Anselm	Date	04/17/07
Checked	J. M. Capron	Date	
Calc. No.	0100F-CA-V0276	Rev. No.	0

Attachment 1. 100-F-36 Sampling Results.

Sample Location	Sample Number	Sample Date	Nickel			Potassium			Selenium			Silicon			Silver			Sodium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
Test pit 2 soil	J13VJ3	12/05/06	7.9		0.61	393		5.9	1.2	U	1.2	328	J	1.8	0.14	U	0.14	95.4	C	0.70
Duplicate of J13VJ3	J13VJ4	12/05/06	8.1		0.62	429		6.0	1.2	U	1.2	349	J	1.8	0.14	U	0.14	104	C	0.71
Test pit 1 soil	J13VH9	12/05/06	7.5		0.62	466		6.0	1.2	U	1.2	404	J	1.8	0.14	U	0.14	133	C	0.70
Test pit 3 soil	J13VJ6	12/05/06	7.7		0.63	409		6.0	1.2	U	1.2	259	J	1.8	0.14	U	0.14	95.2	C	0.71
Equipment Blank	J13J52	12/05/06	0.20	U	0.20	24.3		1.9	0.39	U	0.39	44.3	J	0.59	0.05	U	0.05	7.7	UCJ	0.23
Test pit 4 soil	J13VJ1	12/05/06	9.0		0.63	894		6.1	1.2	U	1.2	289	J	1.8	0.14	U	0.14	107	C	0.72
Test pit 5 soil	J13VJ2	12/05/06	8.1		0.66	1230		6.4	1.3	U	1.3	423	J	1.9	0.15	U	0.15	108	C	0.75
Test pit 3 pipe	J13VJ5	12/05/06	8.4		0.68	1120		6.5	1.3	U	1.3	474	J	2.0	0.15	U	0.15	190	C	0.77

Sample Location	Sample Number	Sample Date	Vanadium			Zinc		
			mg/kg	Q	PQL	mg/kg	Q	PQL
Test pit 2 soil	J13VJ3	12/05/06	22.2		0.17	21.7	C	0.11
Duplicate of J13VJ3	J13VJ4	12/05/06	27.7		0.17	23.9	C	0.11
Test pit 1 soil	J13VH9	12/05/06	24.8		0.17	25.3	C	0.11
Test pit 3 soil	J13VJ6	12/05/06	27.6		0.17	24.0	C	0.11
Equipment Blank	J13J52	12/05/06	0.06	U	0.06	0.67	UCJ	0.04
Test pit 4 soil	J13VJ1	12/05/06	32.7		0.17	37.1	C	0.11
Test pit 5 soil	J13VJ2	12/05/06	44.8		0.18	41.0	C	0.12
Test pit 3 pipe	J13VJ5	12/05/06	33.3		0.18	33.6	C	0.12

Sample Location	Sample Number	Sample Date	Asbestos
Test pit 2 soil	J13J48	12/05/06	None detected
Duplicate of J13VJ3	J13J49	12/05/06	None detected
Test pit 1 soil	J13J44	12/05/06	None detected
Test pit 3 soil	J13J51	12/05/06	None detected
Test pit 4 soil	J13J46	12/05/06	None detected
Test pit 5 soil	J13J47	12/05/06	None detected
Test pit 3 pipe	J13J50	12/05/06	None detected

Attachment	1	Sheet No.	4 of 5
Originator	K. A. Anselm	Date	04/17/07
Checked	J. M. Capron	Date	
Calc. No.	0100F-CA-V0276	Rev. No.	0

Attachment 1. 100-F-36 Sampling Results.

Constituent	J13VJ3 Test pit 2 soil Sample Date 12/05/06			J13VJ4 Duplicate of J13VJ3 Sample Date 12/05/06			J13VH9 Test pit 1 soil Sample Date 12/05/06			J13VJ6 Test pit 3 soil Sample Date 12/05/06			J13VJ1 Test pit 4 soil Sample Date 12/05/06			J13VJ2 Test pit 5 soil Sample Date 12/05/06			J13VJ5 Test pit 3 pipe Sample Date 12/05/06		
	µg/kg	Q	PQL	µg/kg	Q	PQL	µg/kg	Q	PQL	µg/kg	Q	PQL	µg/kg	Q	PQL	µg/kg	Q	PQL	µg/kg	Q	PQL
Polychlorinated biphenyls																					
Aroclor-1016	14	UJ	14	14	UJ	14	14	UJ	14	14	UJ	14	14	UJ	14	14	UJ	14	15	UJ	15
Aroclor-1221	14	UJ	14	14	UJ	14	14	UJ	14	14	UJ	14	14	UJ	14	14	UJ	14	15	UJ	15
Aroclor-1232	14	UJ	14	14	UJ	14	14	UJ	14	14	UJ	14	14	UJ	14	14	UJ	14	15	UJ	15
Aroclor-1242	14	UJ	14	14	UJ	14	14	UJ	14	14	UJ	14	14	UJ	14	14	UJ	14	15	UJ	15
Aroclor-1248	14	UJ	14	14	UJ	14	14	UJ	14	14	UJ	14	14	UJ	14	14	UJ	14	15	UJ	15
Aroclor-1254	14	UJ	14	14	UJ	14	14	UJ	14	14	UJ	14	14	UJ	14	14	UJ	14	15	UJ	15
Aroclor-1260	14	UJ	14	14	UJ	14	14	UJ	14	14	UJ	14	14	UJ	14	14	UJ	14	15	UJ	15

Attachment	1	Sheet No.	5 of 5
Originator	K. A. Anselm	Date	04/17/07
Checked	J. M. Capron	Date	
Calc. No.	0100F-CA-V0276	Rev. No.	0

CALCULATION COVER SHEET

Project Title:	Field Remediation	**Job No.**	14655
Area	100-F		
Discipline	Environmental	***Calc. No.**	0100F-CA-V0277
Subject	116-F-15 Cleanup Verification 95% UCL Calculations		
Computer Program	Excel	**Program No.**	Excel 2003

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

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

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover = 1 Sheets = 13 Attm. 1 = 6 Total = 20	K.A. Anselm 4/16/07 K. A. Anselm	J.M. Capron 4/23/07 J. M. Capron	L.M. Blakely 4/24/07 T. M. Blakely	S.W. Callison 4-24-07 S. W. Callison	4-24-07

SUMMARY OF REVISIONS

WCH-DE-018 (09/01/2006) * Obtain Calc. No. from Document Control and Form from Intranet

CALCULATION SHEET

Washington Closure Hanford

Originator K. A. Anselm KAA **Date** 04/16/07 **Calc. No.** 0100F-CA-V0277 **Rev. No.** 0
Project Field Remediation **Job No.** 14655 **Checked** J. M. Capron JMC **Date** 4/23/07
Subject 116-F-15 Cleanup Verification 95% UCL Calculations **Sheet No.** 1 of 13

Summary

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

Table of Contents:

Given/References:

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

Solution:
Calculation methodology is described in Ecology publication #92-54 (Ecology 1992, 1993), below, and in the RDR/RAWP (DOE-RL 2005b). Use data from attached worksheets to perform the 95% UCL calculation for each COPC, the WAC 173-340-740(7)(e) 3-part test for nonradionuclides, and the RPD calculations for primary-duplicate sample pairs, as required. The hazard quotient and carcinogenic risk calculations are located in a separate calculation brief and are included as an appendix to the remaining sites verification package (RSVP).

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

CALCULATION SHEET

Washington Closure Hanford

Originator K. A. Anselm KAA **Date** 04/16/07 **Calc. No.** 0100F-CA-V0277 **Rev. No.** 0
Project Field Remediation **Job No.** 14655 **Checked** J. M. Capron JMC **Date** 4/23/07
Subject 116-F-15 Cleanup Verification 95% UCL Calculations **Sheet No.** 2 of 13

Summary (continued)

Methodology:

For nonradioactive analytes with ≤50% of the data below detection limits and all detected radionuclide analytes, the statistical value calculated to evaluate the effectiveness of cleanup is the 95% UCL. For nonradioactive analytes with >50% of the data below detection limits, as determined by direct inspection of the sample results (Attachment 1), the maximum detected value for the data set is used instead of the 95% UCL, and no further calculations are performed for those data sets. The 95% UCL is also not calculated for data sets with no reported detections. Calculated cleanup levels are not available in Ecology (2005) under WAC 173-340-740(3) for aluminum, calcium, iron, magnesium, potassium, silicon, and sodium; therefore, these constituents are not considered site COPCs and are also not included in these tables. Potassium-40, radium-226, radium-228, thorium-228, and thorium-232 were detected in samples collected at these sites, but are excluded from these tables because these isotopes are not related to the operational history of the site.

All nonradionuclide data reported as being undetected are set to ½ the detection limit value for calculation of the statistics (Ecology 1993). For radionuclide data, calculation of the statistics is done using the reported value. In cases where the laboratory does not report a value below the minimum detectable activity (MDA), half of the MDA is used in the calculation. For the statistical evaluation of duplicate sample pairs, the samples are averaged before being included in the data set, after adjustments for censored data as described above.

For nonradionuclides, the WAC 173-340 statistical guidance suggests that a test for distributional form be performed on the data and the 95% UCL calculated on the appropriate distribution using Ecology software. For nonradionuclide small data sets ($n < 10$) and all radionuclide data sets, the calculations are performed assuming nonparametric distribution, so no tests for distribution are performed. For nonradionuclide data sets of ten or greater, as for the subject site, distributional testing and calculation of the 95% UCL is done using Ecology's MTCAStat software (Ecology 1993). Due to differences in addressing censored data between the RDR/RAWP (DOE-RL 2005b) and MTCAStat coding and due to a limitation in the MTCAStat coding (no direct capability to address variable quantitation limits within a data set), substitutions for censored data are performed before software input and the resulting input set treated as uncensored.

