WASTE SITE RECLASSIFICATION FORM

Operable Unit: 100-HR-1 **Control No.:** 2015-013

Waste Site Code(s)/Subsite Code(s): 100-H-59:1

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-59:1, 100-H Area Railroad Track Soil Contamination Area subsite is part of the 100-H-59, Soil Contamination Area and Debris Piles Near 100-H Area Railroad Track waste site. The 100-H-59 waste site 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 in the Fact Sheet *100 Area "Plug-In" and Candidate Waste Sites for Calendar Year 2011,* U.S. Department of Energy, Richland Operations Office, Richland, Washington (DOE-RL 2012). The 100-H-59:1 subsite was recommended for remediation without confirmatory sampling.

Remedial action at the 100-H-59:1 subsite began on August 20, 2014, and was completed on August 21, 2014. Two areas of radiological contamination were removed to less than 1 m (3.3 ft) below ground surface, resulting in approximately 334 bank cubic meters (437 bank cubic yards) of contaminated soil being disposed at the Environmental Restoration Disposal Facility (ERDF). Approximately 109 tons of steel railroad track and wood railroad ties were also removed and disposed. The soil was direct loaded for disposal at ERDF; however, the railroad ties and rails were staged prior to loadout, thus creating two small waste staging pile areas. The staging pile area waste was loaded out for disposal at ERDF on September 17, 2014. No overburden material was salvaged for use as clean backfill. No anomalies were encountered during remediation of the 100-H-59:1 waste site.

Verification samples from the 100-H-59:1 subsite were collected on January 5, 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). 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 ERDF, (3) demonstrating through verification sampling that cleanup goals have been achieved, and (4) proposing the site for reclassification to Interim Closed Out.

Basis for reclassification:

The verification sampling and modeling results for the 100-H-59:1 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-59:1, 100-H-Area Railroad Track Soil Contamination Area Subsite* (attached).

WASTE SITE RECLASSIFICATION FORM

Operable Unit: 100-HR-1 **Control No.:** 2015-013

Waste Site Code(s)/Subsite Code(s): 100-H-59:1

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	J P Neath	6/3/15
DOE Federal Project Director (printed)	Signature	Date
N. Menard	Nina M. Menard	6/4/15
Ecology Project Manager (printed)	Signature	Date
NA		
EPA Project Manager (printed)	Signature	Date

REMAINING SITES VERIFICATION PACKAGE FOR THE 100-H-59:1, 100-H AREA RAILROAD TRACK SOIL CONTAMINATION AREA SUBSITE

Attachment to Waste Site Reclassification Form 2015-013

June 2015

REMAINING SITES VERIFICATION PACKAGE FOR THE 100-H-59:1, 100-H AREA RAILROAD TRACK SOIL CONTAMINATION AREA SUBSITE

EXECUTIVE SUMMARY

The 100-H-59:1, 100-H Area Railroad Track Soil Contamination Area subsite is part of the 100-H-59, Soil Contamination Area and Debris Piles Near 100-H Area Railroad Track waste site and is located within the 100-HR-1 Operable Unit. The 100-H-59:1 subsite consists of radiological contamination along two sections of railroad track in the 100-H Area south and west of the 105-H Reactor. It is believed to have been caused by mud daubers.

Remedial action at the 100-H-59:1 subsite began on August 20, 2014, and was completed on August 21, 2014. Two areas of radiological contamination were removed to less than 1 m (3.3 ft) below ground surface, resulting in approximately 334 bank cubic meters (437 bank cubic yards) of contaminated soil being disposed at the Environmental Restoration Disposal Facility (ERDF). Approximately 109 tons of steel railroad track and wood railroad ties were also removed and disposed. The soil was direct loaded for disposal at ERDF; however, the railroad ties and rails were staged prior to loadout, thus creating two small waste staging pile areas. The staging pile area waste was loaded out for disposal at ERDF on September 17, 2014.

Following remediation, verification soil sampling was conducted on January 5, 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 *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).

