WASTE SITE RECLASSIFICATION FORM

Operable Unit: 100-HR-1 **Control No.:** 2015-025

Waste Site Code(s)/Subsite Code(s): 100-H-51:2

Reclassification Category: Interim ☒ Final ☐

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

Approvals Needed: DOE ☒ Ecology ☒ EPA ☐

Description of current waste site condition:

The 100-H-51:2, 117-H Seal Pit Crib Feedline subsite is part of the 100-H-51, Potentially Contaminated Pipeline Segments waste site. The 100-H-51 waste site, part of the 100-HR-1 Operable Unit, was added to 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* (Remaining Sites ROD), U.S. Environmental Protection Agency, Region 10, Seattle, Washington (EPA 1999), as a candidate site for confirmatory sampling via the *Explanation of Significant Differences for the 100 Area Remaining Sites Interim Remedial Action Record of Decision, Hanford Site, Benton County, Washington*, U.S. Environmental Protection Agency, Region 10, Seattle, Washington (EPA 2009). Subsequently, the 100-H-51 waste site was divided into six subsites and the 100-H-51:2 subsite was recommended for remediation because this pipeline transported drainage from the 132-H-2, 117-H Air Filter Building seal pits to the 116-H-9, 117-H Seal Pit Crib waste site.

The selected remedy involved (1) excavating the site to the extent required to meet specified soil cleanup levels, (2) disposing of contaminated excavation materials at the Environmental Restoration Disposal Facility, (3) demonstrating through verification sampling that cleanup goals have been achieved, and (4) proposing the site for reclassification to Interim Closed Out.

Remedial action at the 100-H-51:2 subsite was conducted on September 23 and 24, 2014. The remediation extended to an approximate maximum depth of 2 m (6.6 ft) below ground surface, resulting in approximately 322 bank cubic meters (421 bank cubic yards) of contaminated soil and debris (cement asbestos pipe) being loaded out and disposed at the Environmental Restoration Disposal Facility.

Verification samples from the 100-H-51:2 subsite were collected on February 15, 2015. The sampling was performed to determine if the site met the remedial action objectives and remedial action goals established by the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (100 Area RDR/RAWP), DOE/RL-97-17, Rev. 6, U.S. Department of Energy, Richland Operations Office, Richland, Washington (DOE-RL 2009b), and the Remaining Sites ROD (EPA 1999).

Basis for reclassification:

The verification sampling and modeling results for the 100-H-51:2 subsite demonstrate that the site meets the remedial action objectives and corresponding remedial action goals established in the 100 Area RDR/RAWP (DOE-RL 2009b) and the Remaining Sites ROD (EPA 1999) to support a reclassification to Interim Closed Out. These sampling and modeling results established 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. Contamination above direct exposure levels was not observed in shallow zone soils and is concluded to not exist in deep zone soils; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone soil are not required. The basis for reclassification is described in detail in the *Remaining Sites Verification Package for the 100-H-51:2 117-H Seal Pit Crib Feedline Subsite* (attached).

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WASTE SITE RECLASSIFICATION FORM

Operable Unit: 100-HR-1 **Control No.:** 2015-025

Waste Site Code(s)/Subsite Code(s): 100-H-51:2

Regulator comments:

Waste Site Controls:

Engineered Controls: ☐ Yes ☒ No Institutional Controls: ☐ Yes ☒ No O&M Requirements: ☐ Yes ☒ No

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

J. P. Neath		7/8/15
DOE Federal Project Director (printed)	Signature	Date
N. Menard		7/9/15
Ecology Project Manager (printed)	Signature	Date
NA		
EPA Project Manager (printed)	Signature	Date

REMAINING SITES VERIFICATION PACKAGE FOR THE 100-H-51:2, 117-H SEAL PIT CRIB FEEDLINE SUBSITE

Attachment to Waste Site Reclassification Form 2015-025

July 2015

REMAINING SITES VERIFICATION PACKAGE FOR THE 100-H-51:2, 117-H SEAL PIT CRIB FEEDLINE SUBSITE

EXECUTIVE SUMMARY

The 100-H-51:2, 117-H Seal Pit Crib Feedline subsite is part of the 100-H-51, Potentially Contaminated Pipeline Segments waste site. The 100-H-51 waste site, part of the 100-HR-1 Operable Unit, was added to 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) as a candidate site for confirmatory sampling via the *Explanation of Significant Differences for the 100 Area Remaining Sites Interim Remedial Action Record of Decision, Hanford Site, Benton County, Washington* (EPA 2009). Subsequently, the 100-H-51 waste site was divided into six subsites. The 100-H-51:2, subsite was identified for remediation because this pipeline transported drainage from the 132-H-2, 117-H Air Filter Building seal pits to the 116-H-9, 117-H Seal Pit Crib where it was discharged to the soil.

Remedial action at the 100-H-51:2 subsite was conducted on September 23 and 24, 2014. The remediation extended to an approximate maximum depth of 2 m (6.6 ft) below ground surface, resulting in approximately 322 bank cubic meters (421 bank cubic yards) of contaminated soil and debris (cement asbestos pipe) being loaded out and disposed at the Environmental Restoration Disposal Facility.

Following remediation, verification soil sampling was conducted on February 15, 2015. The verification sampling results indicate that the waste removal action achieved compliance with the remedial action objectives and remedial action goals established in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (100 Area RDR/RAWP) (DOE-RL 2009b) and the Remaining Sites ROD (EPA 1999).

A summary of the cleanup evaluation for the results from verification sampling compared to applicable criteria is presented in Table ES-1. The results of verification sampling are used to make reclassification decisions for the 100-H-51:2 subsite in accordance with the TPA-MP-14 procedure in the *Tri-Party Agreement Handbook Management Procedures* (DOE-RL 2011).

In accordance with this evaluation, the verification sampling results support a reclassification of this subsite to Interim Closed Out. The current site conditions achieve the remedial action objectives and the corresponding remedial action goals of the 100 Area RDR/RAWP (DOE-RL 2009b) and the Remaining Sites ROD (EPA 1999). The results also demonstrate that residual contaminant concentrations support unrestricted future use of shallow zone soil (surface to 4.6 m [15 ft] below ground surface), and that contaminant levels remaining in the soil are protective of groundwater and the Columbia River. Contamination above direct exposure levels was not observed in shallow zone soils and is concluded to not exist in deep zone soils; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone soil are not required.

Table ES-1. Summary of Remedial Action Goals for the 100-H-51:2 Subsite.

Regulatory Requirement	Remedial Action Goals	Results	Remedial Action Objectives Attained?
Direct Exposure – Radionuclides	Attain dose rate of <15 mrem/yr above background for 1,000 years.	The cumulative radionuclide activity for the 100-H-51:2 subsite, based on a sum-of-fractions calculation (1.21 mrem/yr), is below the 15 mrem/yr dose rate limitation.	Yes
Direct Exposure – Nonradionuclides	Attain individual COPC direct exposure RAGs.	All individual COPC concentrations are below the direct exposure RAGs.	Yes
Risk Requirements – Nonradionuclides	Attain a hazard quotient of <1 for all individual noncarcinogens.	The hazard quotients for individual nonradionuclide COPCs are <1.	Yes
	Attain a cumulative hazard quotient of <1 for noncarcinogens.	The cumulative hazard quotient for the 100-H-51:2 subsite (1.3×10^{-3}) is <1.	
	Attain an excess cancer risk of $<1 \times 10^{-6}$ for individual carcinogens.	The excess cancer risk for individual carcinogens is $<1 \times 10^{-6}$.	
	Attain a cumulative excess cancer risk of $<1 \times 10^{-5}$ for carcinogens.	The cumulative excess cancer risk (1.3×10^{-7}) is $<1 \times 10^{-5}$.	
Groundwater/River Protection – Radionuclides	Attain single-COPC groundwater and river protection RAGs.	All individual radionuclide concentrations are below the groundwater and river protection RAGs.	Yes
	Attain national primary drinking water standards [a]: 4 mrem/yr (beta/gamma) dose rate to target receptor/organs.		
	Meet drinking water standards for alpha emitters: the most stringent of 15 pCi/L MCL or 1/25th of the derived concentration guides from DOE Order 5400.5 [b].		
	Meet total uranium standard of 30 µg/L (21.2 pCi/L) [c].		
Groundwater/River Protection – Nonradionuclides	Attain individual nonradionuclide groundwater and river cleanup requirements.	All individual nonradionuclide COPC concentrations are below the groundwater and river protection RAGs.	Yes

[a] "National Primary Drinking Water Regulations" (40 *Code of Federal Regulations* 141).
[b] *Radiation Protection of the Public and the Environment* (DOE Order 5400.5).
[c] Based on the isotopic distribution of uranium in the 100 Area, the 30 µg/L MCL corresponds to 21.2 pCi/L. Concentration-to-activity calculations are documented in *Calculation of Total Uranium Activity Corresponding to a Maximum Contaminant Level for Total Uranium of 30 Micrograms per Liter in Groundwater* (BHI 2001).

COPC = contaminant of potential concern
DOE = U.S. Department of Energy
MCL = maximum contaminant level
RAG = remedial action goal

Soil cleanup levels were established in the Remaining Sites ROD (EPA 1999) based in part on a limited ecological risk assessment. Although not required by the Remaining Sites ROD, a comparison against ecological risk screening levels has been made for the 100-H-51:2 subsite contaminants of potential concern and other constituents (Appendix A). Ecological screening levels from the *Washington Administrative Code* (WAC) 173-340, "Model Toxics Control Act – Cleanup," were exceeded for boron and vanadium. The U.S. Environmental Protection Agency's ecological soil screening levels were exceeded for manganese and vanadium. Exceedance of screening values is intended to trigger additional evaluation and does not necessarily indicate the existence of risk to ecological receptors. Because concentrations of manganese and vanadium are below Hanford Site background values, it is believed that the presence of these constituents does not pose a risk to ecological receptors. All exceedances will be evaluated in the context of additional lines of evidence for risk to ecological receptors as part of the final closeout decision for this site.

REMAINING SITES VERIFICATION PACKAGE FOR THE 100-H-51:2, 117-H SEAL PIT CRIB FEEDLINE SUBSITE

STATEMENT OF PROTECTIVENESS

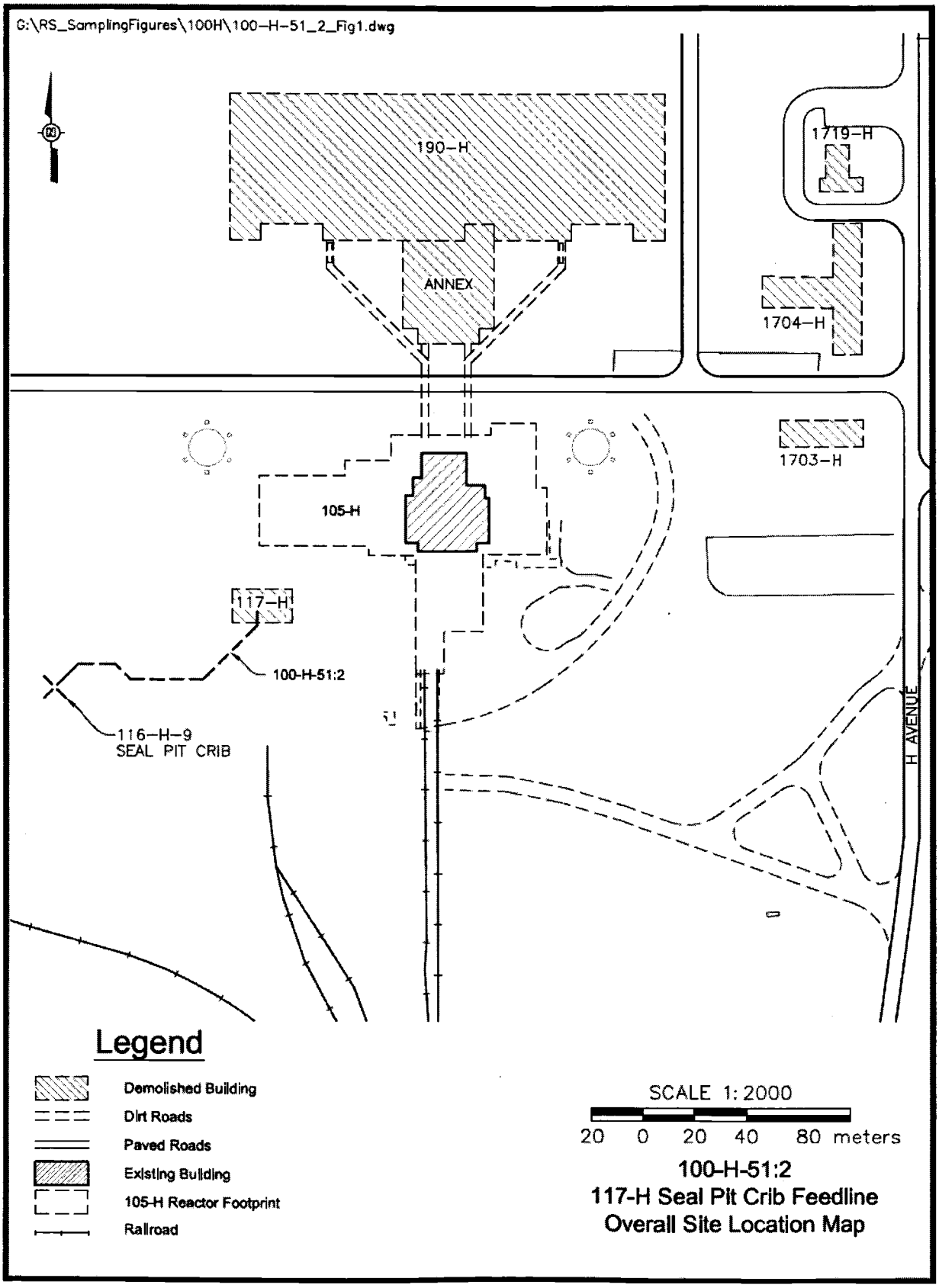
The 100-H-51:2 subsite verification sampling data, site evaluations, and supporting documentation demonstrate that this site meets the objectives established in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (100 Area RDR/RAWP) (DOE-RL 2009b) and the *Interim Action Record of 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). These results show that residual soil concentrations support future land uses that can be represented (or bounded) by a rural-residential scenario. The results also demonstrate that residual contaminant concentrations support unrestricted future use of shallow zone soil (i.e., surface to 4.6 m [15 ft]) and that contaminant levels remaining in the soil are protective of groundwater and the Columbia River. Contamination above direct exposure levels was not observed in shallow zone soils and is concluded to not exist in deep zone soils; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone soil are not required.

Soil cleanup levels were established in the Remaining Sites ROD (EPA 1999) based in part on a limited ecological risk assessment. Although not required by the Remaining Sites ROD, a comparison against ecological risk screening levels has been made for the 100-H-51:2 subsite contaminants of potential concern (COPCs) and other constituents (Appendix A). Ecological screening levels from the *Washington Administrative Code* (WAC) 173-340, "Model Toxics Control Act – Cleanup," were exceeded for boron and vanadium. The U.S. Environmental Protection Agency's (EPA) ecological soil screening levels were exceeded for manganese and vanadium. Exceedance of screening values is intended to trigger additional evaluation and does not necessarily indicate the existence of risk to ecological receptors. Because concentrations of manganese and vanadium are below Hanford Site background values, it is believed that the presence of these constituents does not pose a risk to ecological receptors. All exceedances will be evaluated in the context of additional lines of evidence for risk to ecological receptors as part of the final closeout decision for this site.

GENERAL SITE INFORMATION AND BACKGROUND

The 100-H-51:2, 117-H Seal Pit Crib Feedline subsite, part of the 100-HR-1 Operable Unit, is located southwest of the 105-H Reactor Building between the demolished 132-H-2, 117-H Air Filter Building footprint and the former 116-H-9, 117-H Seal Pit Crib waste site (Figure 1).

Figure 1. The 100-H-51:2 Overall Site Location Map.



The 117-H Filter Building and the 117-H Seal Pit Crib, along with the connecting pipeline, were constructed in 1960. During operation, the 117-H Building filtered ventilation air from the reactor building containment zone prior to discharge to the environment. The 117-H Seal Pit Crib Feedline transported drainage from the 117-H Building seal pits to the seal pit crib where it was discharged to the soil column. In 1984, the 117-H Building was decontaminated to remove all hazardous materials and demolished to 1 m (3 ft) below grade. The 132-H-2 waste site was reclassified as interim closed out in 2006 (BHI 2006) and the 116-H-9 waste site was reclassified as interim closed out in 2009 (WCH 2010).

REMEDIAL ACTION SUMMARY

Remedial action at the 100-H-51:2 subsite was conducted on September 23 and 24, 2014. The remediation extended to an approximate maximum depth of 2 m (6.6 ft) below ground surface, resulting in approximately 322 bank cubic meters (421 bank cubic yards) of contaminated soil and debris (cement asbestos pipe) being loaded out and disposed at the Environmental Restoration Disposal Facility (ERDF). The soil and debris were direct loaded for disposal at ERDF; therefore, no waste staging pile areas were generated. No overburden material was salvaged for use as clean backfill and no anomalies were encountered during remediation. No in-process soil samples were collected. A post-remediation photograph of the site is provided in Figure 2. Following remediation, global positional environmental radiological surveyor (GPERS) surveys were conducted over the pipeline excavation. The GPERS radiological survey beta and gamma track maps are provided in Figures 3 and 4.

VERIFICATION SAMPLING ACTIVITIES

Verification soil sampling was conducted on February 15, 2015, per the *Work Instruction for Verification Sampling of the 100-H-51:2 Subsite* (WCH 2015b). Sampling was conducted to support a determination that residual contaminant concentrations in the soil meet cleanup criteria specified in the 100 Area RDR/RAWP (DOE-RL 2009b) and the Remaining Sites ROD (EPA 1999).

The verification sample results are provided in Appendix B and indicate that the waste removal action achieved compliance with the remedial action objectives and remedial action goals (RAGs) for the 100-H-51:2 subsite. The following subsections provide additional discussion of the information used to develop the verification sampling design. The results of verification sampling are also summarized to support interim closure of the site.

Figure 2. Post-Remediation Photograph of the 100-H-51:2 Subsite, September 2014.

Figure 3. The 100-H-51:2 GPERS Beta Track Map.