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

The WAC 173-340-740(7)(e) 3-part test is not performed for COPCs where the statistical value defaults to the maximum value in the data set. Instead, direct comparison of the maximum value against site remedial action goals (RAGs) (within the RSVP) is used as the compliance basis.

The RPD values are evaluated for analytes detected in a primary-duplicate or primary-split sample pair for the purposes of data quality assessment within the RSVP (where direct evaluation of the attached data showed that a given analyte was undetected in both the primary and duplicate sample, no further calculations were performed). The RPD is calculated when both the primary value and the duplicate value for a given analyte are above detection limits and are greater than 5 times the target detection limit (TDL). The TDL is a laboratory detection limit pre-determined for each analytical method and is listed in Table II-1 of the SAP (DOE-RL 2005a). The RPD calculations use the following formula:

$$RPD = [\,|M-S|/((M+S)/2)]*100$$

where, M = main sample value S = split (or duplicate) sample value

When an analyte is detected in the primary or duplicate sample, but was quantified at less than 5 times the TDL in one or both samples, an additional parameter is evaluated. In this case, if the difference between the primary and duplicate results

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Subject 116-F-15 Cleanup Verification 95% UCL Calculations **Sheet No.** 3 of 13

Summary (continued)

Methodology (continued):
exceeds a control limit of 2 times the TDL, further assessment regarding the usability of the data is performed. This assessment is provided in the data quality assessment section of the RSVP.

For quality assurance/quality control (QA/QC) split and duplicate RPD calculations, a value less than 30% indicates the data compare favorably. For regulatory splits, a threshold of 35% is used (EPA 1994). If the RPD is greater than 30% (or 35% for regulatory split data), further investigation regarding the usability of the data is performed. No split samples were collected for cleanup verification of the subject site. Additional discussion is provided in the data quality assessment section of the applicable RSVP, as necessary.

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

Results Summary[a]

Analyte	95% UCL[b]	Maximum Value[c]	Units
Cesium-137	0.100		pCi/g
Europium-152	0.06		pCi/g
Uranium-233/234	0 (< BG)		pCi/g
Uranium-238	0 (< BG)		pCi/g
Arsenic	2.7		mg/kg
Barium	74.0		mg/kg
Beryllium	0.13		mg/kg
Boron	4.4		mg/kg
Cadmium		0.11	mg/kg
Chromium	13		mg/kg
Cobalt	5.5		mg/kg
Copper	14.0		mg/kg
Hexavalent chromium	0.6		mg/kg
Lead	9.8		mg/kg
Manganese	244		mg/kg
Mercury		0.19	mg/kg
Molybdenum	0.66		mg/kg
Nickel	11		mg/kg
Vanadium	38.3		mg/kg
Zinc	38.5		mg/kg
Aroclor-1254	0.014		mg/kg
Aroclor-1260		0.027	mg/kg

[a]No detections were reported in any data set for COPCs not listed in this table.
[b]For nonradionuclides, where ≤ 50% of a data set is below detection limits, the 95% UCL value is used for a given analyte.
[c]For nonradionuclides, where > 50% of a data set is below detection limits, the statistical value defaults to the maximum detected value in the data set (Attachment 1).

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Summary (continued)

WAC 173-340 3-Part Test for most stringent RAG:

95% UCL > Cleanup Limit?	NO
> 10% above Cleanup Limit?	YES
Any sample > 2x Cleanup Limit?	YES

Because of the "yes" answers to the WAC 173-340 3-part test for lead and aroclor-1254, additional evaluation of the attainment of cleanup criteria will be performed and included in the RSVP.

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

Analyte	Duplicate Analysis[b]
Potassium-40	131%
Aluminum	18%
Barium	83%
Calcium	37%
Chromium	2.6%
Copper	15%
Iron	5.2%
Magnesium	10%
Manganese	2.0%
Silicon	48%
Vanadium	3.4%
Zinc	2.9%

[a]Relative percent difference evaluation was not required for analytes not included in this table.

[b]The significance of relative percent difference values is discussed within the RSVP for this site.

Abbreviations/Acronyms:

The following abbreviations and/or acronyms are used in this calcuation:

BG = background
C = method blank contamination (inorganic constituents)
COPC = contaminant of potential concern
GEA = gamma energy analysis
GW = groundwater
J = estimate
MDA = minimum detectable activity
MTCA = *Model Toxics Control Act*
NA = not applicable
PQL = practical quantitation limit
Q = qualifier
QA/QC = quality assurance/quality control
RAG = remedial action goal
RDL = required detection limit
RDR/RAWP = remedial design report/remedial action work plan
RESRAD = RESidual RADioactivity (dose model)
RPD = relative percent difference
RSVP = remaining sites verification package
SAP = sampling and analysis plan
TDL = target detection limit
U = undetected
UCL = upper confidence limit
WAC = *Washington Administrative Code*

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Originator K. A. Anselm KAA Date 04/16/07
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Sampling Data

Sample Location	Sample Number	Sample Date	Cesium-137			Europium-152			Uranium-233/234			Uranium-238			Arsenic			Barium			Beryllium			Boron		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
S-1	J13W02	12/12/06	0.056		0.035	0.070		0.067	0.452		0.19	0.251		0.19	1.8		0.96	190	CJ	0.03	0.27		0.03	19.6	CJ	0.59
Duplicate of J13W02	J13W03	12/12/06	0.316		0.057	0.20	U	0.20	0.436		0.15	0.594		0.15	2.0		0.95	78.1	CJ	0.03	0.17		0.03	4.0	CJ	0.58
S-2	J13W04	12/12/06	0.055	U	0.055	0.16	U	0.16	0.273		0.21	0.491		0.21	2.4		0.96	48.3	CJ	0.03	0.13		0.03	0.76	UCJ	0.59
S-3	J13W05	12/12/06	0.038	U	0.038	0.080	U	0.080	0.664		0.16	0.428		0.16	2.1		0.93	44.5	CJ	0.03	0.09		0.03	0.57	UCJ	0.57
S-4	J13W06	12/12/06	0.117		0.028	0.062	U	0.062	0.640		0.20	0.563		0.20	4.4		0.93	55.1	CJ	0.03	0.12		0.03	2.9	CJ	0.57
S-5	J13W07	12/12/06	0.027		0.027	0.075	U	0.075	0.531		0.14	0.601		0.14	2.8		0.92	38.3	CJ	0.03	0.09		0.03	1.4	CJ	0.56
S-6	J13W08	12/12/06	0.115		0.065	0.16	U	0.16	0.568		0.14	0.461		0.14	1.4		0.93	42.1	CJ	0.03	0.07		0.03	0.66	UCJ	0.57
S-7	J13W09	12/12/06	0.037	U	0.037	0.084	U	0.084	0.516		0.14	0.516		0.14	1.9		0.94	38.1	CJ	0.03	0.07		0.03	0.58	UCJ	0.58
S-8	J13W10	12/12/06	0.056		0.031	0.069	U	0.069	0.733		0.16	0.625		0.16	1.9		0.93	63.6	CJ	0.03	0.10		0.03	2.4	CJ	0.57
S-9	J13W11	12/12/06	0.028	U	0.028	0.065	U	0.065	0.407		0.17	0.362		0.17	1.9		0.92	51.5	CJ	0.03	0.07		0.03	2.1	CJ	0.56
S-10	J13W12	12/12/06	0.108		0.041	0.096	U	0.096	0.386		0.21	0.551		0.21	2.3		0.95	74.9	CJ	0.03	0.09		0.03	3.9	CJ	0.58

Statistical Computation Input Data

Sample Location	Sample Number	Sample Date	Cesium-137 pCi/g	Europium-152 pCi/g	Uranium-233/234 pCi/g	Uranium-238 pCi/g	Arsenic mg/kg	Barium mg/kg	Beryllium mg/kg	Boron mg/kg
S-1	J13W02/ J13W03	12/12/06	0.186	0.09	0.444	0.423	1.9	134	0.22	12
S-2	J13W04	12/12/06	0.028	0.08	0.273	0.491	2.4	48.3	0.13	0.30
S-3	J13W05	12/12/06	0.019	0.040	0.664	0.428	2.1	44.5	0.09	0.29
S-4	J13W06	12/12/06	0.117	0.031	0.640	0.563	4.4	55.1	0.12	2.9
S-5	J13W07	12/12/06	0.027	0.038	0.531	0.601	2.8	38.3	0.09	1.4
S-6	J13W08	12/12/06	0.115	0.08	0.568	0.461	1.4	42.1	0.07	0.29
S-7	J13W09	12/12/06	0.019	0.042	0.516	0.516	1.9	38.1	0.07	0.29
S-8	J13W10	12/12/06	0.056	0.035	0.733	0.625	1.9	63.6	0.10	2.4
S-9	J13W11	12/12/06	0.014	0.033	0.407	0.362	1.9	51.5	0.07	2.1
S-10	J13W12	12/12/06	0.108	0.048	0.386	0.551	2.3	74.9	0.09	3.9