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-59:1 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-59:1 Subsite. (2 Pages)

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-59:1 subsite, based on a sum-of-fractions calculation (0.0934 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-59:1 subsite (1.8×10^{-3}) is <1.	
	Attain an excess cancer risk of $<1 \times 10^{-6}$ for individual carcinogens.	No carcinogenic constituents met the criteria for excess cancer risk evaluation; therefore, no calculations were performed.	
	Attain a cumulative excess cancer risk of $<1 \times 10^{-5}$ for carcinogens.		
Groundwater/River Protection – Radionuclides	Attain single-COPC groundwater and river protection RAGs.	No radionuclide COPCs were quantified above groundwater/river protection lookup values.	Yes
	Attain national primary drinking water standards [a]: 4 mrem/yr (beta/gamma) dose rate to target receptor/organs.	No radionuclide COPCs were quantified above groundwater/river protection lookup values.	
	Meet drinking water standards for alpha emitters: the most stringent of 15 pCi/L MCL or 1/25th of the derived concentration guides from DOE Order 5400.5 [b].	No alpha-emitting radionuclide COPCs were identified for this waste site.	
	Meet total uranium standard of 30 µg/L (21.2 pCi/L) [c].	Uranium was not identified as a COPC for this waste site.	

Table ES-1. Summary of Remedial Action Goals for the 100-H-59:1 Subsite. (2 Pages)

Regulatory Requirement	Remedial Action Goals	Results	Remedial Action Objectives Attained?
Groundwater/River Protection – Nonradionuclides	Attain individual nonradionuclide groundwater and river cleanup requirements.	Lead exceeded soil RAGs for groundwater and river protection. However, based on RESRAD modeling discussed in Appendix C of the 100 Area RDR/RAWP (DOE-RL 2009b), it is predicted that the residual concentration of lead will not reach groundwater (and thus the Columbia River) within 1,000 years [d].	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).
[d] Based on RESRAD modeling discussed in Appendix C of the 100 Area RDR/RAWP (DOE-RL 2009b), the residual concentration of lead is not predicted to migrate more than 1.8 m (5.9 ft) vertically within 1,000 years (based on the lead soil-partitioning coefficient of 30 mL/g). The vadose zone underlying the 100-H-59:1 subsite is approximately 10 m (33 ft) thick. Therefore, the residual concentration of lead is predicted to be protective of groundwater and the Columbia River.

COPC = contaminant of potential concern
DOE = U.S. Department of Energy
MCL = maximum contaminant level
RAG = remedial action goal
RDR/RAWP = remedial design report/remedial action work plan
RESRAD = RESidual RADioactivity (dose model)

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-59:1 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 arsenic, boron, and vanadium. The U.S. Environmental Protection Agency's ecological soil screening levels were exceeded for lead, 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-59:1, 100-H AREA RAILROAD TRACK SOIL CONTAMINATION AREA SUBSITE