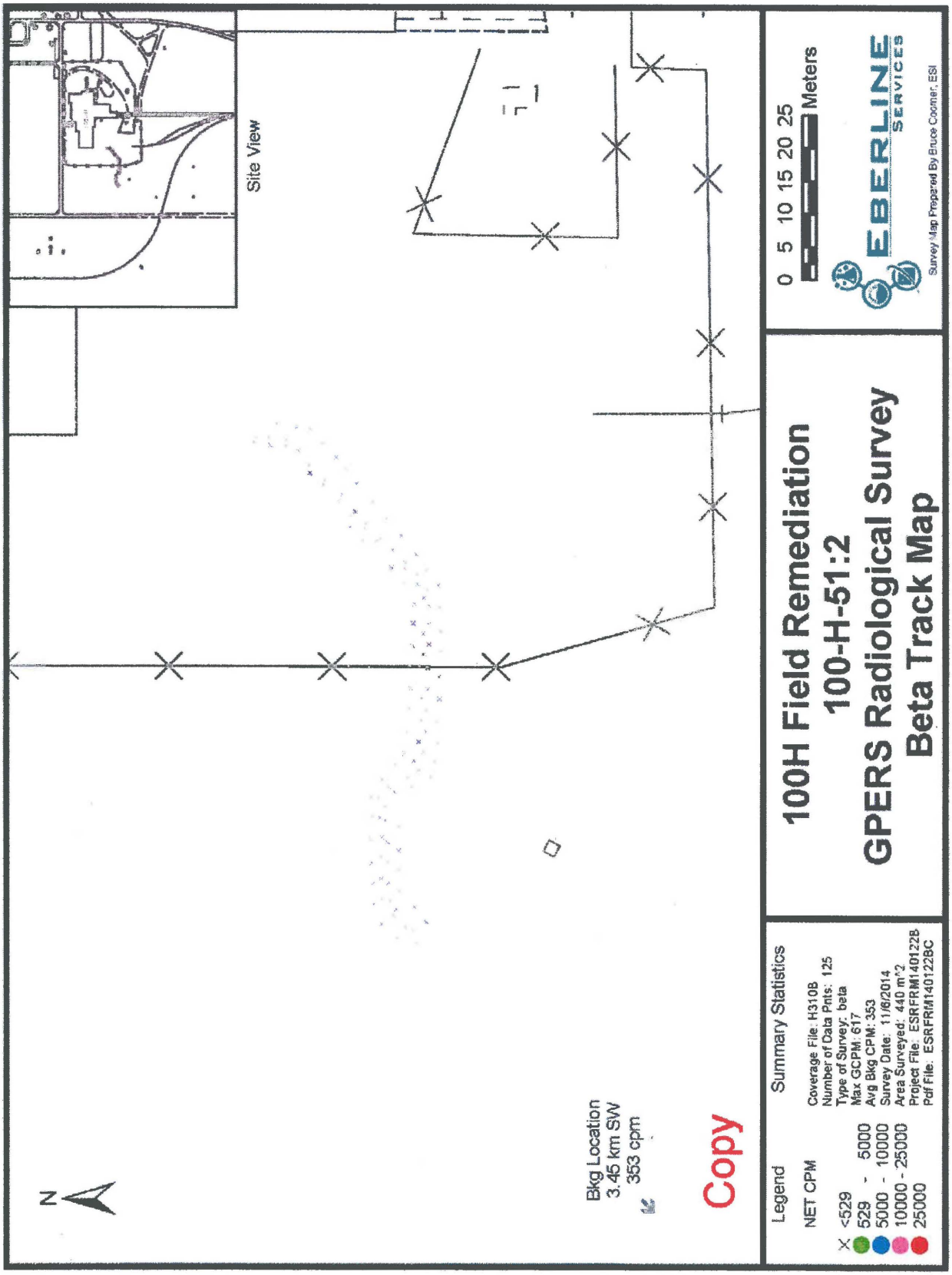
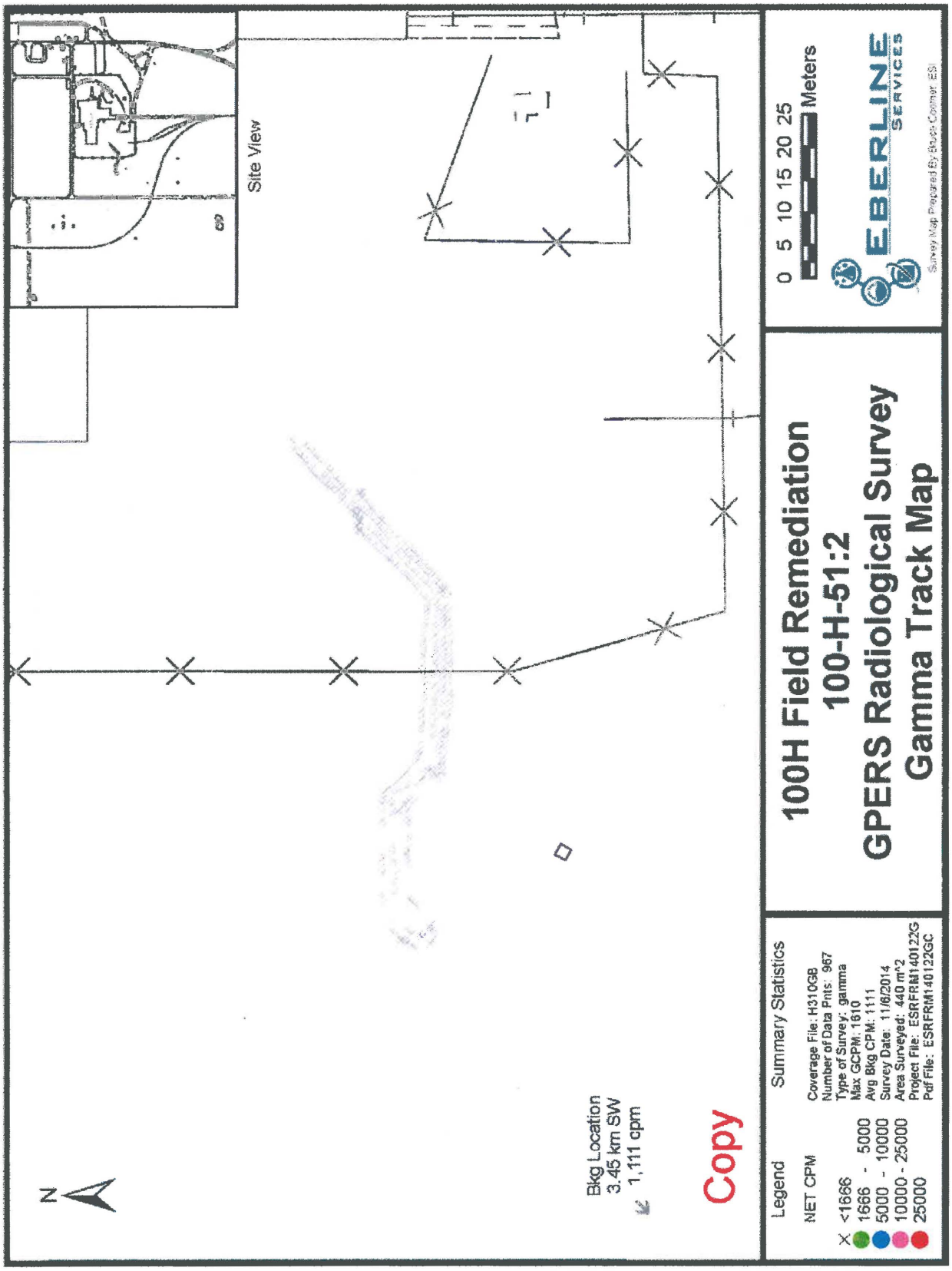


Figure 4. The 100-H-51:2 GPERS Gamma Track Map.



Contaminants of Potential Concern for Verification Sampling

The COPCs for the 100-H-51:2 subsite were determined based on the known waste sources; the 116-H-9, 117-H Seal Pit Crib waste site and the 132-H-2, 117-H Filter Building; and included cadmium, chromium (total), lead, selenium, silver, mercury, hexavalent chromium, asbestos, polychlorinated biphenyls, cesium-137, cobalt-60, europium-152, europium-154, europium-155, radium-226, thorium-238, thorium-232, carbon-14, plutonium-238, plutonium-239/240, uranium-238, strontium-90, and tritium.

Although not considered site COPCs, the analysis for the expanded list of inductively coupled plasma metals (which also included antimony, arsenic, barium, beryllium, boron, cobalt, copper, manganese, molybdenum, nickel, vanadium, and zinc) was requested.

The analytical methods that were performed to evaluate the site COPCs are provided in Table 1.

Table 1. Laboratory Analytical Methods for the 100-H-51:2 Subsite.

Analytical Method	Contaminant of Potential Concern
ICP metals [a] – EPA Method 6010	Cadmium, chromium, lead, selenium, silver
Hexavalent chromium – EPA Method 7196	Hexavalent chromium
Mercury – EPA Method 7471	Mercury
Asbestos – NIOSH Method 9002	Asbestos
PCB – EPA Method 8082	Polychlorinated biphenyls
GEA – Gamma spectroscopy	Cesium-137, cobalt-60, europium-152, europium-154, europium-155, radium-226, thorium-228, thorium-232.
Carbon-14 – Liquid scintillation	Carbon-14
Isotopic plutonium	Plutonium-238 and plutonium-239/240
Isotopic uranium	Uranium-238
Strontium-90 – liquid scintillation	Strontium-90
Tritium – liquid scintillation	Tritium

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

EPA = U.S. Environmental Protection Agency
GEA = gamma energy analysis
ICP = inductively coupled plasma
NIOSH = National Institute for Occupational Safety and Health
PCB = polychlorinated biphenyl

Verification Sampling Design

One decision unit was identified for the 100-H-51:2 subsite and consists of the excavation only. A statistical sample design was used to evaluate the decision unit. Thirteen statistical verification soil samples plus one duplicate were collected from the excavation. Additionally, one equipment blank sample was also collected.

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* (DOE-RL 2009a). All samples were grab samples collected at the predetermined coordinates identified in Table 2. Additional information related to verification sampling can be found in the field sampling logbook (WCH 2015a). The verification sample locations for the excavation are shown in Figure 5.

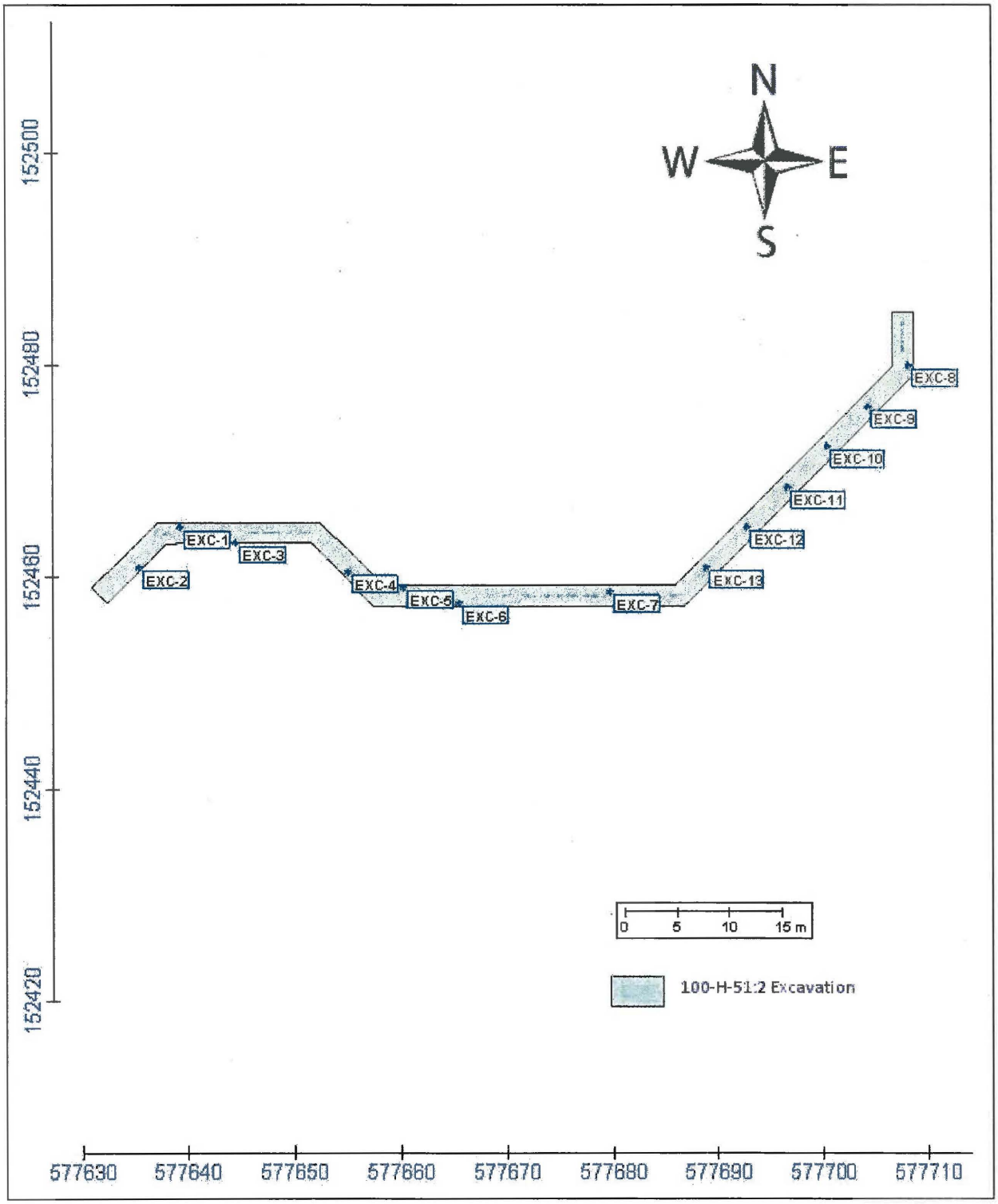
Table 2. The 100-H-51:2 Subsite Verification Sample Summary.

Sample Location	HEIS Sample Number	Washington State Plane Coordinates (m)		Sample Analysis
		Northing	Easting	
EXC-1	J1V430	152464.8	577639.3	ICP metals [a], mercury, hexavalent chromium, asbestos, PCB, GEA, carbon-14, isotopic uranium, strontium-90, isotopic plutonium, tritium
EXC-2	J1V431	152461.0	577635.5	
EXC-3	J1V432	152463.4	577644.5	
EXC-4	J1V433	152460.5	577655.0	
EXC-5	J1V434	152459.1	577660.2	
EXC-6	J1V435	152457.6	577665.5	
EXC-7	J1V436	152458.6	577679.8	
EXC-8	J1V437	152480.0	577708.1	
EXC-9	J1V438	152476.2	577704.3	
EXC-10	J1V439	152472.4	577700.4	
EXC-11	J1V440	152468.6	577696.6	
EXC-12	J1V441	152464.8	577692.7	
EXC-13	J1V442	152461.0	577688.9	
Duplicate of EXC-8	J1V443	152480.0	577708.1	
Equipment blank	J1V444	NA	NA	ICP metals [a], mercury

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

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

Figure 5. The 100-H-51:2 Pipeline Subsite Verification Sample Locations.



Verification Sampling Results

All verification samples were collected for full protocol laboratory analysis and analyzed using EPA-approved analytical methods. Evaluation of the verification data from the 100-H-51:2 subsite was performed by direct comparison of the statistical sample results for each COPC against the cleanup criteria.

Comparisons of the results for site COPCs from the 100-H-51:2 subsite against the RAGs are summarized in Table 3. Contaminants that were not detected by laboratory analysis are excluded from the table. Calculated cleanup levels are not presented in the Cleanup Levels and Risk Calculations Database (Ecology 2014) under WAC 173-340-740(3) for calcium, magnesium, potassium, silicon, and sodium. The EPA's *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual* (EPA 1989) recommends that aluminum and iron not be considered in site risk evaluations. Therefore, aluminum, calcium, iron, magnesium, potassium, silicon, and sodium are not considered site COPCs and are also not included in the table.