Statistical Computations

	Cesium-137	Europium-152	Uranium-233/234	Uranium-238	Arsenic	Barium	Beryllium	Boron
95% UCL value based on	Radionuclide data set. Use nonparametric z-statistic.	Radionuclide data set. Use nonparametric z-statistic.	Radionuclide data set. Use nonparametric z-statistic.	Radionuclide data set. Use nonparametric z-statistic.	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.
N	10	10	10	10	10	10	10	10
% < Detection limit	40%	90%	0%	0%	0%	0%	0%	40%
Mean	0.069	0.05	0.516	0.502	2.3	59.0	0.11	2.6
Standard deviation	0.059	0.02	0.142	0.085	0.83	28.8	0.05	3.5
95% UCL on mean	0.100	0.06	0.590	0.546	2.7	74.0	0.13	4.4
Maximum detected value	0.316	0.070	0.733	0.625	4.4	190	0.27	19.6
Background	NA	NA	1.1	1.1	6.5	132	1.51	NA
Statistical value above background*	0.100	0.06	0 (< BG)	0 (< BG)	2.7	74.0	0.13	4.4
Most Stringent Cleanup Limit for nonradionuclide and RAG type					20 Direct Exposure/GW & River Protection	132 BG/GW Protection	1.51 BG/GW & River Protection	320 GW Protection
WAC 173-340 3-PART TEST								
95% UCL > Cleanup Limit?					NA	NO	NA	NO
> 10% above Cleanup Limit?					NA	NO	NA	NO
Any sample > 2X Cleanup Limit?					NA	NO	NA	NO
WAC 173-340 Compliance? See next page					Because all values are below background (6.5 mg/kg), the WAC 173-340 3-part test is not required.	The data set meets the 3-part test criteria when compared to the most stringent cleanup limit.	Because all values are below background (1.51 mg/kg), the WAC 173-340 3-part test is not required.	The data set meets the 3-part test criteria when compared to the most stringent cleanup limit.

* Background is not subtracted for nonradionuclides; consideration of background is provided for comparison purposes.

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Originator K. A. Anselm KAA **Date** 04/16/07
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Sampling Data (cont.)

Sample Location	Sample Number	Sample Date	Chromium mg/kg	Q	PQL	Cobalt mg/kg	Q	PQL	Copper mg/kg	Q	PQL	Hexavalent Chromium mg/kg	Q	PQL	Lead mg/kg	Q	PQL	Manganese mg/kg	Q	PQL	Molybdenum mg/kg	Q	PQL	Nickel mg/kg	Q	PQL
S-1	J13W02	12/12/06	7.6		0.37	5.9		0.15	15.4		0.22	0.22	U	0.22	4.7		0.49	251		0.12	0.97		0.49	10.0		0.68
Duplicate of J13W02	J13W03	12/12/06	7.8		0.37	5.7		0.15	13.3		0.22	0.28		0.22	4.8		0.49	256		0.12	0.75		0.49	9.2		0.68
S-2	J13W04	12/12/06	21.3		0.37	5.5		0.15	15.0		0.22	1.7		0.22	26.0		0.49	246		0.12	0.75		0.49	10.1		0.68
S-3	J13W05	12/12/06	9.8		0.36	5.1		0.15	13.7		0.21	0.24		0.22	2.7		0.48	222		0.12	0.51		0.48	11.1		0.66
S-4	J13W06	12/12/06	9.5		0.36	5.4		0.15	12.9		0.21	0.26		0.22	4.5		0.48	237		0.12	0.48	U	0.48	9.7		0.66
S-5	J13W07	12/12/06	13.0		0.36	5.4		0.15	13.0		0.21	0.21	U	0.21	5.4		0.48	229		0.12	0.48	U	0.48	10.6		0.65
S-6	J13W08	12/12/06	9.0		0.36	5.0		0.15	11.6		0.21	0.21	U	0.21	2.8		0.48	221		0.12	0.48	U	0.48	9.5		0.66
S-7	J13W09	12/12/06	8.7		0.36	4.8		0.15	12.8		0.21	0.22	U	0.22	2.7		0.48	217		0.12	0.66		0.48	9.7		0.67
S-8	J13W10	12/12/06	11.6		0.36	5.4		0.15	14.1		0.21	0.23		0.22	4.7		0.48	250		0.12	0.52		0.48	10.8		0.66
S-9	J13W11	12/12/06	8.1		0.36	5.0		0.15	11.8		0.21	0.21	U	0.21	3.2		0.48	217		0.12	0.71		0.48	9.2		0.65
S-10	J13W12	12/12/06	10.8		0.37	5.9		0.15	13.8		0.21	0.26		0.22	4.7		0.49	257		0.12	0.55		0.49	10.8		0.67

Statistical Computation Input Data

Sample Location	Sample Number	Sample Date	Chromium mg/kg			Cobalt mg/kg			Copper mg/kg			Hexavalent Chromium mg/kg			Lead mg/kg			Manganese mg/kg			Molybdenum mg/kg			Nickel mg/kg		
S-1	J13W02/ J13W03	12/12/06	7.7			5.8			14.4			0.20			4.8			254			0.86			9.6		
S-2	J13W04	12/12/06	21.3			5.5			15.0			1.7			26.0			246			0.75			10.1		
S-3	J13W05	12/12/06	9.8			5.1			13.7			0.24			2.7			222			0.51			11.1		
S-4	J13W06	12/12/06	9.5			5.4			12.9			0.26			4.5			237			0.24			9.7		
S-5	J13W07	12/12/06	13.0			5.4			13.0			0.11			5.4			229			0.24			10.6		
S-6	J13W08	12/12/06	9.0			5.0			11.6			0.11			2.8			221			0.24			9.5		
S-7	J13W09	12/12/06	8.7			4.8			12.8			0.11			2.7			217			0.66			9.7		
S-8	J13W10	12/12/06	11.6			5.4			14.1			0.23			4.7			250			0.52			10.8		
S-9	J13W11	12/12/06	8.1			5.0			11.8			0.11			3.2			217			0.71			9.2		
S-10	J13W12	12/12/06	10.8			5.9			13.8			0.26			4.7			257			0.55			10.8		

Statistical Computations

	Chromium	Cobalt	Copper	Hexavalent Chromium	Lead	Manganese	Molybdenum	Nickel
95% UCL value based on	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat normal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.
N	10	10	10	10	10	10	10	10
% < Detection limit	0%	0%	0%	40%	0%	0%	30%	0%
Mean	11.0	5.3	13.3	0.3	6.1	235	0.53	10.1
Standard deviation	4.0	0.36	1.09	0.49	7.0	15.7	0.23	0.66
95% UCL on mean	13	5.5	14.0	0.58	9.8	244	0.66	11
Maximum detected value	21.3	5.9	15.4	1.7	26.0	257	0.97	11.1
Statistical value	13	5.5	14.0	0.6	9.8	244	0.66	11
Most Stringent Cleanup Limit for nonradionuclide and RAG type	18.5 BG/GW & River Protection	32 GW Protection	22 BG/River Protection	2 River Protection	10.2 BG/GW & River Protection	512 BG/GW Protection	8 GW Protection	19.1 BG/GW Protection
WAC 173-340 3-PART TEST								
95% UCL > Cleanup Limit?	NO	NA	NA	NO	NO	NA	NO	NA
> 10% above Cleanup Limit?	NO	NA	NA	NO	NO	NA	NO	NA
Any sample > 2X Cleanup Limit?	NO	NA	NA	NO	YES	NA	NO	NA
WAC 173-340 Compliance? Further assessment required	The data set meets the 3-part test criteria when compared to the most stringent cleanup limit.	Because all values are below background (15.7 mg/kg), the WAC 173-340 3-part test is not required.	Because all values are below background (22 mg/kg), the WAC 173-340 3-part test is not required.	The data set meets the 3-part test criteria when compared to the most stringent cleanup limit.	Because of the "yes" answer to the 3-part test, a detailed assessment using RESRAD will be performed. The data set meets the 3-part test criteria when compared to the direct exposure cleanup level.	Because all values are below background (512 mg/kg), the WAC 173-340 3-part test is not required.	The data set meets the 3-part test criteria when compared to the most stringent cleanup limit.	Because all values are below background (19.1 mg/kg), the WAC 173-340 3-part test is not required.

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Sampling Data (cont.)

Sample Location	Sample Number	Sample Date	Vanadium mg/kg	Q	PQL	Zinc mg/kg	Q	PQL	Aroclor-1254 mg/kg	Q	PQL
S-1	J13W02	12/12/06	38.4		0.19	35.0	C	0.12	0.015	U	0.015
Duplicate of J13W02	J13W03	12/12/06	37.1		0.18	34.0	C	0.12	0.015	U	0.015
S-2	J13W04	12/12/06	38.3		0.19	43.0	C	0.12	0.0046	J	0.015
S-3	J13W05	12/12/06	35.5		0.18	30.6	C	0.12	0.019		0.014
S-4	J13W06	12/12/06	37.3		0.18	38.8	C	0.12	0.014	U	0.014
S-5	J13W07	12/12/06	35.6		0.18	35.0	C	0.12	0.014	U	0.014
S-6	J13W08	12/12/06	35.9		0.18	29.9	C	0.12	0.014	U	0.014
S-7	J13W09	12/12/06	33.6		0.18	30.4	C	0.12	0.0058	J	0.014
S-8	J13W10	12/12/06	39.2		0.18	41.7	C	0.12	0.025		0.014
S-9	J13W11	12/12/06	35.4		0.18	29.3	C	0.12	0.014	U	0.014
S-10	J13W12	12/12/06	41.0		0.18	43.0	C	0.12	0.013	J	0.015