STATEMENT OF PROTECTIVENESS

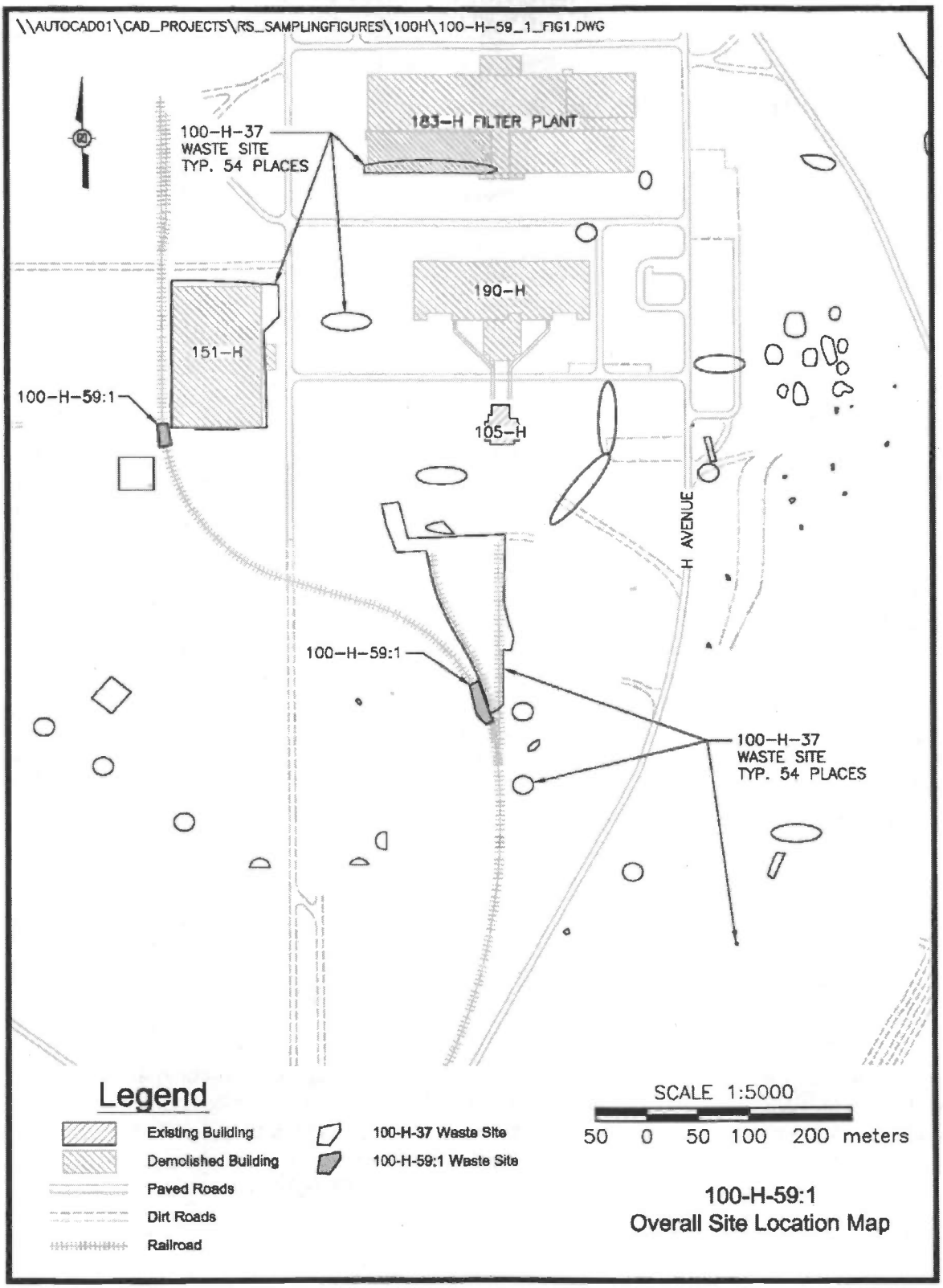
The 100-H-59:1 subsite verification sampling data, site evaluations, and supporting documentation demonstrate that this site meets the objectives established in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (100 Area RDR/RAWP) (DOE-RL 2009b) and the *Interim Action Record of 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-59:1 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 arsenic, boron, and vanadium. The U.S. Environmental Protection Agency's (EPA) ecological soil screening levels were exceeded for lead, 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-59:1, 100-H Area Railroad Track Soil Contamination Area subsite was located within the 100-HR-1 Operable Unit and consisted of radiological contamination along two sections of railroad track in the 100-H Area south and west of the 105-H Reactor. The areas were discovered in 2011 during removal of the railroad berm and tracks and were believed to be due to material deposited by mud daubers. Therefore, the 100-H-59:1 subsite is regarded as being analogous to the 100-H-37, Mud Daubers waste site (WCH 2010). The overall site location map is provided in Figure 1.

Figure 1. 100-H-59:1 Overall Site Location Map.