Table 3. Comparison of Contaminant Concentrations to Action Levels for the 100-H-51:2 Excavation Verification Samples. (2 Pages)

COPC	Statistical Result [b] (mg/kg)	Site Lookup Values [a]			Do the Results Exceed RAGs?	Do the Results Pass RESRAD Modeling?
		Shallow Zone Lookup Value	Groundwater Protection Lookup Value	River Protection Lookup Value		
Cesium-137	0.0134 (<BG)	6.2	1,465	2,930	No	--
Plutonium-239/240	2.76	35.1	-- [c]	-- [c]	No	--
Uranium-234	0.203 (<BG)	1.1 [d]	1.1 [d]	1.1 [d]	No	--
Uranium-238	0.208 (<BG)	1.1 [d]	1.1 [d]	1.1 [d]	No	--
COPC	**Statistical Result [b] (mg/kg)**	**Remedial Action Goals [a]**			**Do the Results Exceed RAGs?**	**Do the Results Pass RESRAD Modeling?**
		Direct Exposure	**Soil Cleanup Level for Groundwater Protection**	**Soil Cleanup Level for River Protection**		
Arsenic	4.1 (<BG)	20 [d]	20 [d]	20 [d]	No	--
Barium	62.2 (<BG)	5,600	200	400	No	--
Beryllium	0.14 (<BG)	10.4 [e]	1.51 [d]	1.51 [d]	No	--
Boron [f]	2.5	7,200	320	-- [g]	No	--
Cadmium [h]	0.049 (<BG)	13.9 [e]	0.81 [d]	0.81 [d]	No	--
Chromium (total)	10.3 (<BG)	80,000	18.5 [d]	18.5 [d]	No	--
Cobalt	6.0 (<BG)	24	15.7 [d]	-- [g]	No	--
Copper	13.0 (<BG)	2,960	59.2	22.0 [d]	No	--
Hexavalent chromium [f]	0.228	2.1 [e]	4.8	2	No	--
Lead	6.6 (<BG)	353	10.2 [d]	10.2 [d]	No	--
Manganese	271 (<BG)	3,760	512 [d]	512 [d]	No	--
Mercury	0.0057 (<BG)	24	0.33 [d]	0.33 [d]	No	--
Nickel	10.9 (<BG)	1,600	19.1 [d]	27.4	No	--
Vanadium	42.3 (<BG)	560	85.1 [d]	-- [g]	No	--
Zinc	35.7 (<BG)	24,000	480	67.8 [d]	No	--

Table 3. Comparison of Contaminant Concentrations to Action Levels for the 100-H-51:2 Excavation Verification Samples. (2 Pages)

COPC	Statistical Result [b] (mg/kg)	Remedial Action Goals [a]			Do the Results Exceed RAGs?	Do the Results Pass RESRAD Modeling?
		Direct Exposure	Soil Cleanup Level for Groundwater Protection	Soil Cleanup Level for River Protection		
Aroclor-1260	0.013	0.5	0.017 [i]	0.017 [i]	No	--

[a] Lookup values and remedial action goals obtained from the 100 Area RDR/RAWP (DOE-RL 2009b).
[b] Maximum or 95% UCL result, depending on data censorship, as described in the *100-H-51:2 Subsite Cleanup Verification 95% UCL Calculation* (Appendix B).
[c] No value; because the K_d value for this contaminant is greater than 80 mL/g, RESRAD modeling discussed in Appendix C of the 100 Area RDR/RAWP (DOE-RL 2009b) predicts that the contaminant will show no migration within the 100 Area vadose zone, and no impact on groundwater or the Columbia River.
[d] Where cleanup levels are less than background, cleanup levels default to background per WAC 173-340-700(4)(d). The arsenic cleanup level of 20 mg/kg has been agreed to by the Tri-Party Agreement project managers as discussed in Section 2.1.2.1 of the 100 Area RDR/RAWP (DOE-RL 2009b).
[e] Carcinogenic cleanup level calculated based on the inhalation exposure pathway per WAC 173-340-750(3), (Method B for air quality) and an airborne particulate mass loading rate of 0.0001 g/m^3 (*Hanford Guidance for Radiological Cleanup* [WDOH 1997]).
[f] No Hanford Site-specific or Washington State background value available.
[g] No parameters (bioconcentration factors or AWQC values) are available from the Cleanup Levels and Risk Calculations Database (Ecology 2014) or other databases to calculate cleanup levels (WAC 173-340-730[3][a][iii], [Method B for surface waters]).
[h] Hanford Site-specific background value is not available. Value used is from *Natural Background Soil Metals Concentrations in Washington State* (Ecology 1994).
[i] Where cleanup levels are less than the RDLs, cleanup levels default to RDLs per WAC 173-340-707(2).

-- = not applicable
AWQC = ambient water quality criteria
BG = background
COPC = contaminant of potential concern
K_d = distribution coefficient
RAG = remedial action goal
RDL = required detection limit
RDR/RAWP = remedial design report/remedial action work plan
RESRAD = RESidual RADioactivity (dose model)
UCL = upper confidence limit
WAC = *Washington Administrative Code*

Potassium-40, radium-226, radium-228, thorium-228, and thorium-232 were detected in samples collected at the site but are not considered in the statistical calculations. These isotopes are naturally occurring, not related to the operational history of the site, and/or were detected below background levels. The complete laboratory results for all constituents are stored in a Washington Closure Hanford project-specific database prior to archival in the Hanford Environmental Information System (HEIS) and are presented in Attachment 1 of the *100-H-51:2 Subsite Cleanup Verification 95% UCL Calculation* (Appendix B).

DATA EVALUATION

This section demonstrates that contaminant concentrations at the 100-H-51:2 subsite achieve the applicable RAGs developed to support unrestricted land use at the 100 Area as established in the Remaining Sites ROD (EPA 1999) and documented in the 100 Area RDR/RAWP (DOE-RL 2009b).

Attainment of Radionuclide Direct Exposure RAGs

Evaluation of RAG attainment for radionuclides was performed using the single-radionuclide dose-equivalence lookup values. The model used to develop these dose-equivalence lookup values is presented in the 100 Area RDR/RAWP (DOE-RL 2009b). A comparison of the radionuclide verification sample results for the statistical data set to the cumulative direct exposure radiological dose limit of 15 mrem/yr was conducted using sum-of-fractions calculations (Appendix B). The sum of fractions were conservatively calculated for the 100-H-51:2 subsite excavation decision unit data set using the greater of the statistical or maximum value for each radionuclide COPC.

The sum of fractions shown in the *100-H-51:2 Subsite Direct Contact Hazard Quotient, Carcinogenic Risk, and Sum of Fractions Calculations* in Appendix B determined that the maximum predicted total radiological dose is 1.21 mrem/yr for the excavation decision unit. By comparing this to the dose limit of <15 mrem/yr the requirement is met.

Attainment of Nonradionuclide RAGs

Table 3 compares the cleanup verification sample values for the 100-H-51:2 subsite to the applicable soil RAGs for direct exposure, protection of groundwater, and protection of the Columbia River. All COPCs were quantified below direct exposure, groundwater, and river protection RAGs.

Three-Part Test for Nonradionuclides

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

The application of the three-part test for the 100-H-51:2 subsite is included in the *100-H-51:2 Subsite Cleanup Verification 95% UCL Calculation* in Appendix B of this remaining sites verification package, where half or more of the data set was detected. The results of this evaluation indicate that residual COPC concentrations pass the three-part test in comparison against applicable RAGs.

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

Nonradionuclide Direct Contact Hazard Quotient and Carcinogenic Risk RAGs Attained

Nonradionuclide risk requirements include an individual hazard quotient of less than 1.0, a cumulative hazard quotient of less than 1.0, an individual contaminant carcinogenic risk of less

than 1 x 10^{-6}, and a cumulative carcinogenic risk of less than 1 x 10^{-5}. For the 100-H-51:2 subsite, these risk values were not calculated for constituents that were either not detected or were detected at concentrations below Hanford Site or Washington State background. All individual hazard quotients for noncarcinogenic constituents were less than 1.0. The cumulative hazard quotient for those noncarcinogenic constituents above background or detected levels is 1.3 x 10^{-3}, which is less than 1.0. The individual carcinogenic risk values for the carcinogenic constituents detected above background are less than 1 x 10^{-6}, and the cumulative carcinogenic risk value is 1.3 x 10^{-7}, which is less than 1 x 10^{-5}. The 100-H-51:2 subsite meets the requirements for the direct contact hazard quotient and excess carcinogenic risk as identified in the 100 Area RDR/RAWP (DOE-RL 2009b).

Nonradionuclide Groundwater Hazard Quotient and Carcinogenic Risk RAGs Attained

Assessment of the risk requirements for the 100-H-51:2 subsite included a calculation of the hazard quotient and carcinogenic (excess cancer) risk values for groundwater protection for nonradionuclides. The requirements include an individual and cumulative hazard quotient of less than 1.0, an individual excess carcinogenic risk of less than 1 x 10^{-6}, and a cumulative excess carcinogenic risk of less than 1 x 10^{-5}. Risk values were calculated for constituents that were detected at concentrations above Hanford Site or Washington State background values or for which there is no background value. In addition, the soil-partitioning coefficients for these contaminants must be less than that necessary to show no migration to groundwater in 1,000 years based on RESidual RADioactivity modeling discussed in Appendix C of the 100 Area RDR/RAWP (DOE-RL 2009b). Based on this model and a vadose zone of approximately 11 m (36 ft) in thickness, a distribution coefficient (K_d) of 6.6 or greater is required to show no predicted migration to groundwater in 1,000 years. All individual hazard quotients for noncarcinogenic constituents are less than 1.0. The cumulative hazard quotient for the 100-H-51:2 subsite is 5.5 x 10^{-2}, which is less than 1.0. No carcinogenic constituents met the criteria for groundwater protection evaluation at the 100-H-51:2 subsite; therefore, no calculation of excess carcinogenic risk was performed. Therefore, nonradionuclide risk requirements related to groundwater are met.

DATA QUALITY ASSESSMENT

A data quality assessment (DQA) was performed to compare the verification sampling approach (WCH 2015b), the field logbook (WCH 2015a), and resulting analytical data with the sampling and data quality requirements specified by the project objectives and performance specifications.

The DQA for the 100-H-51:2 subsite established that the data are of the right type, quality, and quantity to support site closeout decisions within specified error tolerances. The evaluation verified that the sample design was sufficient for the purpose of clean site verification. The cleanup verification sample analytical data are stored in a Washington Closure Hanford project-specific database for data evaluation prior to archival in HEIS and are summarized in Appendix B. The detailed DQA is presented in Appendix C.

SUMMARY FOR INTERIM CLOSURE

The 100-H-51:2 subsite has been evaluated in accordance with the Remaining Sites ROD (EPA 1999) and the 100 Area RDR/RAWP (DOE-RL 2009b). Verification sampling was performed, and the analytical results indicate that the residual concentrations of COPCs at the site meet the remedial action objectives for direct exposure, groundwater protection, and river protection.

In accordance with this evaluation, the verification sampling results support a reclassification of the 100-H-51:2 subsite to Interim Closed Out. Contamination above direct exposure levels was not observed in the shallow zone soils and is concluded to not exist in deep zone soils. Institutional controls to prevent uncontrolled drilling or excavation into the deep zone of the sites are not required.

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WCH, 2015b, *Work Instruction for Verification Sampling of the 100-H-51:2 Subsite,* 0100H-WI-G0068, Rev. 0, Washington Closure Hanford, Richland, Washington.

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APPENDIX A

ECOLOGICAL RISK COMPARISON TABLE

Table A-1. Maximum Contaminant Concentrations that Exceed Ecological Screening Levels for the 100-H-51:2 Subsite [a].

Hazardous Substance		2007 WAC 173-340 Table 749-3			EPA Ecological Soil Screening Levels [b]				Waste Site Analyses
		Plants	Soil Biota	Wildlife	Plants	Soil Biota	Avian [c]	Mammalian [c]	
	Background								
Boron	--	0.5	--	--	--	--	--	--	2.5
Manganese	512	1,100 [d]	--	1,500	220	450	4,300	4,000	271 (<BG)
Vanadium	85.1	2	--	--	--	--	7.8	280	42.3 (<BG)

NOTE: Shaded cells indicate screening values that are exceeded.

[a] Exceedance of screening values does not necessarily indicate the existence of risk to ecological receptors. All exceedances must be evaluated in the context of additional lines of evidence for ecological effects following a baseline risk assessment for the river corridor portion of the Hanford Site, which will include a more complete quantitative ecological risk assessment.

[b] Available on the Internet at www.epa.gov/ecotox/ecossl.

[c] Wildlife.

[d] Benchmark replaced by Washington state natural background concentration from Ecology, 1994, *Natural Background Soil Metals Concentrations in Washington State*, Publication 94-115, Washington State Department of Ecology, Olympia, Washington.

-- = not available
BG = background
EPA = U.S. Environmental Protection Agency
WAC = *Washington Administrative Code*

APPENDIX B

CALCULATIONS

APPENDIX B

CALCULATION BRIEFS

The calculations provided in this appendix are copies of the originals that 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 calculations provided in this appendix include:

100-H-51:2 Subsite Cleanup Verification 95% UCL Calculation, 0100H-CA-V0223, Rev. 0, Washington Closure Hanford, Richland, Washington.

100-H-51:2 Subsite Direct Contact Hazard Quotient, Carcinogenic Risk, and Sum of Fractions Calculations, 0100H-CA-V0224, Rev. 0, Washington Closure Hanford, Richland, Washington.

100-H-51:2 Subsite Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater, 0100H-CA-V0225, 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.

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CALCULATION COVER SHEET

Project Title: 100-H Area Closure Operations **Job No. 14655**

Area: 100-H

Discipline: Environmental *Calculation No: 0100H-CA-V0223

Subject: 100-H-51:2 Subsite Cleanup Verification 95% UCL Calculation

Computer Program: Excel Program No: Excel 2010

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 = 11 Attm. 1 = 5 Total = 17	J. D. Skoglie	I. B. Berezovskiy	R. J. Nielson	S. G. Wilkinson	7/9/15

SUMMARY OF REVISION

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

Washington Closure Hanford **CALCULATION SHEET**

Originator J. D. Skoglie	**Date** 04/06/15	**Calc. No.** 0100H-CA-V0223	**Rev. No.** 0
Project 100-H Area Closure Operations	**Job No.** 14655	**Checked** I. B. Berezovskiy	**Date** 04/06/15
Subject 100-H-51:2 Subsite Cleanup Verification 95% UCL Calculations			**Sheet No.** 1 of 11

Summary

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

Table of Contents:
Sheets 1 to 4 - Calculation Sheet Summary
Sheet 5 to 8- Calculation Sheet Verification Data - Excavation
Sheet 9 to 10 - Ecology Software (MTCAStat) Results
Sheet 11 - Calculation Sheet Duplicate Analysis
Attachment 1 - 100-H-51:2 Verification Sampling Results (5 sheets)

Given/References:
1) Sample Results (Attachment 1).
2) Background values and remedial action goals (RAGs) are taken from DOE-RL (2005b), DOE-RL (2001), and Ecology (1996).
3) DOE-RL, 2001, *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes*, DOE/RL-92-24, Rev. 4, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
4) DOE-RL, 2009a, *100 Area Remedial Action Sampling and Analysis Plan* (SAP), DOE/RL-96-22, Rev. 5, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
5) DOE-RL, 2009b, *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP), DOE/RL-96-17, Rev. 6, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
6) Ecology, 1992, *Statistical Guidance for Ecology Site Managers*, Publication #92-54, Washington Department of Ecology, Olympia, Washington.
7) 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.
8) Ecology, 1996, *Model Toxic Control Act Cleanup Levels and Risk Calculations (CLARC II),* Publication #94-145, Washington State Department of Ecology, Olympia, Washington.
9) Ecology, 2014, Cleanup Levels and Risk Calculations (CLARC) Database, Washington State Department of Ecology, Olympia, Washington, <https://fortress.wa.gov/ecy/clarc/CLARCHome.aspx>.
10) WAC 173-340, 1996, "Model Toxic Control Act - Cleanup," *Washington Administrative Code.*

Solution:
Calculation methodology is described in Ecology Pub. #92-54 (Ecology 1992, 1993), below, and in the RDR/RAWP (DOE-RL 2009b). Use data from attached worksheets to perform the 95% UCL calculation for each analyte, the WAC 173-340-740(7)(e) 3-part test for nonradionuclides, and the RPD calculations for each COC/COPC. The hazard quotient and carcinogenic risk calculations are located in a separate calculation brief as an appendix to the Remaining Sites Verification Package (RSVP).

Calculation Description:
The subject calculations were performed on statistical data from soil verification samples (Attachment 1) from the 100-H-51:2 subsite. The data were entered into an EXCEL 2010 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 2009b) is documented by this calculation. Duplicate RPD results are used in evaluation of data quality within the RSVP for this site.

Methodology:
The 100-H-51:2 subsite underwent statistical sampling at one decision unit for verification sampling that included the excavation area.

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

Washington Closure Hanford **CALCULATION SHEET**

Originator J. D. Skoglie **Date** 05/13/15 **Calc. No.** 0100H-CA-V0228 **Rev. No.** 0
Project 100-H Area Closure Operations **Job No.** 14655 **Checked** I. B. Berezovskiy **Date** 05/13/15
Subject 100-H-51:2 Subsite Cleanup Verification 95% UCL Calculations **Sheet No.** 2 of 11

Summary (continued)

Methodology, continued:

For nonradioactive analytes with ≤50% of the data below detection limits, the statistical value calculated to evaluate the effectiveness of cleanup is the 95% UCL. For nonradioactive analytes with >50% of the data below detection limits, as determined by direct inspection of the sample results (Attachment 1), the maximum detected value for the data set (which includes primary and duplicate samples) is used instead of the 95% UCL, and no further calculations are performed for those data sets. For convenience, these maximum detected values are included in the summary tables that follow. The 95% UCL was not calculated for data sets with no reported detections. Calculated cleanup levels are not available in Ecology (2014) under WAC 173-340-740(3) for aluminum, calcium, iron, magnesium, potassium, silicon, and sodium; therefore, these constituents are not considered site COCs/COPCs and are also not included in these calculations. The 95% UCL value was not calculated for potassium-40, radium-226, radium-228, thorium-228, and thorium-232 based on natural occurence at the Hanford Site.

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

For nonradionuclides, the WAC 173-340 statistical guidance suggests that a test for distributional form be performed on the data and the 95% UCL calculated on the appropriate distribution using Ecology software. For nonradionuclide small data sets (n < 10), the calculations are performed assuming nonparametric distribution, so no tests for distribution are performed. For nonradionuclide data sets of ten or greater, as for the subject site, distributional testing is done using Ecology's MTCAStat software (Ecology 1993). Due to differences in addressing censored data between the RDR/RAWP (DOE-RL 2009b) and MTCAStat coding and due to a limitation in the MTCAStat coding (no direct capability to address variable quantitation limits within a data set), substitutions for censored data are performed before software input and the resulting data set treated as uncensored.

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

The RPD is calculated when both the primary value and either the duplicate or split 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 2-1 of the SAP (DOE-RL 2009a) for certain constituents. All other constituents will have their own pre-determined TDL's based on the laboratory and method used. Where direct evaluation of the attached sample data showed that a given analyte was not detected in the primary and/or duplicate sample, further evaluation of the RPD value was not performed. The RPD calculations use the following formula:

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

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

For quality assurance/quality control (QA/QC) duplicate RPD calculations, a value less than 30% indicates the data compare favorably. If the RPD is greater than 30%, further investigation regarding the usability of the data is performed. To assist in the identification of anomalous sample pairs, when an analyte is detected in the primary or duplicate/split sample, but was quantified at less than 5 times the TDL in one or both samples, an additional parameter is evaluated. In this case, if the difference between the primary and duplicate/split result exceeds a control limit of 2 times the TDL, further assessment regarding the usability of the data is performed. Additional discussion as necessary is provided in the data quality assessment section of the applicable RSVP.