Statistical Computation Input Data

Sample Location	Sample Number	Sample Date	Vanadium mg/kg			Zinc mg/kg			Aroclor-1254 mg/kg		
S-1	J13W02/ J13W03	12/12/06	37.8			34.5			0.008		
S-2	J13W04	12/12/06	38.3			43.0			0.005		
S-3	J13W05	12/12/06	35.5			30.6			0.019		
S-4	J13W06	12/12/06	37.3			38.8			0.007		
S-5	J13W07	12/12/06	35.6			35.0			0.007		
S-6	J13W08	12/12/06	35.9			29.9			0.007		
S-7	J13W09	12/12/06	33.6			30.4			0.0058		
S-8	J13W10	12/12/06	39.2			41.7			0.025		
S-9	J13W11	12/12/06	35.4			29.3			0.007		
S-10	J13W12	12/12/06	41.0			43.0			0.013		

Statistical Computations

	Vanadium			Zinc			Aroclor-1254		
95% UCL value based on	Large data set (n ≥ 10), use MTCAStat lognormal distribution.			Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.			Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.		
N	10			10			10		
% < Detection limit	0%			0%			50%		
Mean	37.0			35.6			0.010		
Standard deviation	2.18			5.61			0.007		
95% UCL on mean	38.3			38.5			0.014		
Maximum detected value	41.0			43.0			0.025		
Statistical value	38.3			38.5			0.014		
Most Stringent Cleanup Limit for nonradionuclide and RAG type	85.1		BG/GW Protection	67.8		BG/River Protection	0.017		RDL/GW & River Protection
WAC 173-340 3-PART TEST									
95% UCL > Cleanup Limit?	NA			NA			NO		
> 10% above Cleanup Limit?	NA			NA			YES		
Any sample > 2X Cleanup Limit?	NA			NA			NO		
WAC 173-340 Compliance? **Further assessment required**	Because all values are below background (85.1 mg/kg), the WAC 173-340 3-part test is not required.			Because all values are below background (67.8 mg/kg), the WAC 173-340 3-part test is not required.			Because of the "yes" answer to the 3-part test, a detailed assessment using RESRAD will be performed. The data set meets the 3-part test criteria when compared to the direct exposure cleanup level.		

CALCULATION SHEET

Washington Closure Hanford
Originator K. A. Anselm kaa
Project Field Remediation
Subject 116-F-15 Cleanup Verification 95% UCL Calculations

Date 04/16/07
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Checked J. M. Capron JMC

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Ecology Software (MTCAStat) Results

Arsenic 95% UCL Calculation

DATA	ID
1.9	J13W02/J13W03
2.4	J13W04
2.1	J13W05
4.4	J13W06
2.8	J13W07
1.4	J13W08
1.9	J13W09
1.9	J13W10
1.9	J13W11
2.3	J13W12

Number of samples		Uncensored values	
Uncensored	10	Mean	2.3
Censored		Lognormal mean	2.3
Detection limit or PQL		Std. devn.	0.8
Method detection limit		Median	2.0
TOTAL	10	Min.	1.4
		Max.	4.4

Lognormal distribution? Normal distribution?
r-squared is: 0.86 r-squared is: 0.74
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 2.7

Barium 95% UCL Calculation

DATA	ID
134	J13W02/J13W03
48.3	J13W04
44.5	J13W05
55.1	J13W06
38.3	J13W07
42.1	J13W08
38.1	J13W09
63.6	J13W10
51.5	J13W11
74.9	J13W12

Number of samples		Uncensored values	
Uncensored	10	Mean	59.0
Censored		Lognormal mean	58.8
Detection limit or PQL		Std. devn.	28.8
Method detection limit		Median	49.9
TOTAL	10	Min.	38.1
		Max.	134

Lognormal distribution? Normal distribution?
r-squared is: 0.85 r-squared is: 0.70
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 74.0

Beryllium 95% UCL Calculation

DATA	ID
0.22	J13W02/J13W03
0.13	J13W04
0.09	J13W05
0.12	J13W06
0.09	J13W07
0.07	J13W08
0.07	J13W09
0.10	J13W10
0.07	J13W11
0.09	J13W12

Number of samples		Uncensored values	
Uncensored	10	Mean	0.11
Censored		Lognormal mean	0.10
Detection limit or PQL		Std. devn.	0.05
Method detection limit		Median	0.09
TOTAL	10	Min.	0.07
		Max.	0.22

Lognormal distribution? Normal distribution?
r-squared is: 0.86 r-squared is: 0.74
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 0.13

Boron 95% UCL Calculation

DATA	ID
12	J13W02/J13W03
0.30	J13W04
0.29	J13W05
2.9	J13W06
1.4	J13W07
0.29	J13W08
0.29	J13W09
2.4	J13W10
2.1	J13W11
3.9	J13W12

Number of samples		Uncensored values	
Uncensored	10	Mean	2.6
Censored		Lognormal mean	3.0
Detection limit or PQL		Std. devn.	3.5
Method detection limit		Median	1.8
TOTAL	10	Min.	0.29
		Max.	12

Lognormal distribution? Normal distribution?
r-squared is: 0.88 r-squared is: 0.66
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 4.4

CALCULATION SHEET

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Ecology Software (MTCAStat) Results

Chromium 95% UCL Calculation

DATA	ID
7.7	J13W02/J13W03
21.3	J13W04
9.8	J13W05
9.5	J13W06
13.0	J13W07
9.0	J13W08
8.7	J13W09
11.6	J13W10
8.1	J13W11
10.8	J13W12

Number of samples	
Uncensored	10
Censored	
Detection limit or PQL	
Method detection limit	
TOTAL	10

Uncensored values	
Mean	11
Lognormal mean	11
Std. devn.	4.0
Median	9.7
Min.	7.7
Max.	21.3

Lognormal distribution? Normal distribution?
r-squared is: 0.84 r-squared is: 0.72
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 13

Cobalt 95% UCL Calculation

DATA	ID
5.8	J13W02/J13W03
5.5	J13W04
5.1	J13W05
5.4	J13W06
5.4	J13W07
5.0	J13W08
4.8	J13W09
5.4	J13W10
5.0	J13W11
5.9	J13W12

Number of samples	
Uncensored	10
Censored	
Detection limit or PQL	
Method detection limit	
TOTAL	10

Uncensored values	
Mean	5.3
Lognormal mean	5.3
Std. devn.	0.4
Median	5.4
Min.	4.8
Max.	5.9

Lognormal distribution? Normal distribution?
r-squared is: 0.96 r-squared is: 0.95
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 5.5

Copper 95% UCL Calculation

DATA	ID
14.4	J13W02/J13W03
15.0	J13W04
13.7	J13W05
12.9	J13W06
13.0	J13W07
11.6	J13W08
12.8	J13W09
14.1	J13W10
11.8	J13W11
13.8	J13W12

Number of samples	
Uncensored	10
Censored	
Detection limit or PQL	
Method detection limit	
TOTAL	10

Uncensored values	
Mean	13.3
Lognormal mean	13.3
Std. devn.	1.1
Median	13.4
Min.	11.6
Max.	15.0

Lognormal distribution? Normal distribution?
r-squared is: 0.964 r-squared is: 0.971
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 14.0

Hexavalent Chromium 95% UCL Calculation

DATA	ID
0.20	J13W02/J13W03
1.7	J13W04
0.24	J13W05
0.26	J13W06
0.11	J13W07
0.11	J13W08
0.11	J13W09
0.23	J13W10
0.11	J13W11
0.26	J13W12

Number of samples	
Uncensored	10
Censored	
Detection limit or PQL	
Method detection limit	
TOTAL	10

Uncensored values	
Mean	0.33
Lognormal mean	0.30
Std. devn.	0.49
Median	0.21
Min.	0.11
Max.	1.7

Lognormal distribution? Normal distribution?
r-squared is: 0.74 r-squared is: 0.46
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 0.58

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Ecology Software (MTCAStat) Results

Lead 95% UCL Calculation

DATA	ID
4.8	J13W02/J13W03
26.0	J13W04
2.7	J13W05
4.5	J13W06
5.4	J13W07
2.8	J13W08
2.7	J13W09
4.7	J13W10
3.2	J13W11
4.7	J13W12

Number of samples	
Uncensored	10
Censored	
Detection limit or PQL	
Method detection limit	
TOTAL	10

Uncensored values	
Mean	6.1
Lognormal mean	5.7
Std. devn.	7.0
Median	4.6
Min.	2.7
Max.	26.0

Lognormal distribution? r-squared is: 0.70
Normal distribution? r-squared is: 0.46
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 9.8

Manganese 95% UCL Calculation

DATA	ID
254	J13W02/J13W03
246	J13W04
222	J13W05
237	J13W06
229	J13W07
221	J13W08
217	J13W09
250	J13W10
217	J13W11
257	J13W12

Number of samples	
Uncensored	10
Censored	
Detection limit or PQL	
Method detection limit	
TOTAL	10

Uncensored values	
Mean	235
Lognormal mean	235
Std. devn.	15.7
Median	233
Min.	217
Max.	257

Lognormal distribution? r-squared is: 0.917
Normal distribution? r-squared is: 0.916
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 244

Molybdenum 95% UCL Calculation

DATA	ID
0.86	J13W02/J13W03
0.75	J13W04
0.51	J13W05
0.24	J13W06
0.24	J13W07
0.24	J13W08
0.66	J13W09
0.52	J13W10
0.71	J13W11
0.55	J13W12

Number of samples	
Uncensored	10
Censored	
Detection limit or PQL	
Method detection limit	
TOTAL	10

Uncensored values	
Mean	0.53
Lognormal mean	0.54
Std. devn.	0.23
Median	0.54
Min.	0.24
Max.	0.86

Lognormal distribution? r-squared is: 0.86
Normal distribution? r-squared is: 0.92
Recommendations:
Use normal distribution.