REMEDIAL ACTION SUMMARY

Remedial action at the 100-H-59:1 subsite began on August 20, 2014, and was completed on August 21, 2014. Two areas of radiological contamination were removed to less than 1 m (3.3 ft) below ground surface, resulting in approximately 334 bank cubic meters (437 bank cubic yards) of contaminated soil being disposed at the Environmental Restoration Disposal Facility (ERDF). Approximately 109 tons of steel railroad track and wood railroad ties were also removed and disposed. The soil was direct loaded for disposal at ERDF; however, the railroad ties and rails were staged prior to loadout, thus creating two small waste staging pile areas (SPAs). The SPA waste was loaded out for disposal at the ERDF on September 17, 2014. No overburden material was salvaged for use as clean backfill. No anomalies were encountered during remediation of the 100-H-59:1. No in-process soil samples were collected. Photographs of the site following remediation are provided in Figures 2 through 4.

Following the remediation, global positional environmental radiological surveyor surveys were conducted over the north and south excavations. The beta and gamma track maps are provided in Appendix B.

VERIFICATION SAMPLING ACTIVITIES

Verification soil sampling was conducted on January 5, 2015, per the *Work Instruction for Verification Sampling of the 100-H-59, 100-H Area Railroad Track Soil Contamination Area Waste Site* (WCH 2014b). At the time the verification work instruction was prepared, the 100-H-59 waste site had not been divided into subsites. 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 C and indicate that the waste removal action achieved compliance with the remedial action objectives and remedial action goals (RAGs) for the 100-H-59:1 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.

Contaminants of Potential Concern for Verification Sampling

The COPCs for the 100-H-59:1 waste site were based on the determination that the radionuclide contamination detected while removing the railroad berm and tracks was due to material deposited by mud daubers (WCH 2012). In-process data from the analogous 100-H-37 Mud Dauber waste site was used as the basis for the 100-H-59:1 waste profile. The COPCs included inductively coupled plasma metals, mercury, and radionuclides (cesium-137, cobalt-60, europium-152, europium-154, and europium-155 by gamma energy analysis) (WCH 2010).

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

Figure 2. 100-H-59 Waste Site North Excavation Dated October 14, 2014.

Figure 3. 100-H-59 Waste Site South Excavation Dated October 14, 2014.

Figure 4. 100-H-59 Waste Site Staging Pile Area Dated October 14, 2014.

Table 1. Laboratory Analytical Methods for the 100-H-59:1 Subsite.

Analytical Method	Contaminant of Potential Concern
ICP metals [a] – EPA Method 6010	Metals
Mercury – EPA Method 7471	Mercury
GEA – gamma spectroscopy	Cesium-137, cobalt-60, europium-152, europium-154, europium-155

[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

Verification Sampling Design

Two decision units were identified for the 100-H-59:1 waste site; specifically, the excavation and the SPA. The excavation decision unit included two excavated areas (north and south excavations), and the SPA decision unit included two SPA footprints (north and south SPAs). A statistical sample design was used to evaluate the 100-H-59:1 excavations and the SPAs. Twelve statistical verification soil samples plus 1 duplicate were collected from the excavations and 12 statistical verification soil samples plus 1 duplicate were collected from the SPAs, for a total of 26 samples. 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 2014a). The verification sample locations for the excavation and SPA are shown on Figures 5 through 9.

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-59:1 subsite was performed by direct comparison of the statistical or maximum sample results for each COPC against the cleanup criteria.

Comparisons of the results for site COPCs from the 100-H-59:1 subsite against the RAGs are summarized in Tables 3 and 4. Contaminants that were not detected by laboratory analysis are excluded from these tables. Calculated cleanup levels are not presented in the Cleanup Levels and Risk Calculations 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. Potassium-40 and silver-108 metastable were included in the verification sampling data set; however, these isotopes are not site COPCs and are not considered in the statistical calculations. Potassium-40 is naturally occurring, not related to the operational history of the site, and was detected below background levels. Silver-108 metastable is not related to the operational history of the site and the results were all undetected.

The complete laboratory results for all constituents are stored in a Washington Closure Hanford (WCH) project-specific database prior to archival in the Hanford Environmental Information System (HEIS) and are presented in Attachment 1 of the *100-H-59:1 Subsite Cleanup Verification 95% UCL Calculations* (Appendix C).