Washington Closure Hanford **CALCULATION SHEET**

Originator J. D. Skoglie	**Date** 04/06/15	**Calc. No.** 0100H-CA-V0223	**Rev. No.** 0
Project 100-H Area Closure Operations	**Job No.** 14655	**Checked** I. B. Berezovskiy	**Date** 04/06/15
Subject 100-H-51:2 Subsite Cleanup Verification 95% UCL Calculations			**Sheet No.** 3 of 11

Summary (continued)

QUALIFIER LIST

B = estimated result. Result is less than the RL but greater than the MDL
J = estimate
M = sample duplicate precision not met.
U = undetected
X = serial dilution in the analytical batch indicates that physical and chemical interferences are present

ACRONYM LIST

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

Washington Closure Hanford **CALCULATION SHEET**

Originator	J. D. Skoglie	**Date** 05/13/15	**Calc. No.** 0100H-CA-V0223	**Rev. No.**	0
Project	100-H Area Closure Operations	**Job No.** 14655	**Checked** I. B. Berezovskiy	**Date**	05/13/15
Subject	100-H-51:2 Subsite Cleanup Verification 95% UCL Calculations			**Sheet No.**	4 of 11

Summary (continued)

Results:
The results presented in the tables that follow include the summary of the results of the 95% UCL calculations for the excavation area, 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	Excavation		Units
	95% UCL Result	Maximum Result	
Cesium-137	0.0134	--	pCi/g
Plutonium-239/240	2.76	--	pCi/g
Uranium-234	0.203	--	pCi/g
Uranium-238	0.208	--	pCi/g
Arsenic	4.1	--	mg/kg
Barium	62.2	--	mg/kg
Beryllium	0.14	--	mg/kg
Boron	--	2.5	mg/kg
Cadmium	0.049	--	mg/kg
Chromium	10.3	--	mg/kg
Cobalt	6.0	--	mg/kg
Copper	13.0	--	mg/kg
Hexavalent chromium	--	0.228	mg/kg
Lead	6.6	--	mg/kg
Manganese	271	--	mg/kg
Mercury	--	0.0057	mg/kg
Nickel	10.9	--	mg/kg
Vanadium	42.3	--	mg/kg
Zinc	35.7	--	mg/kg
Aroclor-1260	--	0.013	mg/kg
3 Part Test Evaluation:			
95% UCL or Maximum[a] > Cleanup Limit?	NA	NO	
> 10% above Cleanup Limit?	NA	NO	
Any sample > 2x Cleanup Limit?	NA	NO	

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

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

Analyte	Excavation
	Duplicate Analysis
Potassium-40	1.3%
Aluminum	6.2%
Barium	6.2%
Calcium	5.3%
Chromium	12.4%
Copper	4.9%
Iron	1.7%
Magnesium	8.6%
Manganese	7.8%
Silicon	10.0%
Vanadium	0.0%
Zinc	0.0%

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

CALCULATION SHEET

Washington Closure Hanford

Originator J. D. Skoglie
Project 100-H Area Closure Operations
Subject 100-H-51:2 Subsite Cleanup Verification 95% UCL Calculations

Date 05/13/15
Job No. 14655

Calc. No. 0100H-CA-V0223
Checked I. B. Berezovskiy

Rev. No. 0
Date 05/13/15
Sheet No. 5 of 11

100-H-51:2 Subsite Statistical Calculations
Verification Data -Excavation

Sample Area	Sample Number	Sample Date	Cesium-137			Plutonium-239/240			Uranium-234			Uranium-238		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
EXC-8	J1V437	2/5/15	-0.0139	U	0.0216	0.102		0.0678	0.288		0.0411	0.211		0.0611
Duplicate of J1V437	J1V443	2/5/15	-0.00648	U	0.0301	0.0301	U	0.0693	0.236		0.0664	0.109		0.0494
EXC-1	J1V430	2/5/15	-0.0165	U	0.0309	10.6		0.0759	0.132		0.0449	0.0954		0.0826
EXC-2	J1V431	2/5/15	0.00840	U	0.0313	3.80		0.0580	0.0793		0.0729	0.139		0.0729
EXC-3	J1V432	2/5/15	-0.00870	U	0.0217	1.29		0.0643	0.233		0.0566	0.249		0.0422
EXC-4	J1V433	2/5/15	-0.00676	U	0.0237	0.898		0.0637	0.154		0.0463	0.102		0.0622
EXC-5	J1V434	2/5/15	-0.00000912	U	0.0226	0.217		0.0630	0.342		0.0543	0.282		0.0600
EXC-6	J1V435	2/5/15	-0.0120	U	0.0317	0.329		0.0632	0.0619	U	0.0928	0.150		0.0582
EXC-7	J1V436	2/5/15	-0.00108	U	0.0297	0.386		0.0521	0.118		0.0458	0.202		0.0615
EXC-9	J1V438	2/5/15	0.0121	U	0.0252	0.319		0.0561	0.0446	U	0.0828	0.182		0.0616
EXC-10	J1V439	2/5/15	0.0239	U	0.0266	0.221		0.0682	0.196		0.0826	0.108		0.0490
EXC-11	J1V440	2/5/15	0.0243	U	0.0258	0.0124	U	0.0672	0.178		0.0370	0.205		0.0370
EXC-12	J1V441	2/5/15	0.0453		0.0214	0.108		0.0663	0.128		0.0854	0.205		0.0680
EXC-13	J1V442	2/5/15	0.0102	U	0.0244	0.177		0.0498	0.206		0.0373	0.261		0.0373

Statistical Computation Input Data

Sample Area	Sample Number	Sample Date	Cesium-137 pCi/g			Plutonium-239/240 pCi/g			Uranium-234 pCi/g			Uranium-238 pCi/g		
EXC-8	J1V437/ J1V443	2/5/15	-0.0102			0.0661			0.262			0.160		
EXC-1	J1V430	2/5/15	-0.0165			10.6			0.132			0.0954		
EXC-2	J1V431	2/5/15	0.00840			3.80			0.0793			0.139		
EXC-3	J1V432	2/5/15	-0.00870			1.29			0.233			0.249		
EXC-4	J1V433	2/5/15	-0.00676			0.898			0.154			0.102		
EXC-5	J1V434	2/5/15	-0.00000912			0.217			0.342			0.282		
EXC-6	J1V435	2/5/15	-0.0120			0.329			0.0619			0.150		
EXC-7	J1V436	2/5/15	-0.00108			0.386			0.118			0.202		
EXC-9	J1V438	2/5/15	0.0121			0.319			0.0446			0.182		
EXC-10	J1V439	2/5/15	0.0239			0.221			0.196			0.108		
EXC-11	J1V440	2/5/15	0.0243			0.0124			0.178			0.205		
EXC-12	J1V441	2/5/15	0.0453			0.108			0.128			0.205		
EXC-13	J1V442	2/5/15	0.0102			0.177			0.206			0.261		

Statistical Computations

	Cesium-137			Plutonium-239/240			Uranium-234			Uranium-238		
95% UCL based on	Radionuclide data set. Use nonparametric z-statistic.			Radionuclide data set. Use nonparametric z-statistic.			Radionuclide data set. Use nonparametric z-statistic.			Radionuclide data set. Use nonparametric z-statistic.		
N	13			13			13			13		
% < Detection limit	92%			8%			15%			0%		
Mean	0.00530			1.42			0.164			0.180		
Standard deviation	0.0178			2.94			0.0844			0.0611		
Z-statistic	1.64			1.64			1.64			1.64		
95% UCL on mean	0.0134			2.76			0.203			0.208		
Maximum value	0.0453			10.6			0.342			0.282		

CALCULATION SHEET

Washington Closure Hanford

Originator J. D. Skoglie
Project 100-H Area Closure Operations
Subject 100-H-51:2 Subsite Cleanup Verification 95% UCL Calculations

Date 04/06/15
Job No. 14655

Calc. No. 0100H-CA-V0223
Checked I. B. Berezovskiy

Rev. No. 0
Date 04/06/15
Sheet No. 6 of 11

1 **100-H-51:2 Subsite Statistical Calculations**
2 **Verification Data -Excavation**

3	Sample	Sample	Sample	Arsenic			Barium			Beryllium			Cadmium			Chromium			Cobalt			Copper			Lead		
4	Area	Number	Date	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
5	EXC-8	J1V437	2/5/15	4.7		0.66	78.0	X	0.075	0.17	B	0.033	0.054	B	0.041	9.8	X	0.058	6.0	X	0.099	12.5		0.22	4.7		0.27
6	Duplicate of J1V437	J1V443	2/5/15	3.9		0.60	73.3	X	0.069	0.17	B	0.030	0.046	B	0.037	11.1	X	0.053	6.3	X	0.091	11.9		0.20	4.4		0.25
7	EXC-1	J1V430	2/5/15	2.1	M	0.66	66.6	X	0.076	0.070	BM	0.033	0.058	BM	0.041	7.4	X	0.058	6.3	X	0.10	13.7		0.22	2.4		0.27
8	EXC-2	J1V431	2/5/15	4.3		0.64	59.4	X	0.073	0.18	B	0.032	0.040	U	0.040	11.7	X	0.056	5.9	X	0.096	10.6		0.21	4.1		0.26
9	EXC-3	J1V432	2/5/15	2.2		0.59	39.3	X	0.068	0.13	B	0.029	0.039	B	0.037	9.2	X	0.052	4.5	X	0.089	11.6		0.19	2.7		0.24
10	EXC-4	J1V433	2/5/15	3.0		0.66	67.8	X	0.076	0.16	B	0.033	0.061	B	0.041	10.2	X	0.058	6.0	X	0.10	11.7		0.22	4.1		0.27
11	EXC-5	J1V434	2/5/15	3.6		0.69	47.1	X	0.079	0.12	B	0.034	0.044	B	0.043	9.7	X	0.060	5.5	X	0.10	12.6		0.23	3.1		0.28
12	EXC-6	J1V435	2/5/15	2.9		0.65	57.9	X	0.075	0.11	B	0.033	0.071	B	0.041	8.7	X	0.057	5.8	X	0.099	13.9		0.21	2.7		0.27
13	EXC-7	J1V436	2/5/15	3.0		0.60	41.0	X	0.069	0.12	B	0.030	0.037	U	0.037	7.5	X	0.053	5.1	X	0.091	11.6		0.20	3.3		0.25
14	EXC-9	J1V438	2/5/15	3.8		0.67	60.0	X	0.077	0.15	B	0.033	0.045	B	0.041	11.1	X	0.059	6.1	X	0.10	11.7		0.22	7.0		0.27
15	EXC-10	J1V439	2/5/15	4.6		0.64	49.3	X	0.074	0.11	B	0.032	0.040	U	0.040	9.5	X	0.056	5.7	X	0.097	11.8		0.21	9.0		0.26
16	EXC-11	J1V440	2/5/15	3.2		0.63	63.1	X	0.072	0.12	B	0.031	0.051	B	0.039	9.2	X	0.055	6.4	X	0.095	14.2		0.21	7.4		0.26
17	EXC-12	J1V441	2/5/15	4.1		0.67	53.6	X	0.078	0.13	B	0.034	0.042	U	0.042	9.5	X	0.059	5.9	X	0.10	13.4		0.22	8.3		0.28
18	EXC-13	J1V442	2/5/15	5.1		0.65	44.2	X	0.075	0.11	B	0.032	0.040	U	0.040	10.4	X	0.057	5.8	X	0.098	12.9		0.21	6.2		0.27

19 **Statistical Computation Input Data**

20	Sample	Sample	Sample	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Lead
21	Area	Number	Date	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
22	EXC-8	J1V437/ J1V443	2/5/15	4.3	75.7	0.17	0.050	10.5	6.2	12.2	4.6
23	EXC-1	J1V430	2/5/15	2.1	66.6	0.070	0.058	7.4	6.3	13.7	2.4
24	EXC-2	J1V431	2/5/15	4.3	59.4	0.18	0.020	11.7	5.9	10.6	4.1
25	EXC-3	J1V432	2/5/15	2.2	39.3	0.13	0.039	9.2	4.5	11.6	2.7
26	EXC-4	J1V433	2/5/15	3.0	67.8	0.16	0.061	10.2	6.0	11.7	4.1
27	EXC-5	J1V434	2/5/15	3.6	47.1	0.12	0.044	9.7	5.5	12.6	3.1
28	EXC-6	J1V435	2/5/15	2.9	57.9	0.11	0.071	8.7	5.8	13.9	2.7
29	EXC-7	J1V436	2/5/15	3.0	41.0	0.12	0.019	7.5	5.1	11.6	3.3
30	EXC-9	J1V438	2/5/15	3.8	60.0	0.15	0.045	11.1	6.1	11.7	7.0
31	EXC-10	J1V439	2/5/15	4.6	49.3	0.11	0.020	9.5	5.7	11.8	9.0
32	EXC-11	J1V440	2/5/15	3.2	63.1	0.12	0.051	9.2	6.4	14.2	7.4
33	EXC-12	J1V441	2/5/15	4.1	53.6	0.13	0.021	9.5	5.9	13.4	8.3
34	EXC-13	J1V442	2/5/15	5.1	44.2	0.11	0.020	10.4	5.8	12.9	6.2

35 **Statistical Computations**

36		Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Lead
37	95% UCL based on	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat normal distribution.	Large data set (n ≥ 10), use MTCAStat normal 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), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.
38	N	13	13	13	13	13	13	13	13
39	% < Detection limit	0%	0%	0%	38%	0%	0%	0%	0%
40	Mean	3.6	55.8	0.13	0.040	9.6	5.8	12.5	5.0
41	Standard deviation	0.92	11.1	0.030	0.018	1.3	0.51	1.1	2.3
42	95% UCL on mean	4.1	62.2	0.14	0.049	10.3	6.0	13.0	6.6
43	Maximum value	5.1	78.0	0.18	0.071	11.7	6.4	14.2	9.0
44	**Most Stringent Cleanup Limit for nonradionuclide and RAG type (mg/kg)**	20 DE, GW & River Protection	200 GW Protection	1.51 GW & River Protection	0.81 GW & River Protection	18.5 GW & River Protection	15.7 GW Protection	22.0 River Protection	10.2 GW & River Protection
45	**WAC 173-340 3-PART TEST**								
46	95% UCL > Cleanup Limit?	NA	NA	NA	NA	NA	NA	NA	NA
47	> 10% above Cleanup Limit?	NA	NA	NA	NA	NA	NA	NA	NA
48	Any sample > 2X Cleanup Limit?	NA	NA	NA	NA	NA	NA	NA	NA
49	**WAC 173-340 Compliance?**	Because all values are below background (6.5 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (132 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (1.51 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (0.81 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (18.5 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (15.7 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (22.0 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (10.2 mg/kg) the WAC 173-340 3-part test is not required.

CALCULATION SHEET

Washington Closure Hanford

Originator J. D. Skoglie
Project 100-H Area Closure Operations
Subject 100-H-51:2 Subsite Cleanup Verification 95% UCL Calculations

Date 04/06/15
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Date 04/06/15
Sheet No. 7 of 11

100-H-51:2 Subsite Statistical Calculations

Verification Data -Excavation

Sample Area	Sample Number	Sample Date	Manganese mg/kg	Q	PQL	Nickel mg/kg	Q	PQL	Vanadium mg/kg	Q	PQL	Zinc mg/kg	Q	PQL
EXC-8	J1V437	2/5/15	295	X	0.099	10.3		0.12	40.7	X	0.093	37.1		0.40
Duplicate of J1V437	J1V443	2/5/15	319	X	0.091	12.2		0.11	40.7	X	0.085	37.1		0.36
EXC-1	J1V430	2/5/15	244	X	0.10	9.7		0.12	50.1	X	0.094	37.2		0.40
EXC-2	J1V431	2/5/15	299	X	0.096	10.9		0.12	35.9	X	0.091	36.9		0.38
EXC-3	J1V432	2/5/15	214	X	0.089	9.4		0.11	34.1	X	0.084	27.9		0.36
EXC-4	J1V433	2/5/15	269	X	0.10	10.7		0.12	36.8	X	0.094	34.2		0.40
EXC-5	J1V434	2/5/15	255	X	0.10	11.0		0.13	40.2	X	0.098	33.7		0.41
EXC-6	J1V435	2/5/15	238	X	0.099	9.9		0.12	41.5	X	0.093	34.2		0.39
EXC-7	J1V436	2/5/15	238	X	0.091	8.9		0.11	36.7	X	0.086	32.9		0.36
EXC-9	J1V438	2/5/15	283	X	0.10	12.5		0.12	43.0	X	0.095	36.8		0.40
EXC-10	J1V439	2/5/15	259	X	0.097	9.9		0.12	40.3	X	0.091	34.0		0.39
EXC-11	J1V440	2/5/15	229	X	0.095	9.3		0.12	40.6	X	0.090	32.2		0.38
EXC-12	J1V441	2/5/15	252	X	0.10	10.7		0.13	40.9	X	0.096	36.0		0.41
EXC-13	J1V442	2/5/15	251	X	0.098	10.6		0.12	42.1	X	0.092	36.0		0.39

Statistical Computation Input Data

Sample Area	Sample Number	Sample Date	Manganese mg/kg			Nickel mg/kg			Vanadium mg/kg			Zinc mg/kg		
EXC-8	J1V437/ J1V443	2/5/15	307			11.3			40.7			37.1		
EXC-1	J1V430	2/5/15	244			9.7			50.1			37.2		
EXC-2	J1V431	2/5/15	299			10.9			35.9			36.9		
EXC-3	J1V432	2/5/15	214			9.4			34.1			27.9		
EXC-4	J1V433	2/5/15	269			10.7			36.8			34.2		
EXC-5	J1V434	2/5/15	255			11.0			40.2			33.7		
EXC-6	J1V435	2/5/15	238			9.9			41.5			34.2		
EXC-7	J1V436	2/5/15	238			8.9			36.7			32.9		
EXC-9	J1V438	2/5/15	283			12.5			43.0			36.8		
EXC-10	J1V439	2/5/15	259			9.9			40.3			34.0		
EXC-11	J1V440	2/5/15	229			9.3			40.6			32.2		
EXC-12	J1V441	2/5/15	252			10.7			40.9			36.0		
EXC-13	J1V442	2/5/15	251			10.6			42.1			36.0		

Statistical Computations

	Manganese	Nickel	Vanadium	Zinc
95% UCL based on	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.
N	13	13	13	13
% < Detection limit	0%	0%	0%	0%
Mean	257	10.4	40.2	34.5
Standard deviation	26.9	0.97	4.0	2.6
95% UCL on mean	271	10.9	42.3	35.7
Maximum value	319	12.5	50.1	37.2
Most Stringent Cleanup Limit for nonradionuclide and RAG type (mg/kg)	512 GW & River Protection	19.1 GW Protection	85.1 GW Protection	67.8 River Protection
WAC 173-340 3-PART TEST				
95% UCL > Cleanup Limit?	NA	NA	NA	NA
> 10% above Cleanup Limit?	NA	NA	NA	NA
Any sample > 2X Cleanup Limit?	NA	NA	NA	NA
WAC 173-340 Compliance?	Because all values are below background (512 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (19.1 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (85.1 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (67.8 mg/kg) the WAC 173-340 3-part test is not required.