UCL (based on t-statistic) is 0.66

Nickel 95% UCL Calculation

DATA	ID
9.6	J13W02/J13W03
10.1	J13W04
11.1	J13W05
9.7	J13W06
10.6	J13W07
9.5	J13W08
9.7	J13W09
10.8	J13W10
9.2	J13W11
10.8	J13W12

Number of samples	
Uncensored	10
Censored	
Detection limit or PQL	
Method detection limit	
TOTAL	10

Uncensored values	
Mean	10.1
Lognormal mean	10.1
Std. devn.	0.66
Median	9.9
Min.	9.2
Max.	11.1

Lognormal distribution? r-squared is: 0.93
Normal distribution? r-squared is: 0.93
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 11

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Ecology Software (MTCAStat) Results

Vanadium 95% UCL Calculation

DATA	ID
37.8	J13W02/J13W03
38.3	J13W04
35.5	J13W05
37.3	J13W06
35.6	J13W07
35.9	J13W08
33.6	J13W09
39.2	J13W10
35.4	J13W11
41.0	J13W12

Number of samples		Uncensored values	
Uncensored	10	Mean	37.0
Censored		Lognormal mean	37.0
Detection limit or PQL		Std. devn.	2.18
Method detection limit		Median	36.6
TOTAL	10	Min.	33.6
		Max.	41.0

Lognormal distribution? — Normal distribution?

r-squared is: 0.965 — r-squared is: 0.960

Recommendations:

Use lognormal distribution.

UCL (Land's method) is 38.3

Zinc 95% UCL Calculation

DATA	ID
34.5	J13W02/J13W03
43.0	J13W04
30.6	J13W05
38.8	J13W06
35.0	J13W07
29.9	J13W08
30.4	J13W09
41.7	J13W10
29.3	J13W11
43.0	J13W12

Number of samples		Uncensored values	
Uncensored	10	Mean	35.6
Censored		Lognormal mean	35.7
Detection limit or PQL		Std. devn.	5.61
Method detection limit		Median	34.8
TOTAL	10	Min.	29.3
		Max.	43.0

Lognormal distribution? — Normal distribution?

r-squared is: 0.899 — r-squared is: 0.894

Recommendations:

Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 38.5

Aroclor-1254 95% UCL Calculation

DATA	ID
0.008	J13W02/J13W03
0.005	J13W04
0.019	J13W05
0.007	J13W06
0.007	J13W07
0.007	J13W08
0.0058	J13W09
0.025	J13W10
0.007	J13W11
0.013	J13W12

Number of samples		Uncensored values	
Uncensored	10	Mean	0.010
Censored		Lognormal mean	0.010
Detection limit or PQL		Std. devn.	0.007
Method detection limit		Median	0.007
TOTAL	10	Min.	0.0046
		Max.	0.025

Lognormal distribution? — Normal distribution?

r-squared is: 0.847 — r-squared is: 0.745

Recommendations:

Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 0.014

CALCULATION SHEET

Washington Closure Hanford
Originator K. A. Anselm jcaa
Project Field Remediation
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Duplicate Analysis

Sample Location	Sample Number	Sample Date	Cesium-137			Europium-152			Uranium-233/234			Uranium-238			Arsenic			Barium			Beryllium			Boron		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
S-1	J13W02	12/12/06	0.056		0.035	0.070		0.067	0.452		0.19	0.251		0.19	1.8		0.96	190	CJ	0.03	0.27		0.03	19.6	CJ	0.59
Duplicate of J13W02	J13W03	12/12/06	0.316		0.057	0.20	U	0.20	0.436		0.15	0.594		0.15	2.0		0.95	78.1	CJ	0.03	0.17		0.03	4.0	CJ	0.58

Analysis:

TDL		0.05	0.1	1	1	10	2	0.5	2
Duplicate Analysis	Both > MDA/PQL?	**Yes (continue)**	No - evaluate difference	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**
	Both >5xTDL?	No - evaluate difference		No - evaluate difference	No - evaluate difference	No - evaluate difference	**Yes (calc RPD)**	No - evaluate difference	No - evaluate difference
	RPD						*83%*		
	Difference >2xTDL?	Yes - assess further	No - acceptable	No - acceptable	No - acceptable	No - acceptable	Not applicable	No - acceptable	Yes - assess further

Duplicate Analysis (continued)

Sample Location	Sample Number	Sample Date	Chromium			Cobalt			Copper			Hexavalent Chromium			Lead			Manganese			Molybdenum			Nickel		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
S-1	J13W02	12/12/06	7.6		0.37	5.9		0.15	15.4		0.22	0.22	U	0.22	4.7		0.49	251		0.12	0.97		0.49	10.0		0.68
Duplicate of J13W02	J13W03	12/12/06	7.8		0.37	5.7		0.15	13.3		0.22	0.28		0.22	4.8		0.49	256		0.12	0.75		0.49	9.2		0.68

Analysis:

TDL		1	2	1	0.5	5	5	2	4
Duplicate Analysis	Both > PQL?	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	No - evaluate difference	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**
	Both >5xTDL?	**Yes (calc RPD)**	No - evaluate difference	**Yes (calc RPD)**		No - evaluate difference	**Yes (calc RPD)**	No - evaluate difference	No - evaluate difference
	RPD	2.6%		15%			2.0%		
	Difference >2xTDL?	Not applicable	No - acceptable	Not applicable	No - acceptable	No - acceptable	Not applicable	No - acceptable	No - acceptable

Duplicate Analysis (continued)

Sample Location	Sample Number	Sample Date	Vanadium			Zinc		
			mg/kg	Q	PQL	mg/kg	Q	PQL
S-1	J13W02	12/12/06	38.4		0.19	35.0	C	0.12
Duplicate of J13W02	J13W03	12/12/06	37.1		0.18	34.0	C	0.12

Analysis:

TDL		2.5	1
Duplicate Analysis	Both > PQL?	**Yes (continue)**	**Yes (continue)**
	Both >5xTDL?	**Yes (calc RPD)**	**Yes (calc RPD)**
	RPD	3.4%	2.9%
	Difference >2xTDL?	Not applicable	Not applicable

CALCULATION SHEET

Washington Closure Hanford

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Project Field Remediation
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Duplicate Analysis (continued)

Sample Location	Sample Number	Sample Date	Potassium-40			Radium-226			Radium-228			Thorium-228 GEA			Thorium-232 GEA			Aluminum			Calcium			Iron		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
S-1	J13W02	12/12/06	5.76		0.37	0.261		0.063	0.292		0.13	0.282		0.032	0.292		0.13	6220		6.5	7210	CJ	3.9	15000		7.5
Duplicate of J13W02	J13W03	12/12/06	27.4		2.3	0.996		0.12	1.32		0.27	1.60		0.10	1.32		0.27	5200		6.5	4940	CJ	3.8	15800		7.5

Analysis:

TDL		0.5	0.1	0.2	1	1	5	100	5
Duplicate Analysis	Both > MDA/PQL?	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**
	Both >5xTDL?	**Yes (calc RPD)**	No - evaluate difference	No - evaluate difference	No - evaluate difference	No - evaluate difference	**Yes (calc RPD)**	**Yes (calc RPD)**	**Yes (calc RPD)**
	RPD	*131%*					18%	*37%*	5.2%
	Difference >2xTDL?	Not applicable	Yes - assess further	Yes - assess further	No - acceptable	No - acceptable	Not applicable	Not applicable	Not applicable

Duplicate Analysis (continued)

Sample Location	Sample Number	Sample Date	Magnesium			Potassium			Silicon			Sodium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
S-1	J13W02	12/12/06	3950	C	1.4	925		6.5	907	CJ	2.0	420	C	0.77
Duplicate of J13W02	J13W03	12/12/06	3560	C	1.4	904		6.5	553	CJ	2.0	129	C	0.77

Analysis:

TDL		75	400	2	50
Duplicate Analysis	Both > PQL?	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**
	Both >5xTDL?	**Yes (calc RPD)**	No - evaluate difference	**Yes (calc RPD)**	No - evaluate difference
	RPD	10%		*48%*	
	Difference >2xTDL?	Not applicable	No - acceptable	Not applicable	Yes - assess further

Attachment 1. 116-F-15 Verification Sampling Results.

Sample Location	Sample Number	Sample Date	Americium-241 GEA			Cesium-137			Cobalt-60			Europium-152			Europium-154			Europium-155		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
S-1	J13W02	12/12/06	0.045	U	0.045	0.056		0.035	0.050	U	0.050	0.070		0.067	0.082	U	0.082	0.065	U	0.065
Duplicate of J13W02	J13W03	12/12/06	0.65	U	0.65	0.316		0.057	0.063	U	0.063	0.20	U	0.20	0.21	U	0.21	0.22	U	0.22
S-2	J13W04	12/12/06	0.57	U	0.57	0.055	U	0.055	0.057	U	0.057	0.16	U	0.16	0.19	U	0.19	0.19	U	0.19
S-3	J13W05	12/12/06	0.24	U	0.24	0.038	U	0.038	0.038	U	0.038	0.080	U	0.080	0.12	U	0.12	0.11	U	0.11
S-4	J13W06	12/12/06	0.038	U	0.038	0.117		0.028	0.028	U	0.028	0.062	U	0.062	0.090	U	0.090	0.076	U	0.076
S-5	J13W07	12/12/06	0.18	U	0.18	0.027		0.027	0.029	U	0.029	0.075	U	0.075	0.090	U	0.090	0.099	U	0.099
S-6	J13W08	12/12/06	0.92	U	0.92	0.115		0.065	0.059	U	0.059	0.16	U	0.16	0.20	U	0.20	0.20	U	0.20
S-7	J13W09	12/12/06	0.25	U	0.25	0.037	U	0.037	0.037	U	0.037	0.084	U	0.084	0.14	U	0.14	0.11	U	0.11
S-8	J13W10	12/12/06	0.17	U	0.17	0.056		0.031	0.026	U	0.026	0.069	U	0.069	0.085	U	0.085	0.093	U	0.093
S-9	J13W11	12/12/06	0.039	U	0.039	0.028	U	0.028	0.028	U	0.028	0.065	U	0.065	0.092	U	0.092	0.059	U	0.059
S-10	J13W12	12/12/06	0.26	U	0.26	0.108		0.041	0.042	U	0.042	0.096	U	0.096	0.13	U	0.13	0.12	U	0.12