Table 2. 100-H-59:1 Subsite Verification Sample Summary.

Sample Location	HEIS Sample Number	Washington State Plane Coordinates (m)		Sample Analysis
		Northing	Easting	
North and South Excavations Decision Unit [a]				
EXC-1	J1V2P7	152236.1	577764.3	ICP metals [b], mercury, GEA
EXC-2	J1V2P8	152244.9	577759.2	ICP metals [b], mercury, GEA
EXC-3	J1V2P9	152244.9	577769.4	ICP metals [b], mercury, GEA
EXC-4	J1V2R0	152253.7	577754.1	ICP metals [b], mercury, GEA
EXC-5	J1V2R1	152253.7	577764.3	ICP metals [b], mercury, GEA
EXC-6	J1V2R2	152262.5	577749.1	ICP metals [b], mercury, GEA
EXC-7	J1V2R3	152262.5	577759.2	ICP metals [b], mercury, GEA
EXC-8	J1V2R4	152271.3	577754.1	ICP metals [b], mercury, GEA
EXC-9	J1V2R5	152509.0	577444.1	ICP metals [b], mercury, GEA
EXC-10	J1V2R6	152509.0	577454.3	ICP metals [b], mercury, GEA
EXC-11	J1V2R7	152517.8	577449.2	ICP metals [b], mercury, GEA
EXC-12	J1V2R8	152526.6	577444.1	ICP metals [b], mercury, GEA
Duplicate of EXC-10 (J1V2R6)	J1V2R9	152509.0	577454.3	ICP metals [b], mercury, GEA
North and South Staging Pile Areas Decision Unit [a]				
SPA-1	J1V2T0	152242.9	577801.3	ICP metals [b], mercury, GEA
SPA-2	J1V2T1	152246.9	577799.2	ICP metals [b], mercury, GEA
SPA-3	J1V2T2	152246.7	577803.7	ICP metals [b], mercury, GEA
SPA-4	J1V2T3	152246.5	577808.2	ICP metals [b], mercury, GEA
SPA-5	J1V2T4	152246.3	577812.7	ICP metals [b], mercury, GEA
SPA-6	J1V2T5	152250.5	577806.1	ICP metals [b], mercury, GEA
SPA-7	J1V2T6	152250.3	577810.6	ICP metals [b], mercury, GEA
SPA-8	J1V2T7	152250.1	577815.1	ICP metals [b], mercury, GEA
SPA-9	J1V2T8	152249.9	577819.6	ICP metals [b], mercury, GEA
SPA-10	J1V2T9	152335.8	577726.5	ICP metals [b], mercury, GEA
SPA-11	J1V2V0	152339.8	577724.5	ICP metals [b], mercury, GEA
SPA-12	J1V2V1	152343.8	577722.4	ICP metals [b], mercury, GEA
Duplicate of SPA-6 (J1V2T5)	J1V2V2	152250.5	577806.1	ICP metals [b], mercury, GEA
Equipment blank	J1V2V3	NA	NA	ICP metals [b], mercury

[a] Sample locations EXC-1, EXC-2, EXC-3, EXC-4, EXC-5, EXC-6, EXC-7, and EXC-8 are located within the southernmost excavation, and EXC-9, EXC-10, EXC-11, and EXC-12 are located within the northernmost excavation. Sample locations SPA-1, SPA-2, SPA-3, SPA-4, SPA-5, SPA-6, SPA-7, SPA-8, and SPA-9 are located within the southernmost SPA, and SPA-10, SPA-11, and SPA-12 are located within the northernmost SPA.

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

EXC = excavation
GEA = gamma energy analysis
HEIS = Hanford Environmental Information System
ICP = inductively coupled plasma
NA = not applicable
SPA = staging pile area

Figure 5. 100-H-59 Waste Site Overall Verification Sample Locations.