MAXIMUM VALUE 3-PART TEST CALCULATION SHEET

Washington Closure Hanford

Originator J. D. Skoglie
Project 100-H Area Closure Operations
Subject 100-H-51:2 Subsite Cleanup Verification 95% UCL Calculations

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Sheet No. 8 of 11

100-H-51:2 Subsite Maximum Calculations
Verification Data - Excavation

Sample Area	Sample Number	Sample Date	Boron			Hexavalent Chromium			Mercury			Aroclor-1260		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	ug/kg	Q	PQL
EXC-8	J1V437	2/5/15	0.97	U	0.97	0.155	U	0.155	0.0053	U	0.0053	2.7	U	2.7
Duplicate of J1V437	J1V443	2/5/15	0.89	U	0.89	0.185		0.155	0.0057	U	0.0057	2.8	U	2.8
EXC-1	J1V430	2/5/15	0.98	U	0.98	0.155	U	0.155	0.0053	U	0.0053	2.7	U	2.7
EXC-2	J1V431	2/5/15	1.1	B	0.95	0.155	U	0.155	0.0058	U	0.0058	2.7	U	2.7
EXC-3	J1V432	2/5/15	0.88	U	0.88	0.155	U	0.155	0.0056	U	0.0056	2.7	U	2.7
EXC-4	J1V433	2/5/15	1.1	B	0.98	0.199		0.155	0.0054	U	0.0054	2.8	U	2.8
EXC-5	J1V434	2/5/15	1.0	U	1.0	0.155	U	0.155	0.0057	U	0.0057	2.7	U	2.7
EXC-6	J1V435	2/5/15	0.97	U	0.97	0.155	U	0.155	0.0054	U	0.0054	2.6	U	2.6
EXC-7	J1V436	2/5/15	0.89	U	0.89	0.155	U	0.155	0.0055	U	0.0055	2.5	U	2.5
EXC-9	J1V438	2/5/15	0.99	U	0.99	0.155	U	0.155	0.0057	B	0.0053	13		2.6
EXC-10	J1V439	2/5/15	1.1	B	0.95	0.155	U	0.155	0.0055	U	0.0055	13		2.6
EXC-11	J1V440	2/5/15	2.5		0.93	0.189		0.155	0.0057	U	0.0057	2.6	U	2.6
EXC-12	J1V441	2/5/15	1.0	U	1.0	0.187		0.155	0.0057	U	0.0057	3.2	J	2.6
EXC-13	J1V442	2/5/15	0.96	U	0.96	0.228		0.155	0.0056	U	0.0056	2.6	U	2.6

3-Part Test Evaluations

	Boron	Hexavalent Chromium	Mercury	Aroclor-1260
% < Detection limit	75%	67%	92%	83%
Maximum value	2.5	0.228	0.0057	13
Most Stringent Cleanup Limit for nonradionuclide and RAG type (mg/kg) unless stated otherwise	320 GW Protection	2 River Protection	0.33 GW & River Protection	17 ug/kg GW & River Protection
3-PART TEST				
Maximum > Cleanup Limit?	NO	NO	NA	NO
> 10% above Cleanup Limit?	NO	NO	NA	NO
Any sample > 2X Cleanup Limit?	NO	NO	NA	NO
3-Part Test Compliance?	The data set meets the 3-part test criteria when compared to the most stringent RAG.	The data set meets the 3-part test criteria when compared to the most stringent RAG.	Because all values are below background (0.33 mg/kg) the 3-part test is not required.	The data set meets the 3-part test criteria when compared to the most stringent RAG.

CALCULATION SHEET

Washington Closure Hanford

Originator J. D. Skoglie
Project 100-H Area Closure Operations
Subject 100-H-51:2 Subsite Cleanup Verification 95% UCL Calculations

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Date 04/06/15
Sheet No. 9 of 11

Ecology Software (MTCAStat) Results, 100-H-51:2 Subsite Excavation

Arsenic 95% UCL Calculation

DATA	ID
4.3	J1V437/ J1V443
2.1	J1V430
4.3	J1V431
2.2	J1V432
3.0	J1V433
3.6	J1V434
2.9	J1V435
3.0	J1V436
3.8	J1V438
4.6	J1V439
3.2	J1V440
4.1	J1V441
5.1	J1V442

Number of samples		Uncensored values	
Uncensored	13	Mean	3.6
Censored		Lognormal mean	3.6
Detection limit or PQL		Std. devn.	0.92
Method detection limit		Median	3.6
TOTAL	13	Min.	2.1
		Max.	5.1

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

UCL (Land's method) is 4.1

Barium 95% UCL Calculation

DATA	ID
75.7	J1V437/ J1V443
66.6	J1V430
59.4	J1V431
39.3	J1V432
67.8	J1V433
47.1	J1V434
57.9	J1V435
41.0	J1V436
60.0	J1V438
49.3	J1V439
63.1	J1V440
53.6	J1V441
44.2	J1V442

Number of samples		Uncensored values	
Uncensored	13	Mean	55.8
Censored		Lognormal mean	55.9
Detection limit or PQL		Std. devn.	11.1
Method detection limit		Median	57.9
TOTAL	13	Min.	39.3
		Max.	75.7

Lognormal distribution? r-squared is: 0.975
Normal distribution? r-squared is: 0.980
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 62.2

Beryllium 95% UCL Calculation

DATA	ID
0.17	J1V437/ J1V443
0.070	J1V430
0.18	J1V431
0.13	J1V432
0.16	J1V433
0.12	J1V434
0.11	J1V435
0.12	J1V436
0.15	J1V438
0.11	J1V439
0.12	J1V440
0.13	J1V441
0.11	J1V442

Number of samples		Uncensored values	
Uncensored	13	Mean	0.13
Censored		Lognormal mean	0.13
Detection limit or PQL		Std. devn.	0.030
Method detection limit		Median	0.12
TOTAL	13	Min.	0.070
		Max.	0.18

Lognormal distribution? r-squared is: 0.898
Normal distribution? r-squared is: 0.935
Recommendations:
Use normal distribution.

UCL (based on t-statistic) is 0.14

Cadmium 95% UCL Calculation

DATA	ID
0.050	J1V437/ J1V443
0.058	J1V430
0.020	J1V431
0.039	J1V432
0.061	J1V433
0.044	J1V434
0.071	J1V435
0.019	J1V436
0.045	J1V438
0.020	J1V439
0.051	J1V440
0.021	J1V441
0.020	J1V442

Number of samples		Uncensored values	
Uncensored	13	Mean	0.040
Censored		Lognormal mean	0.041
Detection limit or PQL		Std. devn.	0.018
Method detection limit		Median	0.044
TOTAL	13	Min.	0.019
		Max.	0.071

Lognormal distribution? r-squared is: 0.871
Normal distribution? r-squared is: 0.909
Recommendations:
Use normal distribution.

UCL (based on t-statistic) is 0.049

Chromium 95% UCL Calculation

DATA	ID
10.5	J1V437/ J1V443
7.4	J1V430
11.7	J1V431
9.2	J1V432
10.2	J1V433
9.7	J1V434
8.7	J1V435
7.5	J1V436
11.1	J1V438
9.5	J1V439
9.2	J1V440
9.5	J1V441
10.4	J1V442

Number of samples		Uncensored values	
Uncensored	13	Mean	9.6
Censored		Lognormal mean	9.6
Detection limit or PQL		Std. devn.	1.3
Method detection limit		Median	9.5
TOTAL	13	Min.	7.4
		Max.	11.7

Lognormal distribution? r-squared is: 0.944
Normal distribution? r-squared is: 0.964
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 10.3

Cobalt 95% UCL Calculation

DATA	ID
6.2	J1V437/ J1V443
6.3	J1V430
5.9	J1V431
4.5	J1V432
6.0	J1V433
5.5	J1V434
5.8	J1V435
5.1	J1V436
6.1	J1V438
5.7	J1V439
6.4	J1V440
5.9	J1V441
5.8	J1V442

Number of samples		Uncensored values	
Uncensored	13	Mean	5.8
Censored		Lognormal mean	5.8
Detection limit or PQL		Std. devn.	0.51
Method detection limit		Median	5.9
TOTAL	13	Min.	4.5
		Max.	6.4

Lognormal distribution? r-squared is: 0.835
Normal distribution? r-squared is: 0.872
Recommendations:
Reject BOTH lognormal and normal distributions

UCL (based on Z-statistic) is 6.0

Copper 95% UCL Calculation

DATA	ID
12.2	J1V437/ J1V443
13.7	J1V430
10.6	J1V431
11.6	J1V432
11.7	J1V433
12.6	J1V434
13.9	J1V435
11.6	J1V436
11.7	J1V438
11.8	J1V439
14.2	J1V440
13.4	J1V441
12.9	J1V442

Number of samples		Uncensored values	
Uncensored	13	Mean	12.5
Censored		Lognormal mean	12.5
Detection limit or PQL		Std. devn.	1.1
Method detection limit		Median	12.2
TOTAL	13	Min.	10.6
		Max.	14.2

Lognormal distribution? r-squared is: 0.947
Normal distribution? r-squared is: 0.946
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 13.0

Lead 95% UCL Calculation

DATA	ID
4.6	J1V437/ J1V443
2.4	J1V430
4.1	J1V431
2.7	J1V432
4.1	J1V433
3.1	J1V434
2.7	J1V435
3.3	J1V436
7.0	J1V438
9.0	J1V439
7.4	J1V440
8.3	J1V441
6.2	J1V442

Number of samples		Uncensored values	
Uncensored	13	Mean	5.0
Censored		Lognormal mean	5.0
Detection limit or PQL		Std. devn.	2.3
Method detection limit		Median	4.1
TOTAL	13	Min.	2.4
		Max.	9.0

Lognormal distribution? r-squared is: 0.944
Normal distribution? r-squared is: 0.912
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 6.6

Manganese 95% UCL Calculation

DATA	ID
307	J1V437/ J1V443
244	J1V430
299	J1V431
214	J1V432
269	J1V433
255	J1V434
238	J1V435
238	J1V436
283	J1V438
259	J1V439
229	J1V440
252	J1V441
251	J1V442

Number of samples		Uncensored values	
Uncensored	13	Mean	257
Censored		Lognormal mean	257
Detection limit or PQL		Std. devn.	27
Method detection limit		Median	252
TOTAL	13	Min.	214
		Max.	307

Lognormal distribution? r-squared is: 0.972
Normal distribution? r-squared is: 0.959
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 271

CALCULATION SHEET

Washington Closure Hanford

Originator J. D. Skoglie
Project 100-H Area Closure Operations
Subject 100-H-51:2 Subsite Cleanup Verification 95% UCL Calculations

Date 04/06/15
Job No. 14655

Calc. No. 0100H-CA-V0223
Checked I. B. Berezovskiy

Rev. No. 0
Date 04/06/15
Sheet No. 10 of 11

Ecology Software (MTCAStat) Results, 100-H-51:2 Subsite Excavation

Nickel 95% UCL Calculation

DATA	ID
11.3	J1V437/ J1V443
9.7	J1V430
10.9	J1V431
9.4	J1V432
10.7	J1V433
11.0	J1V434
9.9	J1V435
8.9	J1V436
12.5	J1V438
9.9	J1V439
9.3	J1V440
10.7	J1V441
10.6	J1V442

Number of samples		Uncensored values	
Uncensored	13	Mean	10.4
Censored		Lognormal mean	10.4
Detection limit or PQL		Std. devn.	0.97
Method detection limit		Median	10.6
TOTAL	13	Min.	8.9
		Max.	12.5

Lognormal distribution? r-squared is: 0.962
Normal distribution? r-squared is: 0.950
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 10.9

Vanadium 95% UCL Calculation

DATA	ID
40.7	J1V437/ J1V443
50.1	J1V430
35.9	J1V431
34.1	J1V432
36.8	J1V433
40.2	J1V434
41.5	J1V435
36.7	J1V436
43.0	J1V438
40.3	J1V439
40.6	J1V440
40.9	J1V441
42.1	J1V442

Number of samples		Uncensored values	
Uncensored	13	Mean	40.2
Censored		Lognormal mean	40.2
Detection limit or PQL		Std. devn.	4.0
Method detection limit		Median	40.6
TOTAL	13	Min.	34.1
		Max.	50.1

Lognormal distribution? r-squared is: 0.906
Normal distribution? r-squared is: 0.882
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 42.3

Zinc 95% UCL Calculation

DATA	ID
37.1	J1V437/ J1V443
37.2	J1V430
36.9	J1V431
27.9	J1V432
34.2	J1V433
33.7	J1V434
34.2	J1V435
32.9	J1V436
36.8	J1V438
34.0	J1V439
32.2	J1V440
36.0	J1V441
36.0	J1V442

Number of samples		Uncensored values	
Uncensored	13	Mean	34.5
Censored		Lognormal mean	34.6
Detection limit or PQL		Std. devn.	2.6
Method detection limit		Median	34.2
TOTAL	13	Min.	27.9
		Max.	37.2

Lognormal distribution? r-squared is: 0.830
Normal distribution? r-squared is: 0.859
Recommendations:
Reject BOTH lognormal and normal distributions

UCL (based on Z-statistic) is 35.7

CALCULATION SHEET

Washington Closure Hanford

Originator J. D. Skoglie
Project 100-H Area Closure Operations
Subject 100-H-51:2 Subsite Cleanup Verification 95% UCL Calculations

Date 05/12/15
Job No. 14655

Calc. No. 0100H-CA-V0223
Checked I. B. Berezovskiy

Rev. No. 0
Date 05/12/15
Sheet No. 11 of 11

Duplicate Analysis - 100-H-51:2 Subsite Excavation

Sampling Area	Sample Number	Sample Date	Potassium-40			Radium-226			Radium-228			Thorium-228			Thorium-232			Uranium-234			Uranium-238			Aluminum			Arsenic		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-8	J1V437	2/5/15	15.5		0.204	0.486		0.0375	0.689		0.0857	0.578		0.0589	0.642		0.117	0.288		0.0411	0.211		0.0611	6520		1.5	4.7		0.66
Duplicate of J1V437	J1V443	2/5/15	15.7		0.241	0.441		0.0564	0.820		0.110	0.665		0.0782	0.743		0.208	0.236		0.0664	0.109		0.0494	6940		1.4	3.9		0.60

Analysis:

TDL		0.5	0.1	0.2	1	1	1	1	5	10
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	Yes (calc RPD)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	Yes (calc RPD)	No-Stop (acceptable)
	RPD	1.3%							6.2%	
	Difference > 2 TDL?	Not applicable	No - acceptable	No - acceptable	No - acceptable	No - acceptable	No - acceptable	No - acceptable	Not applicable	No - acceptable

Duplicate Analysis - 100-H-51:2 Subsite Excavation

Sampling Area	HEIS Number	Sample Date	Barium			Beryllium			Cadmium			Calcium			Chromium			Cobalt			Copper			Iron			Lead		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-8	J1V437	2/5/15	78.0	X	0.075	0.17	B	0.033	0.054	B	0.041	8040	X	14.0	9.8	X	0.058	6.0	X	0.099	12.5		0.22	17800	X	3.8	4.7		0.27
Duplicate of J1V437	J1V443	2/5/15	73.3	X	0.069	0.17	B	0.030	0.046	B	0.037	8480	X	12.8	11.1	X	0.053	6.3	X	0.091	11.9		0.20	18100	X	3.5	4.4		0.25

Analysis:

TDL		2	0.2	0.2	100	1	2	1	5	5
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	Yes (calc RPD)	No-Stop (acceptable)	No-Stop (acceptable)	Yes (calc RPD)	Yes (calc RPD)	No-Stop (acceptable)	Yes (calc RPD)	Yes (calc RPD)	No-Stop (acceptable)
	RPD	6.2%			5.3%	12.4%		4.9%	1.7%	
	Difference > 2 TDL?	Not applicable	No - acceptable	No - acceptable	Not applicable	Not applicable	No - acceptable	Not applicable	Not applicable	No - acceptable

Duplicate Analysis - 100-H-51:2 Subsite Excavation

Sampling Area	HEIS Number	Sample Date	Magnesium			Manganese			Nickel			Potassium			Silicon			Sodium			Vanadium			Zinc		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-8	J1V437	2/5/15	4690	X	3.7	295	X	0.099	10.3		0.12	1360		40.7	304	J	5.6	176		58.6	40.7	X	0.093	37.1		0.40
Duplicate of J1V437	J1V443	2/5/15	5110	X	3.4	319	X	0.091	12.2		0.11	1330		37.2	275	J	5.1	176		53.6	40.7	X	0.085	37.1		0.36

Analysis:

TDL		75	5	4	400	2	50	2.5	1
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	Yes (calc RPD)	Yes (calc RPD)	No-Stop (acceptable)	No-Stop (acceptable)	Yes (calc RPD)	No-Stop (acceptable)	Yes (calc RPD)	Yes (calc RPD)
	RPD	8.6%	7.8%			10.0%		0.0%	0.0%
	Difference > 2 TDL?	Not applicable	Not applicable	No - acceptable	No - acceptable	Not applicable	No - acceptable	Not applicable	Not applicable

Attachment 1. 100-H-51:2 Subsite Verification Sample Results (Radionuclides).