Sample Location	Sample Number	Sample Date	Nickel-63			Plutonium-238			Plutonium-239/240			Potassium-40			Radium-226			Radium-228		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
S-1	J13W02	12/12/06	-0.359	U	3.7	0.081	U	0.16	0.061	U	0.16	5.76		0.37	0.261		0.063	0.292		0.13
Duplicate of J13W02	J13W03	12/12/06	1.40	U	3.8	-0.030	U	0.23	0	U	0.23	27.4		2.3	0.996		0.12	1.32		0.27
S-2	J13W04	12/12/06	0.514	U	3.6	-0.018	U	0.19	0	U	0.13	30.9		2.2	0.734		0.099	1.37		0.22
S-3	J13W05	12/12/06	-1.23	U	3.7	-0.020	U	0.19	0.040	U	0.15	13.2		0.36	0.458		0.064	0.650		0.13
S-4	J13W06	12/12/06	-1.22	U	3.6	0.042	U	0.16	0.063	U	0.16	14.7		0.23	0.460		0.045	0.719		0.11
S-5	J13W07	12/12/06	-1.79	U	3.5	-0.028	U	0.21	0	U	0.21	16.5		0.25	0.479		0.053	0.813		0.13
S-6	J13W08	12/12/06	-0.924	U	3.7	0	U	0.19	0	U	0.19	23.7		0.38	0.845		0.089	1.30		0.25
S-7	J13W09	12/12/06	-1.15	U	3.5	0	U	0.26	0	U	0.26	13.7		0.30	0.479		0.068	0.775		0.15
S-8	J13W10	12/12/06	-1.48	U	3.4	-0.026	U	0.20	0	U	0.20	15.6		0.26	0.512		0.052	0.745		0.11
S-9	J13W11	12/12/06	-0.541	U	3.5	-0.028	U	0.21	0.028	U	0.21	13.8		1.4	0.426		0.055	0.775		0.11
S-10	J13W12	12/12/06	-1.32	U	3.5	0.025	U	0.19	0.050	U	0.19	12.6		0.42	0.463		0.073	0.724		0.17

Note: The following abbreviations apply to all Attachment 1 tables. Data qualified with C and/or J are considered acceptable values.

C = method blank contamination (inorganic constituents)
GEA = gamma energy analysis
J = estimated
MDA = minimum detectable activity
PQL = practical quantitation limit
Q = qualifier
U = undetected

Attachment	1	Sheet No.	1 of 6
Originator	K. A. Anselm	Date	04/16/07
Checked	J. M. Capron	Date	4/23/07
Calc. No.	0100F-CA-V0277	Rev. No.	0

Attachment 1. 116-F-15 Verification Sampling Results.

Sample Location	Sample Number	Sample Date	Silver-108m			Thorium-228 GEA			Thorium-232 GEA			Total beta radiostrontium			Uranium-233/234			Uranium-235		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
S-1	J13W02	12/12/06	0.020	U	0.020	0.282		0.032	0.292		0.13	-0.073	U	0.32	0.452		0.19	0.030	U	0.23
Duplicate of J13W02	J13W03	12/12/06	0.046	U	0.046	1.60		0.10	1.32		0.27	-0.043	U	0.35	0.436		0.15	0	U	0.18
S-2	J13W04	12/12/06	0.041	U	0.041	1.25		0.093	1.37		0.22	0.022	U	0.34	0.273		0.21	0	U	0.25
S-3	J13W05	12/12/06	0.022	U	0.022	0.512		0.038	0.650		0.13	0.190	U	0.32	0.664		0.16	-0.026	U	0.20
S-4	J13W06	12/12/06	0.018	U	0.018	0.620		0.030	0.719		0.11	-0.011	U	0.16	0.640		0.20	0.093	U	0.24
S-5	J13W07	12/12/06	0.020	U	0.020	0.665		0.037	0.813		0.13	0.046	U	0.30	0.531		0.14	0	U	0.16
S-6	J13W08	12/12/06	0.042	U	0.042	1.31		0.092	1.30		0.25	0.100	U	0.30	0.568		0.14	0.064	U	0.16
S-7	J13W09	12/12/06	0.024	U	0.024	0.528		0.044	0.775		0.15	0.005	U	0.30	0.516		0.14	0.022	U	0.17
S-8	J13W10	12/12/06	0.019	U	0.019	0.692		0.035	0.745		0.11	0.080	U	0.34	0.733		0.16	0	U	0.20
S-9	J13W11	12/12/06	0.017	U	0.017	0.568		0.031	0.775		0.11	0.021	U	0.35	0.407		0.17	0	U	0.21
S-10	J13W12	12/12/06	0.025	U	0.025	0.620		0.047	0.724		0.17	0.161	U	0.31	0.386		0.21	0.033	U	0.26

Sample Location	Sample Number	Sample Date	Uranium-235 GEA			Uranium-238			Uranium-238 GEA		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
S-1	J13W02	12/12/06	0.11	U	0.11	0.251		0.19	3.7	U	3.7
Duplicate of J13W02	J13W03	12/12/06	0.29	U	0.29	0.594		0.15	7.5	U	7.5
S-2	J13W04	12/12/06	0.25	U	0.25	0.491		0.21	6.6	U	6.6
S-3	J13W05	12/12/06	0.15	U	0.15	0.428		0.16	4.5	U	4.5
S-4	J13W06	12/12/06	0.092	U	0.092	0.563		0.20	3.3	U	3.3
S-5	J13W07	12/12/06	0.13	U	0.13	0.601		0.14	3.3	U	3.3
S-6	J13W08	12/12/06	0.26	U	0.26	0.461		0.14	7.0	U	7.0
S-7	J13W09	12/12/06	0.16	U	0.16	0.516		0.14	4.8	U	4.8
S-8	J13W10	12/12/06	0.12	U	0.12	0.625		0.16	3.1	U	3.1
S-9	J13W11	12/12/06	0.094	U	0.094	0.362		0.17	3.3	U	3.3
S-10	J13W12	12/12/06	0.16	U	0.16	0.551		0.21	4.5	U	4.5

Attachment	1	Sheet No.	2 of 6
Originator	K. A. Anselm	Date	04/16/07
Checked	J. M. Capron	Date	
Calc. No.	0100F-CA-V0277	Rev. No.	0

Attachment 1. 116-F-15 Verification Sampling Results.

Sample Location	Sample Number	Sample Date	Aluminum			Antimony			Arsenic			Barium			Beryllium			Boron		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
S-1	J13W02	12/12/06	6220		6.5	0.77	UJ	0.77	1.8		0.96	190	CJ	0.03	0.27		0.03	19.6	CJ	0.59
Duplicate of J13W02	J13W03	12/12/06	5200		6.5	0.77	UJ	0.77	2.0		0.95	78.1	CJ	0.03	0.17		0.03	4.0	CJ	0.58
S-2	J13W04	12/12/06	5170		6.5	0.77	UJ	0.77	2.4		0.96	48.3	CJ	0.03	0.13		0.03	0.76	UCJ	0.59
S-3	J13W05	12/12/06	4870		6.3	0.75	UJ	0.75	2.1		0.93	44.5	CJ	0.03	0.09		0.03	0.57	UCJ	0.57
S-4	J13W06	12/12/06	5130		6.3	0.75	UJ	0.75	4.4		0.93	55.1	CJ	0.03	0.12		0.03	2.9	CJ	0.57
S-5	J13W07	12/12/06	4750		6.3	0.74	UJ	0.74	2.8		0.92	38.3	CJ	0.03	0.09		0.03	1.4	CJ	0.56
S-6	J13W08	12/12/06	4640		6.3	0.75	UJ	0.75	1.4		0.93	42.1	CJ	0.03	0.07		0.03	0.66	UCJ	0.57
S-7	J13W09	12/12/06	4530		6.4	0.76	UJ	0.76	1.9		0.94	38.1	CJ	0.03	0.07		0.03	0.58	UCJ	0.58
S-8	J13W10	12/12/06	5680		6.3	0.75	UJ	0.75	1.9		0.93	63.6	CJ	0.03	0.10		0.03	2.4	CJ	0.57
S-9	J13W11	12/12/06	4570		6.3	0.74	UJ	0.74	1.9		0.92	51.5	CJ	0.03	0.07		0.03	2.1	CJ	0.56
S-10	J13W12	12/12/06	5640		6.5	0.76	UJ	0.76	2.3		0.95	74.9	CJ	0.03	0.09		0.03	3.9	CJ	0.58
Equipment Blank	J13J53	12/12/06	46.7		2.0	0.23	UJ	0.23	0.29	U	0.29	1.1	CJ	0.009	0.009	U	0.009	0.18	UCJ	0.18