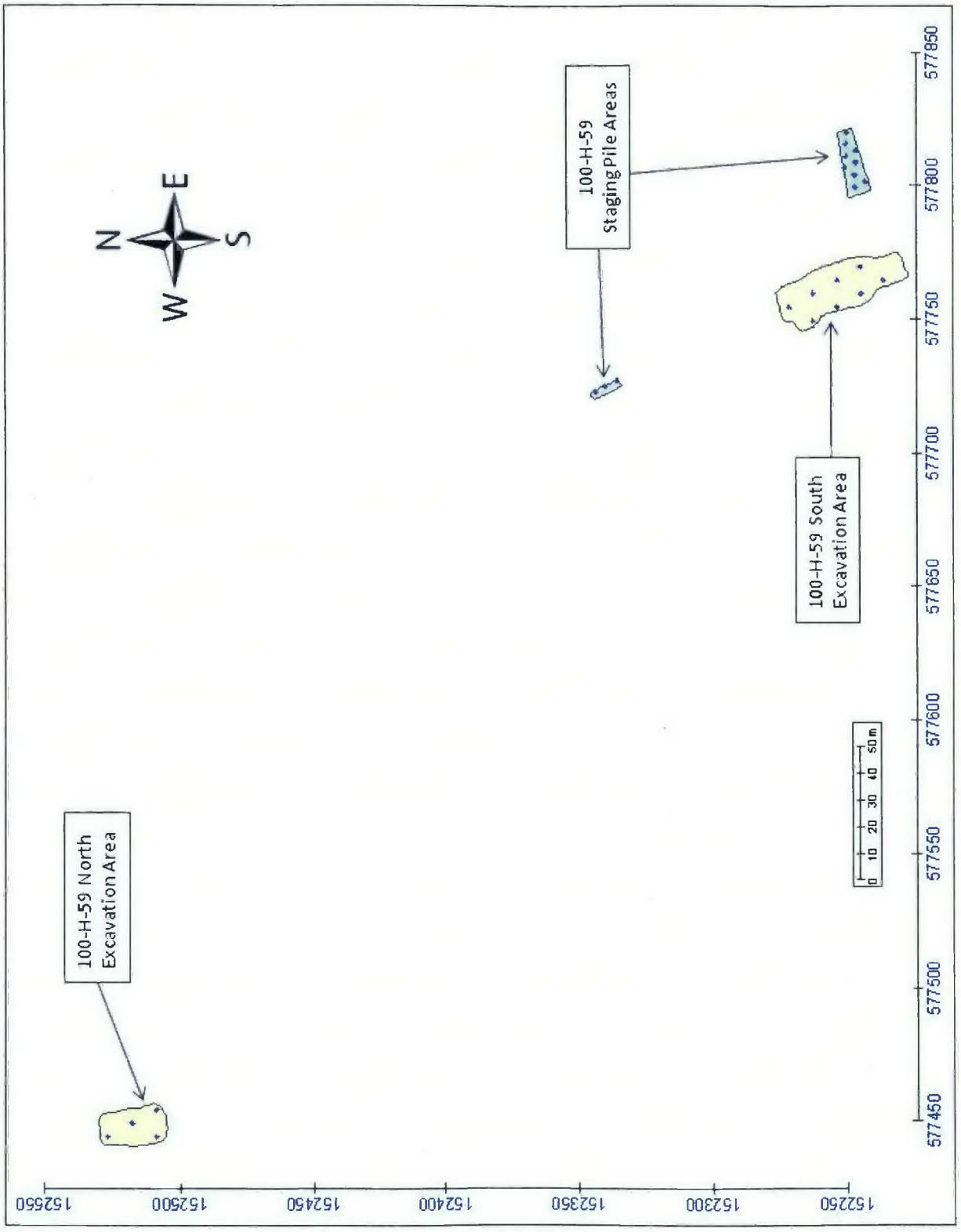


Figure 6. 100-H-59 Waste Site North Excavation Sample Locations.