Sample Location	HEIS Number	Sample Date	Americium-241			Carbon-14			Cesium-137			Cobalt-60			Europium-152		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
EXC-8	J1V437	2/5/15	0.0110	U	0.0311	-0.140	UJ	0.481	-0.0139	U	0.0216	-0.00901	U	0.0250	0.00695	U	0.0464
Duplicate of J1V437	J1V443	2/5/15	-0.0241	U	0.151	-0.142	UJ	0.479	-0.00648	U	0.0301	0.00413	U	0.0280	-0.0118	U	0.0834
EXC-1	J1V430	2/5/15	-0.0235	U	0.0995	-0.253	UJ	0.488	-0.0165	U	0.0309	-0.00506	U	0.0329	-0.0189	U	0.0811
EXC-2	J1V431	2/5/15	-0.108	U	0.152	-0.0133	UJ	0.488	0.00840	U	0.0313	0.00629	U	0.0286	-0.0127	U	0.0852
EXC-3	J1V432	2/5/15	0.00271	U	0.0304	0.0889	UJ	0.483	-0.00870	U	0.0217	-0.00647	U	0.0278	-0.00616	U	0.0469
EXC-4	J1V433	2/5/15	-0.00157	U	0.0371	-0.260	UJ	0.485	-0.00676	U	0.0237	-0.00503	U	0.0276	0.0236	U	0.0551
EXC-5	J1V434	2/5/15	0.00407	U	0.0317	-0.0901	UJ	0.483	-9.12E-06	U	0.0226	-0.000178	U	0.0245	-0.0148	U	0.0490
EXC-6	J1V435	2/5/15	0.00529	U	0.102	-0.0634	UJ	0.488	-0.0120	U	0.0317	0.0189	U	0.0406	-0.0198	U	0.0871
EXC-7	J1V436	2/5/15	-0.131	U	0.146	-0.125	UJ	0.484	-0.00108	U	0.0297	-0.00342	U	0.0276	-0.0163	U	0.0843
EXC-9	J1V438	2/5/15	-0.00965	U	0.0290	-0.0618	UJ	0.481	0.0121	U	0.0252	-0.00546	U	0.0236	-0.00926	U	0.0473
EXC-10	J1V439	2/5/15	-0.00450	U	0.0302	-0.176	UJ	0.477	0.0239	U	0.0266	0.00627	U	0.0250	-0.0295	U	0.0439
EXC-11	J1V440	2/5/15	-0.00191	U	0.0286	-0.0286	UJ	0.483	0.0243	U	0.0258	-0.0109	U	0.0219	-0.00166	U	0.0450
EXC-12	J1V441	2/5/15	0.0102	U	0.0306	-0.0126	UJ	0.485	0.0453		0.0214	-0.00792	U	0.0215	0.000265	U	0.0463
EXC-13	J1V442	2/5/15	0.00546	U	0.0298	0.00673	UJ	0.483	0.0102	U	0.0244	-0.000356	U	0.0247	-0.00197	U	0.0466

Sample Location	HEIS Number	Sample Date	Europium-154			Europium-155			Plutonium-238			Plutonium-239/240			Potassium-40		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
EXC-8	J1V437	2/5/15	-0.0238	U	0.0757	0.0289	U	0.0454	0.00534	UJ	0.0954	0.102		0.0678	15.5		0.204
Duplicate of J1V437	J1V443	2/5/15	-0.0253	U	0.0960	-0.0110	U	0.106	-0.00385	UJ	0.0800	0.0301	U	0.0693	15.7		0.241
EXC-1	J1V430	2/5/15	0.0257	U	0.120	0.0383	U	0.0791	0.0659	UJ	0.111	10.6		0.0759	12.8		0.262
EXC-2	J1V431	2/5/15	-0.0118	U	0.0960	0.0153	U	0.110	0.0179	UJ	0.0975	3.80		0.0580	16.9		0.221
EXC-3	J1V432	2/5/15	0.0125	U	0.0927	0.0461	U	0.0442	0.00952	UJ	0.0818	1.29		0.0643	16.1		0.287
EXC-4	J1V433	2/5/15	-0.0282	U	0.0850	0.0253	U	0.0524	0.0348	UJ	0.0948	0.898		0.0637	15.7		0.229
EXC-5	J1V434	2/5/15	-0.0134	U	0.0812	0.0439	U	0.0474	-0.00992	UJ	0.0955	0.217		0.0630	15.0		0.200
EXC-6	J1V435	2/5/15	-0.00656	U	0.122	0.0650	U	0.0854	0.0358	UJ	0.105	0.329		0.0632	14.1		0.333
EXC-7	J1V436	2/5/15	0.0425	U	0.0989	-0.0166	U	0.106	0.0177	UJ	0.0967	0.386		0.0521	15.2		0.220
EXC-9	J1V438	2/5/15	-0.0556	U	0.0854	0.0241	U	0.0441	0.00558	UJ	0.0880	0.319		0.0561	14.2		0.273
EXC-10	J1V439	2/5/15	-0.0232	U	0.0788	0.0141	U	0.0451	0.0125	UJ	0.0682	0.221		0.0682	14.9		0.209
EXC-11	J1V440	2/5/15	-0.00659	U	0.0760	0.0408	U	0.0422	-0.00176	UJ	0.0635	0.0124	U	0.0672	14.5		0.214
EXC-12	J1V441	2/5/15	0.00684	U	0.0783	0.0330	U	0.0448	-0.000554	UJ	0.0504	0.108		0.0663	14.4		0.186
EXC-13	J1V442	2/5/15	0.0137	U	0.0746	0.0243	U	0.0441	-0.00493	UJ	0.0753	0.177		0.0498	14.4		0.198

Sample Location	HEIS Number	Sample Date	Radium-226			Radium-228			Thorium-228			Thorium-232			Total beta radiostrontium		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
EXC-8	J1V437	2/5/15	0.486		0.0375	0.689		0.0857	0.578		0.0589	0.642		0.117	-0.0404	U	0.275
Duplicate of J1V437	J1V443	2/5/15	0.441		0.0564	0.820		0.110	0.665		0.0782	0.743		0.208	0.0736	U	0.273
EXC-1	J1V430	2/5/15	0.480		0.0630	0.472		0.125	0.466		0.0795	0.725		0.204	0.114	U	0.282
EXC-2	J1V431	2/5/15	0.535		0.0563	0.792		0.108	0.659		0.0797	0.688		0.201	-0.0210	U	0.259
EXC-3	J1V432	2/5/15	0.391		0.0369	0.556		0.0978	0.455		0.0561	0.563		0.115	0.134	U	0.278
EXC-4	J1V433	2/5/15	0.551		0.0432	0.946		0.0967	0.743		0.0641	0.895		0.140	0.0415	U	0.261
EXC-5	J1V434	2/5/15	0.428		0.0381	0.546	U	0.189	0.495		0.0567	0.560		0.116	-0.0447	U	0.258
EXC-6	J1V435	2/5/15	0.430		0.0643	0.687		0.128	0.574		0.0916	0.804		0.186	-0.0220	U	0.286
EXC-7	J1V436	2/5/15	0.466	U	0.107	0.540		0.104	0.769		0.0822	0.703		0.192	0.125	U	0.335
EXC-9	J1V438	2/5/15	0.384		0.0389	0.592		0.080	0.635		0.0538	0.667		0.116	0.0552	U	0.248
EXC-10	J1V439	2/5/15	0.400		0.0382	0.696		0.0861	0.531		0.0595	0.671		0.115	0.0971	U	0.252
EXC-11	J1V440	2/5/15	0.463		0.0332	0.721		0.0789	0.537		0.0528	0.677		0.118	-0.00142	U	0.277
EXC-12	J1V441	2/5/15	0.408		0.0336	0.668		0.0816	0.466		0.0511	0.631		0.105	-0.0202	U	0.275
EXC-13	J1V442	2/5/15	0.363		0.0378	0.485		0.0844	0.537		0.0490	0.638		0.107	-0.0192	U	0.258

Sample Location	HEIS Number	Sample Date	Tritium			Uranium-234			Uranium-235			Uranium-238		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
EXC-8	J1V437	2/5/15	0.0222	UJ	0.110	0.288		0.0411	0.0152	UJ	0.0411	0.211		0.0611
Duplicate of J1V437	J1V443	2/5/15	0.00305	UJ	0.0607	0.236		0.0664	0.0182	UJ	0.0494	0.109		0.0494
EXC-1	J1V430	2/5/15	0.0136	UJ	0.0589	0.132		0.0449	0.0166	UJ	0.0449	0.0954		0.0826
EXC-2	J1V431	2/5/15	0.0125	UJ	0.0622	0.0793		0.0729	0.0393	UJ	0.0729	0.139		0.0729
EXC-3	J1V432	2/5/15	-0.00904	UJ	0.0600	0.233		0.0566	-0.000622	UJ	0.0566	0.249		0.0422
EXC-4	J1V433	2/5/15	0.0315	UJ	0.180	0.154		0.0463	0.0171	UJ	0.0463	0.102		0.0622
EXC-5	J1V434	2/5/15	0.00035	UJ	0.0586	0.342		0.0543	0	UJ	0.0404	0.282		0.0600
EXC-6	J1V435	2/5/15	0.00311	UJ	0.0565	0.0619	U	0.0928	0	UJ	0.0582	0.150		0.0582
EXC-7	J1V436	2/5/15	0.0156	UJ	0.0766	0.118		0.0458	0	UJ	0.0458	0.202		0.0615
EXC-9	J1V438	2/5/15	-0.0300	UJ	0.0606	0.0446	U	0.0828	0.0227	UJ	0.0616	0.182		0.0616
EXC-10	J1V439	2/5/15	-0.00410	UJ	0.0634	0.196		0.0826	0.0181	UJ	0.0490	0.108		0.0490
EXC-11	J1V440	2/5/15	-0.0111	UJ	0.0812	0.178		0.0370	0	UJ	0.0370	0.205		0.0370
EXC-12	J1V441	2/5/15	0.0435	UJ	0.0895	0.128		0.0854	-0.000747	UJ	0.0680	0.205		0.0680
EXC-13	J1V442	2/5/15	-0.0119	UJ	0.0666	0.206		0.0373	-0.000550	UJ	0.0501	0.261		0.0373

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

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

B = blank contamination (inorganic constituents)

HEIS = Hanford Environmental Information System

J = estimate

M = sample duplicate precision not met.

MDA = minimum dection allowed

ND = not detected

PQL = practical quantitation limit

Q = qualifier

U = undetected

X = serial dilution in the analytical batch indicates physical and chemical interferences are present.

Attachment	1	Sheet No.	1 of 5
Originator	J. D. Skoglie	Date	5/12/15
Checked	I. B. Berezovskiy	Job No.	2/14/40
Calc. No.	0100H-CA-V0223	Rev. No.	0

Attachment 1. 100-H-51:2 Subsite Verification Sample Results (Metals).

Sample Location	HEIS Number	Sample Date	Aluminum			Antimony			Arsenic			Barium			Beryllium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-8	J1V437	2/5/15	6520		1.5	0.38	UJ	0.38	4.7		0.66	78.0	X	0.075	0.17	B	0.033
Duplicate of J1V437	J1V443	2/5/15	6940		1.4	0.35	UJ	0.35	3.9		0.60	73.3	X	0.069	0.17	B	0.030
EXC-1	J1V430	2/5/15	5270		1.6	0.38	UJ	0.38	2.1	M	0.66	66.6	X	0.076	0.07	BM	0.033
EXC-2	J1V431	2/5/15	7240		1.5	0.37	UJ	0.37	4.3		0.64	59.4	X	0.073	0.18	B	0.032
EXC-3	J1V432	2/5/15	5600		1.4	0.34	UJ	0.34	2.2		0.59	39.3	X	0.068	0.13	B	0.029
EXC-4	J1V433	2/5/15	7140		1.5	0.38	UJ	0.38	3.0		0.66	67.8	X	0.076	0.16	B	0.033
EXC-5	J1V434	2/5/15	6060		1.6	0.40	UJ	0.40	3.6		0.69	47.1	X	0.079	0.12	B	0.034
EXC-6	J1V435	2/5/15	5700		1.5	0.38	UJ	0.38	2.9		0.65	57.9	X	0.075	0.11	B	0.033
EXC-7	J1V436	2/5/15	5540		1.4	0.35	UJ	0.35	3.0		0.60	41.0	X	0.069	0.12	B	0.030
EXC-9	J1V438	2/5/15	6520		1.6	0.38	UJ	0.38	3.8		0.67	60.0	X	0.077	0.15	B	0.033
EXC-10	J1V439	2/5/15	5590		1.5	0.37	UJ	0.37	4.6		0.64	49.3	X	0.074	0.11	B	0.032
EXC-11	J1V440	2/5/15	5540		1.5	0.36	UJ	0.36	3.2		0.63	63.1	X	0.072	0.12	B	0.031
EXC-12	J1V441	2/5/15	5960		1.6	0.39	UJ	0.39	4.1		0.67	53.6	X	0.078	0.13	B	0.034
EXC-13	J1V442	2/5/15	5770		1.5	0.37	UJ	0.37	5.1		0.65	44.2	X	0.075	0.11	B	0.032
Equipment Blank	J1V444	2/5/15	127		1.4	0.34	UJ	0.34	0.59	B	0.59	1.3	X	0.068	0.029	U	0.029

Sample Location	HEIS Number	Sample Date	Boron			Cadmium			Calcium			Chromium			Cobalt		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-8	J1V437	2/5/15	0.97	U	0.97	0.054	B	0.041	8040	X	14.0	9.8	X	0.058	6.0	X	0.099
Duplicate of J1V437	J1V443	2/5/15	0.89	U	0.89	0.046	B	0.037	8480	X	12.8	11.1	X	0.053	6.3	X	0.091
EXC-1	J1V430	2/5/15	0.98	U	0.98	0.058	BM	0.041	5840	X	14.1	7.4	X	0.058	6.3	X	0.10
EXC-2	J1V431	2/5/15	1.1	B	0.95	0.040	U	0.040	9550	X	13.6	11.7	X	0.056	5.9	X	0.096
EXC-3	J1V432	2/5/15	0.88	U	0.88	0.039	B	0.037	3750	X	12.6	9.2	X	0.052	4.5	X	0.089
EXC-4	J1V433	2/5/15	1.1	B	0.98	0.061	B	0.041	4300	X	14.1	10.2	X	0.058	6.0	X	0.10
EXC-5	J1V434	2/5/15	1.0	U	1.0	0.044	B	0.043	6250	X	14.7	9.7	X	0.060	5.5	X	0.10
EXC-6	J1V435	2/5/15	0.97	U	0.97	0.071	B	0.041	5260	X	14.0	8.7	X	0.057	5.8	X	0.099
EXC-7	J1V436	2/5/15	0.89	U	0.89	0.037	U	0.037	4740	X	12.8	7.5	X	0.053	5.1	X	0.091
EXC-9	J1V438	2/5/15	0.99	U	0.99	0.045	B	0.041	8000	X	14.2	11.1	X	0.059	6.1	X	0.10
EXC-10	J1V439	2/5/15	1.1	B	0.95	0.040	U	0.040	6810	X	13.7	9.5	X	0.056	5.7	X	0.097
EXC-11	J1V440	2/5/15	2.5		0.93	0.051	B	0.039	5680	X	13.4	9.2	X	0.055	6.4	X	0.095
EXC-12	J1V441	2/5/15	1.0	U	1.0	0.042	U	0.042	7330	X	14.4	9.5	X	0.059	5.9	X	0.10
EXC-13	J1V442	2/5/15	0.96	U	0.96	0.040	U	0.040	7600	X	13.9	10.4	X	0.057	5.8	X	0.098
Equipment Blank	J1V444	2/5/15	0.88	U	0.88	0.037	U	0.037	37.5	UJBCX	12.6	0.14	BX	0.052	0.13	BX	0.089

Attachment	1	Sheet No.	2 of 5
Originator	J. D. Skoglie	Date	4/6/15
Checked	I. B. Berezovskiy	Job No.	2/14/40
Calc. No.	0100H-CA-V0223	Rev. No.	0

Attachment 1. 100-H-51:2 Subsite Verification Sample Results (Metals).

Sample Location	HEIS Number	Sample Date	Copper			Hexavalent Chromium			Iron			Lead			Magnesium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-8	J1V437	2/5/15	12.5		0.22	0.155	U	0.155	17800	X	3.8	4.7		0.27	4690	X	3.7
Duplicate of J1V437	J1V443	2/5/15	11.9		0.20	0.185		0.155	18100	X	3.5	4.4		0.25	5110	X	3.4
EXC-1	J1V430	2/5/15	13.7		0.22	0.155	U	0.155	19200	X	3.8	2.4		0.27	3760	X	3.7
EXC-2	J1V431	2/5/15	10.6		0.21	0.155	U	0.155	16900	X	3.7	4.1		0.26	5160	X	3.6
EXC-3	J1V432	2/5/15	11.6		0.19	0.155	U	0.155	13200	X	3.4	2.7		0.24	3660	X	3.3
EXC-4	J1V433	2/5/15	11.7		0.22	0.199		0.155	16900	X	3.8	4.1		0.27	3940	X	3.7
EXC-5	J1V434	2/5/15	12.6		0.23	0.155	U	0.155	15400	X	4.0	3.1		0.28	4150	X	3.9
EXC-6	J1V435	2/5/15	13.9		0.21	0.155	U	0.155	16500	X	3.8	2.7		0.27	4000	X	3.7
EXC-7	J1V436	2/5/15	11.6		0.20	0.155	U	0.155	14700	X	3.5	3.3		0.25	3710	X	3.4
EXC-9	J1V438	2/5/15	11.7		0.22	0.155	U	0.155	17500	X	3.8	7.0		0.27	4750	X	3.7
EXC-10	J1V439	2/5/15	11.8		0.21	0.155	U	0.155	16200	X	3.7	9.0		0.26	4020	X	3.6
EXC-11	J1V440	2/5/15	14.2		0.21	0.189		0.155	15300	X	3.6	7.4		0.26	3800	X	3.5
EXC-12	J1V441	2/5/15	13.4		0.22	0.187		0.155	16200	X	3.9	8.3		0.28	4090	X	3.8
EXC-13	J1V442	2/5/15	12.9		0.21	0.228		0.155	16000	X	3.7	6.2		0.27	4050	X	3.6
Equipment Blank	J1V444	2/5/15	0.36	B	0.19				177	X	3.4	0.24	U	0.24	19	UJCX	3.3

Sample Location	HEIS Number	Sample Date	Manganese			Mercury			Molybdenum			Nickel			Potassium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-8	J1V437	2/5/15	295	X	0.099	0.0053	U	0.0053	0.26	U	0.26	10.3		0.12	1360		40.7
Duplicate of J1V437	J1V443	2/5/15	319	X	0.091	0.0057	U	0.0057	0.24	U	0.24	12.2		0.11	1330		37.2
EXC-1	J1V430	2/5/15	244	X	0.10	0.0053	U	0.0053	0.26	U	0.26	9.7		0.12	687		41.0
EXC-2	J1V431	2/5/15	299	X	0.096	0.0058	U	0.0058	0.25	U	0.25	10.9		0.12	1370		39.5
EXC-3	J1V432	2/5/15	214	X	0.089	0.0056	U	0.0056	0.23	U	0.23	9.4		0.11	734		36.6
EXC-4	J1V433	2/5/15	269	X	0.10	0.0054	U	0.0054	0.26	U	0.26	10.7		0.12	1310		40.9
EXC-5	J1V434	2/5/15	255	X	0.10	0.0057	U	0.0057	0.27	U	0.27	11.0		0.13	823		42.7
EXC-6	J1V435	2/5/15	238	X	0.099	0.0054	U	0.0054	0.26	U	0.26	9.9		0.12	781		40.6
EXC-7	J1V436	2/5/15	238	X	0.091	0.0055	U	0.0055	0.24	U	0.24	8.9		0.11	860		37.3
EXC-9	J1V438	2/5/15	283	X	0.10	0.0057	B	0.0053	0.26	U	0.26	12.5		0.12	1080		41.4
EXC-10	J1V439	2/5/15	259	X	0.097	0.0055	U	0.0055	0.25	U	0.25	9.9		0.12	855		39.8
EXC-11	J1V440	2/5/15	229	X	0.095	0.0057	U	0.0057	0.25	U	0.25	9.3		0.12	773		39.1
EXC-12	J1V441	2/5/15	252	X	0.10	0.0057	U	0.0057	0.27	U	0.27	10.7		0.13	896		41.8
EXC-13	J1V442	2/5/15	251	X	0.098	0.0056	U	0.0056	0.26	U	0.26	10.6		0.12	859		40.3
Equipment Blank	J1V444	2/5/15	3.0	X	0.089	0.0053	U	0.0053	0.23	U	0.23	0.20	B	0.11	48.9	B	36.6

Attachment	1	Sheet No.	3 of 5
Originator	J. D. Skoglie	Date	4/6/15
Checked	I. B. Berezovskiy	Job No.	2/14/40
Calc. No.	0100H-CA-V0223	Rev. No.	0

Attachment 1. 100-H-51:2 Subsite Verification Sample Results (Metals and Physical).