Sample Location	Sample Number	Sample Date	Cadmium			Calcium			Chromium			Cobalt			Copper			Hexavalent Chromium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
S-1	J13W02	12/12/06	0.09	U	0.09	7210	CJ	3.9	7.6		0.37	5.9		0.15	15.4		0.22	0.22	U	0.22
Duplicate of J13W02	J13W03	12/12/06	0.09	U	0.09	4940	CJ	3.8	7.8		0.37	5.7		0.15	13.3		0.22	0.28		0.22
S-2	J13W04	12/12/06	0.09	U	0.09	7730	CJ	3.9	21.3		0.37	5.5		0.15	15.0		0.22	1.7		0.22
S-3	J13W05	12/12/06	0.09	U	0.09	3690	CJ	3.8	9.8		0.36	5.1		0.15	13.7		0.21	0.24		0.22
S-4	J13W06	12/12/06	0.09		0.09	7070	CJ	3.8	9.5		0.36	5.4		0.15	12.9		0.21	0.26		0.22
S-5	J13W07	12/12/06	0.09	U	0.09	5390	CJ	3.7	13.0		0.36	5.4		0.15	13.0		0.21	0.21	U	0.21
S-6	J13W08	12/12/06	0.09	U	0.09	4590	CJ	3.7	9.0		0.36	5.0		0.15	11.6		0.21	0.21	U	0.21
S-7	J13W09	12/12/06	0.09	U	0.09	5600	CJ	3.8	8.7		0.36	4.8		0.15	12.8		0.21	0.22	U	0.22
S-8	J13W10	12/12/06	0.09	U	0.09	6690	CJ	3.8	11.6		0.36	5.4		0.15	14.1		0.21	0.23		0.22
S-9	J13W11	12/12/06	0.11		0.09	4990	CJ	3.7	8.1		0.36	5.0		0.15	11.8		0.21	0.21	U	0.21
S-10	J13W12	12/12/06	0.11		0.09	6320	CJ	3.8	10.8		0.37	5.9		0.15	13.8		0.21	0.26		0.22
Equipment Blank	J13J53	12/12/06	0.03	U	0.03	17.8	UCJ	1.2	0.17		0.11	0.05	U	0.05	0.34		0.07			

Attachment	1	Sheet No.	3 of 6
Originator	K. A. Anselm	Date	04/16/07
Checked	J. M. Capron	Date	
Calc. No.	0100F-CA-V0277	Rev. No.	0

Attachment 1. 116-F-15 Verification Sampling Results.

Sample Location	Sample Number	Sample Date	Iron			Lead			Magnesium			Manganese			Mercury			Molybdenum		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
S-1	J13W02	12/12/06	15000		7.5	4.7		0.49	3950	C	1.4	251		0.12	0.02	U	0.02	0.97		0.49
Duplicate of J13W02	J13W03	12/12/06	15800		7.5	4.8		0.49	3560	C	1.4	256		0.12	0.02	U	0.02	0.75		0.49
S-2	J13W04	12/12/06	16100		7.5	26.0		0.49	3770	C	1.4	246		0.12	0.19		0.02	0.75		0.49
S-3	J13W05	12/12/06	14000		7.3	2.7		0.48	3800	C	1.4	222		0.12	0.02	U	0.02	0.51		0.48
S-4	J13W06	12/12/06	14400		7.3	4.5		0.48	3620	C	1.4	237		0.12	0.01	U	0.01	0.48	U	0.48
S-5	J13W07	12/12/06	14100		7.3	5.4		0.48	3720	C	1.4	229		0.12	0.02		0.02	0.48	U	0.48
S-6	J13W08	12/12/06	14000		7.3	2.8		0.48	3510	C	1.4	221		0.12	0.01	U	0.01	0.48	U	0.48
S-7	J13W09	12/12/06	13200		7.4	2.7		0.48	3530	C	1.4	217		0.12	0.02	U	0.02	0.66		0.48
S-8	J13W10	12/12/06	15900		7.3	4.7		0.48	3820	C	1.4	250		0.12	0.01	U	0.01	0.52		0.48
S-9	J13W11	12/12/06	13700		7.3	3.2		0.48	3430	C	1.4	217		0.12	0.02	U	0.02	0.71		0.48
S-10	J13W12	12/12/06	16900		7.5	4.7		0.49	3950	C	1.4	257		0.12	0.02	U	0.02	0.55		0.49
Equipment Blank	J13J53	12/12/06	132		2.3	0.31		0.15	6.4	C	0.43	3.4		0.04	0.02	U	0.02	0.16		0.15

Sample Location	Sample Number	Sample Date	Nickel			Potassium			Selenium			Silicon			Silver			Sodium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
S-1	J13W02	12/12/06	10.0		0.68	925		6.5	1.3	U	1.3	907	CJ	2.0	0.15	UC	0.15	420	C	0.77
Duplicate of J13W02	J13W03	12/12/06	9.2		0.68	904		6.5	1.3	U	1.3	553	CJ	2.0	0.15	UC	0.15	129	C	0.77
S-2	J13W04	12/12/06	10.1		0.68	776		6.6	1.3	U	1.3	409	CJ	2.0	0.15	UC	0.15	136	C	0.77
S-3	J13W05	12/12/06	11.1		0.66	678		6.4	1.3	U	1.3	488	CJ	1.9	0.15	UC	0.15	112	C	0.75
S-4	J13W06	12/12/06	9.7		0.66	818		6.4	1.3	U	1.3	366	CJ	1.9	0.15	UC	0.15	124	C	0.75
S-5	J13W07	12/12/06	10.6		0.65	658		6.3	1.3	U	1.3	344	CJ	1.9	0.15	UC	0.15	124	C	0.74
S-6	J13W08	12/12/06	9.5		0.66	661		6.3	1.3	U	1.3	411	CJ	1.9	0.15	UC	0.15	110	C	0.75
S-7	J13W09	12/12/06	9.7		0.67	632		6.4	1.3	U	1.3	349	CJ	1.9	0.15	UC	0.15	120	C	0.76
S-8	J13W10	12/12/06	10.8		0.66	862		6.4	1.3	U	1.3	385	CJ	1.9	0.15	UC	0.15	168	C	0.75
S-9	J13W11	12/12/06	9.2		0.65	705		6.3	1.3	U	1.3	415	CJ	1.9	0.15	UC	0.15	129	C	0.74
S-10	J13W12	12/12/06	10.8		0.67	986		6.5	1.3	U	1.3	395	CJ	2.0	0.15	UC	0.15	152	C	0.76
Equipment Blank	J13J53	12/12/06	0.21	U	0.21	18.6		2.0	0.40	U	0.40	50.9	CJ	0.60	0.05	UC	0.05	7.4	UCJ	0.23

Attachment	1	Sheet No.	4 of 6
Originator	K. A. Anselm	Date	04/16/07
Checked	J. M. Capron	Date	
Calc. No.	0100F-CA-V0277	Rev. No.	0

Attachment 1. 116-F-15 Verification Sampling Results.

Sample Location	Sample Number	Sample Date	Vanadium			Zinc		
			mg/kg	Q	PQL	mg/kg	Q	PQL
S-1	J13W02	12/12/06	38.4		0.19	35.0	C	0.12
Duplicate of J13W02	J13W03	12/12/06	37.1		0.18	34.0	C	0.12
S-2	J13W04	12/12/06	38.3		0.19	43.0	C	0.12
S-3	J13W05	12/12/06	35.5		0.18	30.6	C	0.12
S-4	J13W06	12/12/06	37.3		0.18	38.8	C	0.12
S-5	J13W07	12/12/06	35.6		0.18	35.0	C	0.12
S-6	J13W08	12/12/06	35.9		0.18	29.9	C	0.12
S-7	J13W09	12/12/06	33.6		0.18	30.4	C	0.12
S-8	J13W10	12/12/06	39.2		0.18	41.7	C	0.12
S-9	J13W11	12/12/06	35.4		0.18	29.3	C	0.12
S-10	J13W12	12/12/06	41.0		0.18	43.0	C	0.12
Equipment Blank	J13J53	12/12/06	0.08		0.06	0.80	UCJ	0.04

Sample Location	Sample Number	Sample Date	Asbestos
S-1	J13W13	12/12/06	None detected
Duplicate of J13W13	J13W14	12/12/06	None detected
S-2	J13W15	12/12/06	None detected
S-3	J13W16	12/12/06	None detected
S-4	J13W17	12/12/06	None detected
S-5	J13W18	12/12/06	None detected
S-6	J13W19	12/12/06	None detected
S-7	J13W20	12/12/06	None detected
S-8	J13W21	12/12/06	None detected
S-9	J13W22	12/12/06	None detected
S-10	J13W23	12/12/06	None detected

Attachment	1	Sheet No.	5 of 6
Originator	K. A. Anselm	Date	04/16/07
Checked	J. M. Capron	Date	
Calc. No.	0100F-CA-V0277	Rev. No.	0

Attachment 1. 116-F-15 Verification Sampling Results.