Sample Location	HEIS Number	Sample Date	Selenium			Silicon			Silver			Sodium			Vanadium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-8	J1V437	2/5/15	0.85	U	0.85	304	J	5.6	0.16	U	0.16	176		58.6	40.7	X	0.093
Duplicate of J1V437	J1V443	2/5/15	0.78	U	0.78	275	J	5.1	0.15	U	0.15	176		53.6	40.7	X	0.085
EXC-1	J1V430	2/5/15	0.86	U	0.86	184	J	5.7	0.16	U	0.16	264		59.1	50.1	X	0.094
EXC-2	J1V431	2/5/15	0.83	U	0.83	331	J	5.5	0.15	U	0.15	190		56.9	35.9	X	0.091
EXC-3	J1V432	2/5/15	0.77	U	0.77	218	J	5.1	0.14	U	0.14	147		52.7	34.1	X	0.084
EXC-4	J1V433	2/5/15	0.86	U	0.86	339	J	5.6	0.16	U	0.16	198		58.9	36.8	X	0.094
EXC-5	J1V434	2/5/15	0.90	U	0.90	225	J	5.9	0.17	U	0.17	179		61.4	40.2	X	0.098
EXC-6	J1V435	2/5/15	0.85	U	0.85	277	J	5.6	0.16	U	0.16	185		58.4	41.5	X	0.093
EXC-7	J1V436	2/5/15	0.78	U	0.78	268	J	5.2	0.15	U	0.15	173		53.7	36.7	X	0.086
EXC-9	J1V438	2/5/15	0.87	U	0.87	281	J	5.7	0.16	U	0.16	191		59.6	43.0	X	0.095
EXC-10	J1V439	2/5/15	0.84	U	0.84	230	J	5.5	0.16	U	0.16	218		57.3	40.3	X	0.091
EXC-11	J1V440	2/5/15	0.82	U	0.82	249	J	5.4	0.15	U	0.15	242		56.3	40.6	X	0.090
EXC-12	J1V441	2/5/15	0.88	U	0.88	251	J	5.8	0.16	U	0.16	217		60.2	40.9	X	0.096
EXC-13	J1V442	2/5/15	0.85	U	0.85	251	J	5.6	0.16	U	0.16	199		58.0	42.1	X	0.092
Equipment Blank	J1V444	2/5/15	0.77	U	0.77	95.1	J	5.1	0.14	U	0.14	52.7	U	52.7	0.22	BX	0.084

Sample Location	HEIS Number	Sample Date	Zinc			Percent moisture (wet sample)		
			mg/kg	Q	PQL	%	Q	PQL
EXC-8	J1V437	2/5/15	37.1		0.40	5.9		0
Duplicate of J1V437	J1V443	2/5/15	37.1		0.36	5.9		0
EXC-1	J1V430	2/5/15	37.2		0.40	3.9		0
EXC-2	J1V431	2/5/15	36.9		0.38	5.7		0
EXC-3	J1V432	2/5/15	27.9		0.36	4.3		0
EXC-4	J1V433	2/5/15	34.2		0.40	11.3		0
EXC-5	J1V434	2/5/15	33.7		0.41	5.9		0
EXC-6	J1V435	2/5/15	34.2		0.39	5.6		0
EXC-7	J1V436	2/5/15	32.9		0.36	5.3		0
EXC-9	J1V438	2/5/15	36.8		0.40	6.5		0
EXC-10	J1V439	2/5/15	34.0		0.39	6.4		0
EXC-11	J1V440	2/5/15	32.2		0.38	8		0
EXC-12	J1V441	2/5/15	36.0		0.41	5.7		0
EXC-13	J1V442	2/5/15	36.0		0.39	5.8		0
Equipment Blank	J1V444	2/5/15	1.1		0.36	0.1	U	0

Attachment	1	Sheet No.	4 of 5
Originator	J. D. Skoglie	Date	4/6/15
Checked	I. B. Berezovskiy	Job No.	2/14/40
Calc. No.	0100H-CA-V0223	Rev. No.	0

Attachment 1. 100-H-51:2 Subsite Verification Sample Results (Organics and Asbestos).

CONSTITUENT	CLASS	J1V430			J1V431			J1V432			J1V433			J1V434			J1V435		
		2/5/15			2/5/15			2/5/15			2/5/15			2/5/15			2/5/15		
		ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
Aroclor-1016	PCB	2.8	U	2.8	2.8	U	2.8	2.9	U	2.9	3.0	U	3.0	2.8	U	2.8	2.7	U	2.7
Aroclor-1221	PCB	8.2	U	8.2	8.2	U	8.2	8.3	U	8.3	8.7	U	8.7	8.2	U	8.2	7.9	U	7.9
Aroclor-1232	PCB	2.0	U	2.0	2.1	U	2.1	2.1	U	2.1	2.2	U	2.2	2.0	U	2.0	2.0	U	2.0
Aroclor-1242	PCB	4.8	U	4.8	4.8	U	4.8	4.8	U	4.8	5.0	U	5.0	4.8	U	4.8	4.6	U	4.6
Aroclor-1248	PCB	4.8	U	4.8	4.8	U	4.8	4.8	U	4.8	5.0	U	5.0	4.8	U	4.8	4.6	U	4.6
Aroclor-1254	PCB	2.7	U	2.7	2.7	U	2.7	2.7	U	2.7	2.8	U	2.8	2.7	U	2.7	2.6	U	2.6
Aroclor-1260	PCB	2.7	U	2.7	2.7	U	2.7	2.7	U	2.7	2.8	U	2.8	2.7	U	2.7	2.6	U	2.6

CONSTITUENT	CLASS	J1V436			J1V437			J1V438			J1V439			J1V440			J1V441		
		2/5/15			2/5/15			2/5/15			2/5/15			2/5/15			2/5/15		
		ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
Aroclor-1016	PCB	2.7	U	2.7	2.9	U	2.9	2.8	U	2.8	2.8	U	2.8	2.8	U	2.8	2.8	U	2.8
Aroclor-1221	PCB	7.7	U	7.7	8.4	U	8.4	8.0	U	8.0	8.0	U	8.0	8.0	U	8.0	8.2	U	8.2
Aroclor-1232	PCB	1.9	U	1.9	2.1	U	2.1	2.0	U	2.0	2.0	U	2.0	2.0	U	2.0	2.0	U	2.0
Aroclor-1242	PCB	4.5	U	4.5	4.9	U	4.9	4.6	U	4.6	4.7	U	4.7	4.6	U	4.6	4.7	U	4.7
Aroclor-1248	PCB	4.5	U	4.5	4.9	U	4.9	4.6	U	4.6	4.7	U	4.7	4.6	U	4.6	4.7	U	4.7
Aroclor-1254	PCB	2.5	U	2.5	2.7	U	2.7	2.6	U	2.6	2.6	U	2.6	2.6	U	2.6	2.6	U	2.6
Aroclor-1260	PCB	2.5	U	2.5	2.7	U	2.7	13		2.6	13		2.6	2.6	U	2.6	3.2	J	2.6

CONSTITUENT	CLASS	J1V442			J1V443		
		2/5/15			2/5/15		
		ug/kg	Q	PQL	ug/kg	Q	PQL
Aroclor-1016	PCB	2.7	U	2.7	2.9	U	2.9
Aroclor-1221	PCB	7.9	U	7.9	8.5	U	8.5
Aroclor-1232	PCB	2.0	U	2.0	2.1	U	2.1
Aroclor-1242	PCB	4.6	U	4.6	4.9	U	4.9
Aroclor-1248	PCB	4.6	U	4.6	4.9	U	4.9
Aroclor-1254	PCB	2.6	U	2.6	2.8	U	2.8
Aroclor-1260	PCB	2.6	U	2.6	2.8	U	2.8

Sample Location	HEIS Number	Sample Date	Chrysotyle			Amosite			Crocidolite			Tremolite			Actinolite			Anthophyllite		
			%	Q	RDL	%	Q	RDL	%	Q	RDL	%	Q	RDL	%	Q	RDL	%	Q	RDL
EXC-8	J1V452	2/5/15	ND	U	ND	ND	U	ND	ND	U	ND	ND	U	ND	ND	U	ND	ND	U	ND
Duplicate of J1V452	J1V458	2/5/15	ND	U	ND	ND	U	ND	ND	U	ND	ND	U	ND	ND	U	ND	ND	U	ND
EXC-1	J1V445	2/5/15	ND	U	ND	ND	U	ND	ND	U	ND	ND	U	ND	ND	U	ND	ND	U	ND
EXC-2	J1V446	2/5/15	ND	U	ND	ND	U	ND	ND	U	ND	ND	U	ND	ND	U	ND	ND	U	ND
EXC-3	J1V447	2/5/15	ND	U	ND	ND	U	ND	ND	U	ND	ND	U	ND	ND	U	ND	ND	U	ND
EXC-4	J1V448	2/5/15	ND	U	ND	ND	U	ND	ND	U	ND	ND	U	ND	ND	U	ND	ND	U	ND
EXC-5	J1V449	2/5/15	ND	U	ND	ND	U	ND	ND	U	ND	ND	U	ND	ND	U	ND	ND	U	ND
EXC-6	J1V450	2/5/15	ND	U	ND	ND	U	ND	ND	U	ND	ND	U	ND	ND	U	ND	ND	U	ND
EXC-7	J1V451	2/5/15	ND	U	ND	ND	U	ND	ND	U	ND	ND	U	ND	ND	U	ND	ND	U	ND
EXC-9	J1V453	2/5/15	ND	U	ND	ND	U	ND	ND	U	ND	ND	U	ND	ND	U	ND	ND	U	ND
EXC-10	J1V454	2/5/15	ND	U	ND	ND	U	ND	ND	U	ND	ND	U	ND	ND	U	ND	ND	U	ND
EXC-11	J1V455	2/5/15	ND	U	ND	ND	U	ND	ND	U	ND	ND	U	ND	ND	U	ND	ND	U	ND
EXC-12	J1V456	2/5/15	ND	U	ND	ND	U	ND	ND	U	ND	ND	U	ND	ND	U	ND	ND	U	ND
EXC-13	J1V457	2/5/15	ND	U	ND	ND	U	ND	ND	U	ND	ND	U	ND	ND	U	ND	ND	U	ND

Attachment	1	Sheet No.	5 of 5
Originator	J. D. Skoglie	Date	4/6/15
Checked	I. B. Berezovskiy	Job No.	2/14/40
Calc. No.	0100H-CA-V0223	Rev. No.	0

Acrobat 8.0

CALCULATION COVER SHEET

Project Title: 100-H Area Closure Operations **Job No. 14655**

Area: 100-H

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

Subject: 100-H-51:2 Subsite Direct Contact Hazard Quotient, Carcinogenic Risk, and Sum of Fractions Calculations

Computer Program: Excel Program No: Excel 2010

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 = 5 Total = 6	J. D. Skoglie	L. B. Berezovskiy	R. J. Nielson	S. G. Wilkinson	7/9/15

SUMMARY OF REVISION

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

Washington Closure Hanford CALCULATION SHEET

Originator:	J. D. Skoglie	Date:	04/06/15	Calc. No.:	0100H-CA-V0224	Rev.:	0
Project:	100-H Area Closure Operations	Job No:	14655	Checked:	I. B. Berezovskiy	Date:	04/06/15
Subject:	100-H-51:2 Subsite Direct Contact Hazard Quotient, Carcinogenic Risk, and Sum of Fractions Calculations					Sheet No.	1 of 5

PURPOSE:

Provide documentation to support the calculation of the direct contact hazard quotient (HQ) and excess carcinogenic risk for the 100-H-51:2 subsite. In accordance with the remedial action goals (RAGs) in the remedial design report/remedial action work plan (RDR/RAWP) (DOE-RL 2009b), the following criteria must be met:

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

This calculation also provides documentation to support the calculation of the sum of fractions evaluation for radionuclide direct exposure risk. Attainment of direct exposure RAGs is demonstrated using the single-radionuclide dose-equivalence lookup values to perform sum of fractions evaluations for comparison of the total radionuclide dose to the RAG of 15 mrem/yr above background. The model used to develop these dose-equivalence lookup values is presented in the 100 Area RDR/RAWP (DOE-RL 2009b).

GIVEN/REFERENCES:

1) DOE-RL, 2009a, *100 Area Remedial Action Sampling and Analysis Plan*, DOE/RL-96-22, Rev. 5, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

2) DOE-RL, 2009b, *Remedial Design Report/Remedial Action Work Plan for the 100 Areas*, DOE/RL-96-17, Rev. 6, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

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

4) WCH, 2015, *100-H-51:2 Subsite Cleanup Verification 95% UCL Calculation*, 0100H-CA-V0223, Rev. 0, Washington Closure Hanford, Richland, Washington.

SOLUTION:

1) Generate an HQ for each noncarcinogenic constituent detected above background or required detection limit/practical quantitation limit and compare it to the individual HQ of <1.0 (DOE-RL 2009b).

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

3) Generate an excess cancer risk value for each carcinogenic constituent detected above background or required detection limit/practical quantitation limit and compare it to the excess cancer risk of $<1 \times 10^{-6}$ (DOE-RL 2009b).

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

Washington Closure Hanford CALCULATION SHEET

Originator:	J. D. Skoglie	Date:	04/06/15	Calc. No.:	0100H-CA-V0224	Rev.:	0
Project:	100-H Area Closure Operations	Job No:	14655	Checked:	I. B. Berezovskiy	Date:	04/06/15
Subject:	100-H-51:2 Subsite Direct Contact Hazard Quotient, Carcinogenic Risk, and Sum of Fractions Calculations					Sheet No.	2 of 5

Summation of Fractions

The sum-of-fractions compares the radionuclide cleanup verification results from the 100-H-51:2 subsite shallow zone excavation to the direct exposure single radionuclide 15 mrem/yr dose-equivalence values and shows the sum-of-fractions evaluation for comparison of the total radionuclide dose to the RAG of 15 mrem/yr above background. The first two columns of the table present the COPCs and the maximum radionuclide activities for the samples. The third column presents the single radionuclide 15 mrem/yr dose-equivalence activities, and the last column presents the radionuclide activities divided by the dose-equivalence activities, followed by the sum of the fractions and determination of the total waste site dose for comparison to the 15 mrem/yr RAG.

METHODOLOGY:

The 100-H-51:2 subsite is comprised of one decision unit for verification sampling; the excavation area. The direct contact hazard quotient and carcinogenic risk calculations for the 100-H-51:2 subsite was conservatively calculated using the greater of the statistical or maximum value for each analyte within the excavation area decision unit from WCH (2015). Of the contaminants of potential concern (COPCs) for this site, boron, hexavalent chromium, and aroclor-1260 require HQ and risk calculations because these analytes were detected and a Washington State or Hanford Site background value is not available. All other site nonradionuclide COPCs were not detected or were quantified below background levels. An example of the HQ and risk calculations is presented below:

1) For example, the maximum value for boron is 2.5 mg/kg, divided by the noncarcinogenic RAG value of 7,200 mg/kg (calculated in accordance with the noncarcinogenic toxics effects formula in WAC 173-340-740[3]), is 3.5×10^{-4}. Comparing this value, and all other individual values, to the requirement of <1.0, this criterion is met.

2) After the HQ calculation is completed for the appropriate analytes, the cumulative HQ can be obtained by summing the individual values. To avoid errors due to intermediate rounding, the individual HQ values prior to rounding are used for this calculation. The sum of the HQ values is 1.3×10^{-3}. Comparing this value to the requirement of <1.0, this criterion is met.

3) To calculate the excess cancer risk, the maximum or statistical value is divided by the carcinogenic RAG value, and then multiplied by 1.0×10^{-6}. For example, the maximum value for hexavalent chromium is 0.228 mg/kg; divided by 2.1 mg/kg, and multiplied as indicated, is 1.1×10^{-7}. Comparing this value to the requirement of $<1 \times 10^{-6}$, this criterion is met.

4) After these calculations are completed for the carcinogenic analytes, the cumulative excess cancer risk is obtained by summing the individual values. The excess cancer risk for the carcinogenic constituents detected is 1.3×10^{-7}. Comparing this value to the requirement of $<1 \times 10^{-5}$, this criterion is met.