Constituent	J13W02 Location S-1 Sample Date 12/12/06			J13W03 Duplicate of J13W02 Sample Date 12/12/06			J13W04 Location S-2 Sample Date 12/12/06			J13W05 Location S-3 Sample Date 12/12/06			J13W06 Location S-4 Sample Date 12/12/06			J13W07 Location S-5 Sample Date 12/12/06		
	µg/kg	Q	PQL	µg/kg	Q	PQL	µg/kg	Q	PQL	µg/kg	Q	PQL	µg/kg	Q	PQL	µg/kg	Q	PQL
PCBs (Polychlorinated biphenyls)																		
Aroclor-1016	15	U	15	15	U	15	15	U	15	14	U	14	14	U	14	14	U	14
Aroclor-1221	15	U	15	15	U	15	15	U	15	14	U	14	14	U	14	14	U	14
Aroclor-1232	15	U	15	15	U	15	15	U	15	14	U	14	14	U	14	14	U	14
Aroclor-1242	15	U	15	15	U	15	15	U	15	14	U	14	14	U	14	14	U	14
Aroclor-1248	15	U	15	15	U	15	15	U	15	14	U	14	14	U	14	14	U	14
Aroclor-1254	15	U	15	15	U	15	4.6	J	15	19		14	14	U	14	14	U	14
Aroclor-1260	15	U	15	15	U	15	15	U	15	14	U	14	27		14	14	U	14

Constituent	J13W08 Location S-6 Sample Date 12/12/06			J13W09 Location S-7 Sample Date 12/12/06			J13W10 Location S-8 Sample Date 12/12/06			J13W11 Location S-9 Sample Date 12/12/06			J13W12 Location S-10 Sample Date 12/12/06		
	µg/kg	Q	PQL	µg/kg	Q	PQL	µg/kg	Q	PQL	µg/kg	Q	PQL	µg/kg	Q	PQL
PCBs															
Aroclor-1016	14	U	14	14	U	14	14	U	14	14	U	14	15	U	15
Aroclor-1221	14	U	14	14	U	14	14	U	14	14	U	14	15	U	15
Aroclor-1232	14	U	14	14	U	14	14	U	14	14	U	14	15	U	15
Aroclor-1242	14	U	14	14	U	14	14	U	14	14	U	14	15	U	15
Aroclor-1248	14	U	14	14	U	14	14	U	14	14	U	14	15	U	15
Aroclor-1254	14	U	14	5.8	J	14	25		14	14	U	14	13	J	15
Aroclor-1260	14	U	14	14	U	14	11	J	14	14	U	14	5.7	J	15

Attachment	1	Sheet No.	6 of 6
Originator	K. A. Anselm	Date	04/16/07
Checked	J. M. Capron	Date	
Calc. No.	0100F-CA-V0277	Rev. No.	0

APPENDIX C

HAZARD QUOTIENT AND CARCINOGENIC RISK CALCULATIONS

APPENDIX C

HAZARD QUOTIENT AND CARCINOGENIC RISK CALCULATIONS

The calculation in this appendix is kept in the active Washington Closure Hanford project files and is available upon request. When the project is completed, the files will be stored in a U.S. Department of Energy, Richland Operations Office, repository. This calculation has been prepared in accordance with ENG-1, *Engineering Services*, ENG-1-4.5, "Project Calculation," Washington Closure Hanford, Richland, Washington. The following calculation is provided in this appendix:

100-F-36 and 116-F-15 Waste Site Hazard Quotient and Carcinogenic Risk Calculations, 0100F-CA-V0278, Rev. 0, Washington Closure Hanford, Richland, Washington.

DISCLAIMER FOR CALCULATIONS

The calculation provided in this appendix has been generated to document compliance with established cleanup levels. This calculation should be used in conjunction with other relevant documents in the administrative record.

CALCULATION COVER SHEET

Project Title Field Remediation **Job No.** 14655
Area 100-F
Discipline Environmental ***Calc. No.** 0100F-CA-V0278
Subject 100-F-36 and 116-F-15 Hazard Quotient and Carcinogenic Risk Calculations
Computer Program Excel **Program No.** Excel 2003

The attached calculations have been generated to document compliance with established cleanup levels. These 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 Calcs. = 3 Total = 4	K.A. Anselm 4/16/07 K. A. Anselm	4/23/07 J. M. Capron	J. M. Blakley 4/24/07 T. M. Blakley	S.W. Callison 4-24-07 S. W. Callison	4-24-07
SUMMARY OF REVISION						

WCH-DE-018 (09/01/2006) * Obtain Calc. No. from Document Control and Form from Intranet

Washington Closure Hanford CALCULATION SHEET

Originator:	K. A. Anselm KAA	Date:	04/16/07	Calc. No.:	0100F-CA-V0278	Rev.:	0
Project:	Field Remediation	Job No:	14655	Checked:	J. M. Capron JMC	Date:	4/23/07
Subject:	100-F-36 and 116-F-15 Hazard Quotient and Carcinogenic Risk Calculations					Sheet No.	1 of 3

INTRODUCTION:

The 116-F-15 waste site in located within the footprint of the 100-F-36 waste site; therefore, evaluation of the sampling results from both sites are included in these calculations.

PURPOSE:

Provide documentation to support the calculation of the hazard quotient (HQ) and excess carcinogenic risk values for the 100-F-36 and 116-F-15 sampling results. In accordance with the remedial action goals (RAGs) in the remedial design report/remedial action work plan (DOE-RL 2005), the following criteria must be met:

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

GIVEN/REFERENCES:

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

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

3) WCH, 2007a, *100-F-36 Cleanup Verification 95% UCL Calculations*, 0100F-CA-V0276, Rev. 0, Washington Closure Hanford, Richland, Washington.

4) WCH, 2007b, *116-F-15 Cleanup Verification 95% UCL Calculations*, 0100F-CA-V0277, Rev. 0, Washington Closure Hanford, Richland, Washington.

SOLUTION:

1) Calculate an HQ for each noncarcinogenic constituent detected above background and compare to the individual HQ of <1.0 (DOE-RL 2005).

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

3) Calculate an excess carcinogenic risk value for each carcinogenic constituent detected above background and compare to the individual excess carcinogenic risk criterion of $<1 \times 10^{-6}$ (DOE-RL 2005).

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

Washington Closure Hanford CALCULATION SHEET

Originator:	K. A. Anselm KAA	Date:	04/16/07	Calc. No.:	0100F-CA-V0278	Rev.:	0
Project:	Field Remediation	Job No:	14655	Checked:	J. M. Capron JMC	Date:	4/23/07
Subject:	100-F-36 and 116-F-15 Hazard Quotient and Carcinogenic Risk Calculations					Sheet No.	2 of 3

METHODOLOGY:

Hazard quotient and carcinogenic risk calculations for the 100-F-36 and 116-F-15 waste sites were conservatively performed using the highest of the statistical and/or maximum values for each analyte detected above background and for each detected analyte where no background value is available, as presented in WCH (2007a, 2007b).

All of the analytes listed in Table 1 require the HQ and/or carcinogenic risk calculations because they were all detected and no established background value is available. All other nonradionuclide COPCs for these sites were either not detected or were quantified below background levels and are not included. An example of the HQ and risk calculations in Table 1 is presented below:

1) For example, the highest determined value for boron is 4.4 mg/kg, divided by the noncarcinogenic RAG value of 16,000 mg/kg (calculated in accordance with the noncarcinogenic toxics effects formula in WAC 173-340-740[3]), is 2.8×10^{-4}. Comparing this value, and all other individual values, to the requirement of <1.0, this criterion is met.

2) After the HQ calculations are completed for the appropriate analytes, the cumulative HQ is obtained by summing the individual values. (To avoid errors due to intermediate rounding, the individual HQ values prior to rounding are used for this calculation.) The sum of the HQ values is 1.4×10^{-2}. Comparing this value to the requirement of <1.0, this criterion is met.

3) To calculate the excess carcinogenic risk, the highest determined value for each carcinogenic analyte is divided by the carcinogenic RAG value, then multiplied by 1×10^{-6}. For example, the highest determined value for hexavalent chromium is 0.87 mg/kg, divided by 2.1 mg/kg, and multiplied as indicated is 4.1×10^{-7}. Comparing this value, and all other individual values, to the requirement of $<1 \times 10^{-6}$, this criterion is met.

4) After these calculations are completed for the carcinogenic analytes, the cumulative excess carcinogenic risk is obtained by summing the individual values. (To avoid errors due to intermediate rounding, the individual values prior to rounding are used for this calculation.) The sum of the excess carcinogenic risk values is 5.0×10^{-7}. Comparing this value to the requirement of $<1 \times 10^{-5}$, this criterion is met.

CONCLUSION:

These calculations demonstrate that the 100-F-36 and 116-F-15 waste sites meet the requirements for hazard quotient and excess carcinogenic risk as identified in the remedial design report/remedial action work plan (DOE-RL 2005).

RESULTS:

Table 1 shows the results of the HQ and excess carcinogenic risk calculations for these sites.

Washington Closure Hanford CALCULATION SHEET

Originator:	K. A. Anselm KAA	Date:	04/16/07	Calc. No.:	0100F-CA-V0278	Rev.:	0
Project:	Field Remediation	Job No:	14655	Checked:	J. M. Capron JMC	Date:	4/23/07
Subject:	100-F-36 and 116-F-15 Hazard Quotient and Carcinogenic Risk Calculations					Sheet No.	3 of 3

Table 1. Hazard Quotient and Excess Cancer Risk Results for the 100-F-36 and 116-F-15 Waste Sites.

COPC	Maximum or Statistical Value[a] (mg/kg)	Noncarcinogen RAG[b] (mg/kg)	Hazard Quotient	Carcinogen RAG[b] (mg/kg)	Carcinogen Risk
Metals					
Boron	4.4	16,000	2.8E-04	--	--
Chromium, hexavalent[c]	0.87	240	3.6E-03	2.1	4.1E-07
Molybdenum	0.66	400	1.7E-03	--	--
Polychlorinated Biphenyls					
Aroclor-1254	0.014	1.6	8.8E-03	0.5	2.8E-08
Aroclor-1260	0.027	--	--	0.5	5.4E-08
Totals					
Cumulative Hazard Quotient:			**1.4E-02**		
Cumulative Excess Cancer Risk:					**5.0E-07**

[a] = From WCH 2007a, 2007b.

[b] = Value obtained from *Washington Administrative Code* (WAC) 173-340-740(3), Method B, 1996, unless otherwise noted.

[c] = Value for the carcinogenic cleanup level calculated based on inhalation exposure pathway, WAC 173-340-750(3), 1996.

-- = not applicable

COPC = contaminant of potential concern

RAG = remedial action goal