Washington Closure Hanford CALCULATION SHEET

Originator:	J. D. Skoglie	Date:	04/06/15	Calc. No.:	0100H-CA-V0224	Rev.:	0
Project:	100-H Area Closure Operations	Job No:	14655	Checked:	I. B. Berezovskiy	Date:	04/06/15
Subject:	100-H-51:2 Subsite Direct Contact Hazard Quotient, Carcinogenic Risk, and Sum of Fractions Calculations					Sheet No.	3 of 5

Summation of Fractions

The sum-of-fractions were calculated for the data set using the greater of the statistical or maximum value for each radionuclide COPC from the 95% upper confidence limit (UCL) calculation (WCH 2015).

Calculations for 100-H-51:2 subsite were performed using RAGs from the 100 Area RDR/RAWP (DOE/RL 2009b). An example of the sum of fractions calculation of COPCs is presented below:

1) To calculate the fraction, the statistical value for plutonium-239/240 (2.76 pCi/g) is divided by the soil activity equivalent of 35.1 pCi/g equivalent to a 15 mrem/yr dose, resulting in a fraction of 0.0786.

2) The fractions for the remaining COPCs are determined and summed. The sum of these fractions equals 0.0808. The sum of fractions is then multiplied by 15 mrem/yr to determine the total equivalent dose of 1.21 mrem/yr for the 100-H-51:2 subsite. Comparing this value to the dose limit of <15 mrem/yr, the requirement is met.

RESULTS:

Hazard Quotient and Excess Cancer Risk Calculations

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

Table 1 shows the results of the calculations.

Summation of Fractions

As demonstrated by the summation of the fractions, the maximum cumulative dose values contributed by the residual radionuclide populations (1.21 mrem/yr) is predicted to be less than the RAG of 15 mrem/yr above background.

Table 2 shows the results of the sum of fraction evaluation for radionuclide direct exposure risk.

Washington Closure Hanford CALCULATION SHEET

Originator:	J. D. Skoglie	Date:	05/18/15	Calc. No.:	0100H-CA-V0224	Rev.:	0
Project:	100-H Area Closure Operations	Job No:	14655	Checked:	I. B. Berezovskiy	Date:	05/18/15
Subject:	100-H-51:2 Subsite Direct Contact Hazard Quotient, Carcinogenic Risk, and Sum of Fractions Calculations					Sheet No.	4 of 5

Table 1. Direct Contact Hazard Quotient and Excess Cancer Risk Results for the 100-H-51:2 Subsite.

Contaminants of Potential Concern	Maximum or Statistical Value [a] (mg/kg)	Noncarcinogen RAG [b] (mg/kg)	Hazard Quotient	Carcinogen RAG [b] (mg/kg)	Carcinogen Risk
Metals					
Boron	2.5	7,200	3.5E-04	--	--
Chromium, hexavalent [c]	0.228	240	9.5E-04	2.1	1.1E-07
Polychlorinated Biphenyls					
Aroclor-1260	0.013	--	--	0.5	2.6E-08
Totals					
Cumulative Hazard Quotient:			**1.3E-03**		
Cumulative Excess Cancer Risk:					**1.3E-07**

Notes:

[a] = From WCH (2015)

[b] = Value obtained from the 100 Area RDR/RAWP (DOE-RL 2009b) or *Washington Administrative Code* (WAC) 173-340-740(3), Method B, 1996, unless otherwise noted.

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

-- = not applicable

RAG = remedial action goal

Table 2. 100-H-51:2 Subsite Shallow Zone Sum of Fractions Prediction of Maximum Radionuclide Dose.

COPC	95% UCL Statistical Values (pCi/g)	Background (pCi/g) [a]	Statistical Value (Background Corrected) (pCi/g)	Soil Activity for 15 mrem/yr Dose (pCi/g) [b]	Fraction
Cesium-137	0.0134	NA	0.0134	6.2	0.00216
Plutonium-239/240	2.76	NA	2.76	35.1	0.0786
Uranium-234	0.203	1.1	0	0.58	0
Uranium-238	0.208	1.1	0	0.61	0
				Sum of Fractions	**0.0808**
				Equivalent Dose (mrem/yr)	**1.21**

[a] Background is subtracted from all uranium isotopes regardless of the decision unit they were detected in. However, background is subtracted from all other isotopes only if they were detected in the overburden decision unit.

[b] Single radionuclide 15 mrem/yr dose-equivalence values and methodology are presented in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE-RL 2009b).

COPC = contaminant of potential concern

NA = not applicable

Washington Closure Hanford CALCULATION SHEET

Originator:	J. D. Skoglie	Date:	04/06/15	Calc. No.:	0100H-CA-V0224	Rev.:	0
Project:	100-H Area Closure Operations	Job No:	14655	Checked:	I. B. Berezovskiy	Date:	04/06/15
Subject:	100-H-51:2 Subsite Direct Contact Hazard Quotient, Carcinogenic Risk, and Sum of Fractions Calculations					Sheet No.	5 of 5

CONCLUSION:

The calculations in Tables 1 and 2 demonstrate that the 100-H-51:2 subsite meets the requirements for the direct contact hazard quotient, carcinogenic (excess cancer) risk, and radionuclide direct exposure risk as identified in the RDR/RAWP (DOE-RL 2009b) and SAP (DOE-RL 2009a). The direct contact hazard quotient, carcinogenic (excess cancer) risk calculations, and the sum of fractions evaluation for radionuclide direct exposure risk are for use in the RSVP for the 100-H-51:2 subsite.

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CALCULATION COVER SHEET

Project Title: 100-H Area Closure Operations **Job No. 14655**

Area: 100-H

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

Subject: 100-H-51:2 Subsite Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater

Computer Program: Excel Program No: Excel 2010

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 Summary = 3 Total = 4	J. D. Skoglie	I.B. Berezovskiy	R. J. Nielson	S. C. Wilkinson	7/9/15

SUMMARY OF REVISION

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

Washington Closure Hanford, Inc. CALCULATION SHEET

Originator:	J. D. Skoglie	Date:	4/9/2015	Calc. No.:	0100H-CA-V0225	Rev.:	0
Project:	100-H Area Closure Operations	Job No:	14655	Checked:	I. B. Berezovskiy	Date:	4/9/2015
Subject:	100-H-51:2 Subsite Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater					Sheet No.	1 of 3

7/13/15

PURPOSE:

Provide documentation to support the calculation of the hazard quotient (HQ) and excess carcinogenic risk associated with soil contaminant levels compared to soil cleanup levels for protection of groundwater for the 100-H-51:2 subsite. In accordance with the remedial action goals (RAGs) in the remedial design report/remedial action work plan (RDR/RAWP) (DOE-RL 2009), the following criteria must be met:

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

GIVEN/REFERENCES:

1) BHI, 2005, *100 Area Analogous Sites RESRAD Evaluation*, Calculation No. 0100X-CA-V0050 Rev 0, Bechtel Hanford, Inc., Richland, Washington.

2) DOE-RL, 2009, *Remedial Design Report/Remedial Action Work Plan for the 100 Areas,* DOE/RL-96-17, Rev. 6, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

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

4) WCH, 2015, *100-H-51:2 Subsite Cleanup Verification 95% UCL Calculations*, 0100D-CA-V0223, Rev. 0, Washington Closure Hanford, Inc., Richland, Washington.

SOLUTION:

1) Generate a HQ for each noncarcinogenic constituent detected above background in soil and with a K_d less than that required to show no migration to groundwater in 1,000 years using the RESRAD generic site model (BHI 2005).

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

3) Generate an excess cancer risk value for each carcinogenic constituent detected above background in soil and with a K_d less than that required to show no migration to groundwater in 1,000 years using the RESRAD generic site model (BHI 2005).

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

Washington Closure Hanford, Inc. CALCULATION SHEET

Originator:	J. D. Skoglie	Date:	4/13/2015	Calc. No.:	0100H-CA-V0225	Rev.:	0
Project:	100-H Area Closure Operations	Job No:	14655	Checked:	I. B. Berezovskiy	Date:	4/13/2015
Subject:	100-H-51:2 Subsite Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater					Sheet No.	2 of 3

METHODOLOGY:

The 100-H-51:2 subsite is comprised of one decision unit for verification sampling; the excavation area. Hazard quotient and carcinogenic risk calculations for potential impact to groundwater at the 100-H-51:2 subsite were conservatively calculated for the entire waste site using the greater of the statistical or maximum value for each analyte from the 95% UCL calculation (WCH 2015). Based on the generic site RESRAD model (BHI 2005) and a vadose zone of approximately 11 m (36 ft) thickness, a K_d of 6.6 mL/g or greater is required to show no predicted migration to groundwater in 1,000 years. Of the contaminants of potential concern (COPCs) for this site, boron and hexavalent chromium are included because no Washington State or Hanford background value has been established and the distribution coefficient is less than that necessary to show no migration to groundwater in 1,000 years using this model. All other site nonradionuclide COPCs were not detected, quantified below background levels, or has a K_d greater than or equal to 6.6 mL/g. An example of the HQ and risk calculations for soil constituents with a potential impact to groundwater is presented below:

1) The hazard quotient is defined as the ratio of the dose of a substance obtained over a specified time (mg/kg/day) to a reference dose for the same substance derived over the same specified time (mg/kg/day). The hazard quotient can also be calculated as the ratio of the concentration in soil (maximum or statistical value) (mg/kg) to the soil RAG (mg/kg) for protection of groundwater, where the RAG is the groundwater cleanup level (mg/L) (calculated with, and related to the hazard quotient through, WAC 173-340-720(3)(a)(ii)(A), 1996) x 100 x 1 mg/1000 mg (conversion factor). This is based on the "100 times rule" of WAC 173-340-740(3)(a)(ii)(A) (1996). For example, the statistical value for boron is 2.5 mg/kg, divided by the noncarcinogenic RAG value of 320 mg/kg is 7.8×10^{-3}. Comparing this value to the requirement of <1.0, this criterion is met.

2) After the HQ calculation is completed for the appropriate analytes, the cumulative HQ can be obtained by summing the individual values. (To avoid errors due to intermediate rounding, the individual HQ values prior to rounding are used for this calculation.) The cumulative HQ for the 100-H-51:2 subsite is 5.5×10^{-2}. Comparing this value to the requirement of <1.0, this criterion is met.

3) To calculate the excess cancer risk, the maximum or statistical value is divided by the carcinogenic RAG value, and then multiplied by 1×10^{-6}. There were not any detected COPCs with a carcinogenic RAG. Therefore, the individual requirement of $<1 \times 10^{-6}$ is met, and the cumulative excess cancer risk for carcinogens of $<1 \times 10^{-5}$ is also met.

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

RESULTS:

1) List individual noncarcinogens and corresponding HQs >1.0: None
2) List the cumulative noncarcinogenic HQ >1.0: None
3) List individual carcinogens and corresponding excess cancer risk $>1 \times 10^{-6}$: None

Washington Closure Hanford, Inc. CALCULATION SHEET

Originator:	J. D. Skoglie	Date:	4/13/2015	Calc. No.:	0100H-CA-V0222	Rev.:	0
Project:	100-H Area Closure Operations	Job No:	14655	Checked:	I. B. Berezovskiy	Date:	4/13/2015
Subject:	100-H-51:2 Subsite Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater					Sheet No.	3 of 3

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

Table 1 shows the results of the calculations.

Table 1. Hazard Quotient and Excess Cancer Risk Results for the 100-H-51:2 Subsite.

Contaminants of Potential Concern[a]	Statistical Value[a] (mg/kg)	Noncarcinogen RAG[b] (mg/kg)	Hazard Quotient	Carcinogen RAG[b] (mg/kg)	Carcinogen Risk
Metals					
Boron	2.5	320	7.8E-03	--	--
Chromium, hexavalent	0.228	4.8	4.8E-02	--	--
Totals					
Cumulative Hazard Quotient:			**5.5E-02**		
Cumulative Excess Cancer Risk:					**0.0E+00**

Notes:

[a] = From WCH (2015).

[b] = Value obtained from the Cleanup Levels and Risk Calculations (CLARC) database using Groundwater, Method B, results and the "100 times" model.

-- = not applicable

RAG = remedial action goal

CONCLUSION:

This calculation demonstrates that the 100-H-51:2 subsite meets the requirements for the hazard quotients and excess carcinogenic risk for protection of groundwater as identified in the RDR/RAWP (DOE-RL 2009).

APPENDIX C

DATA QUALITY ASSESSMENT

APPENDIX C

DATA QUALITY ASSESSMENT

VERIFICATION SAMPLING

A data quality assessment (DQA) was performed to compare the verification sampling approach and resulting analytical data with the sampling and data requirements specified in the site-specific sample design (WCH 2015b). This DQA was performed in accordance with site-specific data quality objectives found in the *100 Area Remedial Action Sampling and Analysis Plan* (100 Area SAP) (DOE-RL 2009).

A review of the sample design (WCH 2015b), the field logbook (WCH 2015a), and applicable analytical data packages has been performed as part of this DQA. To ensure quality data, the 100 Area SAP (DOE-RL 2009) data assurance requirements and the data validation procedures for chemical analysis and radiochemical analysis (BHI 2000a, BHI 2000b) are used as appropriate. This review involves evaluation of the data to determine if they are of the right type, quality, and quantity to support the intended use (i.e., closeout decisions). The DQA completes the data life cycle (i.e., planning, implementation, and assessment) that was initiated by the data quality objectives process (EPA 2006).

Verification sample data collected at the 100-H-51:2 subsite were provided by the laboratory in two sample delivery groups (SDGs): JP0904 and MA10700. The SDG JP0904 was submitted for third-party validation. No major deficiencies were identified in the analytical data set. Minor deficiencies are discussed for the 100-H-51:2 data set, as follows below. If no comments are made about a specific analysis, it should be assumed that no deficiencies affecting the quality of the data were found.

MINOR DEFICIENCIES

SDG JP0904

This SDG comprises 14 statistical soil samples (J1V430 through J1V443) from the 100-H-51:2 subsite excavation area. This SDG includes one field duplicate pair (J1V437/J1V443). These samples were analyzed for inductively coupled plasma (ICP) metals, mercury, hexavalent chromium, polychlorinated biphenyls (PCBs), gamma energy analysis, carbon-14, isotopic uranium, strontium-90, isotopic plutonium, and tritium. In addition, one field equipment blank (J1V444) was collected and analyzed for ICP metals and mercury. SDG JP0904 was submitted for third-party validation. Minor deficiencies are as follows.

In the ICP metals analysis, the matrix spike (MS) recoveries are out of project acceptance criteria for five analytes (aluminum [904%], antimony [61%], iron [1,642%], manganese [164%], and silicon [28%]). For aluminum, iron, and manganese, the spiking concentration was insignificant compared to the native concentration in the sample from which the MS was prepared.

The deficiency in the MS is a reflection of the variability of the native concentration rather than a measure of the recovery from the sample. Antimony and silicon did not have mismatched spike and native concentrations in the MS. All antimony and silicon results for SDG JP0904 were qualified as estimated with "J" flags by third-party validation. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, the laboratory control sample recovery for silicon was below the project recovery limit at 12%. All silicon results in SDG JP0904 were qualified as estimated with "J" flags by third-party validation. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, calcium and copper were detected in the method blank. Third-party validation qualified calcium and cadmium results in sample J1V444 as undetected with "UJ' flags. Data are usable for decision-making purposes.

In the isotopic uranium and plutonium analysis, due to the lack of laboratory control sample analysis, all uranium-235 and plutonium-238 results were qualified as estimated with "J" flags by third-party validation. Estimated data are usable for decision-making purposes.

In the carbon-14 analysis, due to the lack of MS analysis, all carbon-14 results were qualified as estimated with "J" flags by third-party validation. Estimated data are usable for decision-making purposes.

In the tritium analysis, due to the lack of MS analysis, all tritium results were qualified as estimated with "J" flags by third-party validation. Estimated data are usable for decision-making purposes.

SDG MA10700

This SDG comprises 14 verification soil samples (J1V445 through J1V458) from the 100-H-51:2 subsite. This SDG includes one field duplicate pair (J1V452/J1V458). These samples were analyzed for asbestos. No major or minor deficiencies were noted.

FIELD QUALITY ASSURANCE/QUALITY CONTROL

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

Field quality assurance/quality control (QA/QC) measures are used to assess potential sources of error and cross contamination of samples that could bias results. Field QA/QC samples listed in the field logbook (WCH 2015a) are shown in Table C-1. The main and QA/QC sample results are presented in Appendix B.

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

Sample Area	Main Sample	Duplicate Sample
Excavation area	J1V437	J1V443
Excavation area (asbestos)	J1V452	J1V458

Field duplicate samples are collected to provide a relative measure of the degree of local heterogeneity in the sampling medium, unlike laboratory duplicates that are used to evaluate precision in the analytical process. The field duplicates are evaluated by computing the RPD of the sample/duplicate pair(s) for each contaminant of potential concern. Relative percent differences are not calculated for analytes that are not detected in both the main and duplicate sample at more than 5 times the target detection limit. Relative percent differences of analytes detected at low concentrations (less than five times the detection limit) are not considered to be indicative of the analytical system performance. The calculation brief in Appendix B provides details on duplicate pair evaluation and RPD calculation.

None of the duplicate RPDs calculated for 100-H-51:2 data set are above the duplicate acceptance criteria of 30%.

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. In these cases, a control limit of ±2 times the target detection limit is used (Appendix B) to indicate that a visual check of the data is required by the reviewer. In the duplicate analysis, none of the data required this check. A visual inspection of all of the data is also performed. No additional major or minor deficiencies are noted. The data are useable for decision-making purposes.

Summary

Limited, random, or sample matrix-specific influenced batch QC issues, such as those discussed above, are a potential for any analysis. The number and types seen in these data sets are within expectations for the matrix types and analyses performed. The DQA review of the 100-H-51:2 subsite verification sampling data found that the analytical results are accurate within the standard errors associated with the analytical methods, sampling, and sample handling. The DQA review for 100-H-51:2 subsite concludes that the reviewed data are of the right type, quality, and quantity to support the intended use. The analytical data were found acceptable for decision-making purposes.

The verification sample analytical data are stored in a Washington Closure Hanford project-specific database prior to being submitted for inclusion in the Hanford Environmental Information System database. The verification sample analytical data are also summarized in Appendix B.

REFERENCES

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

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