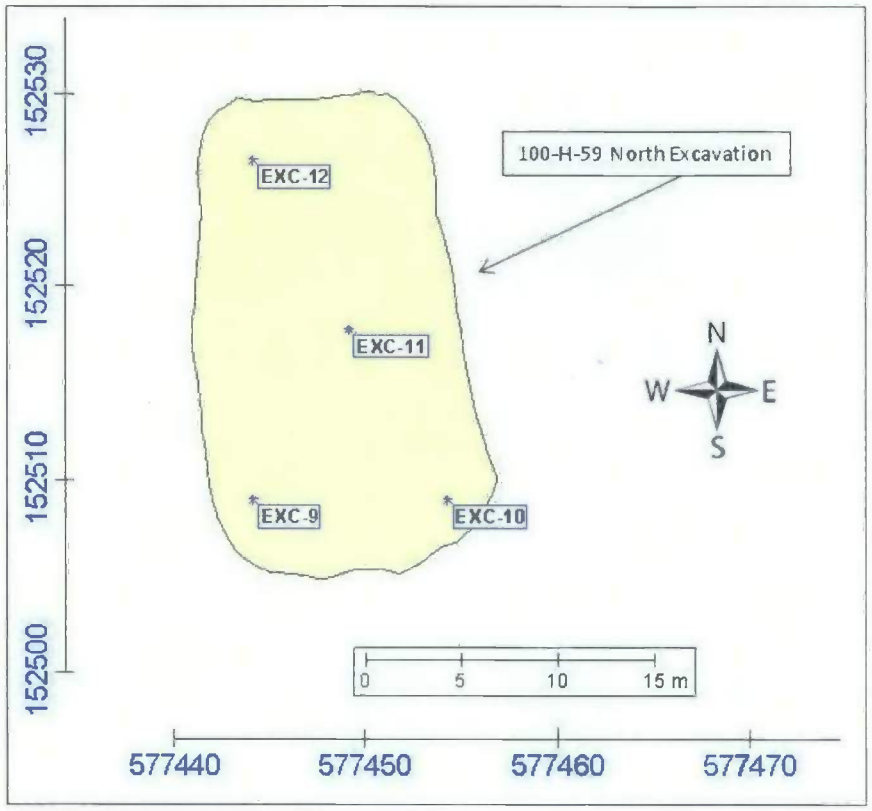


Figure 7. 100-H-59 Waste Site South Excavation Sample Locations.

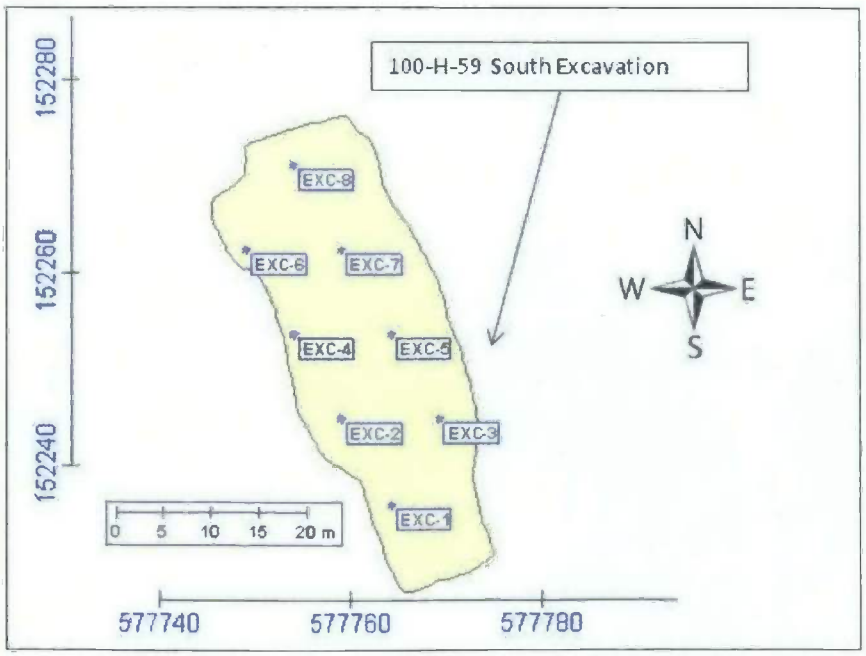


Figure 8. 100-H-59 North SPA Sample Locations.

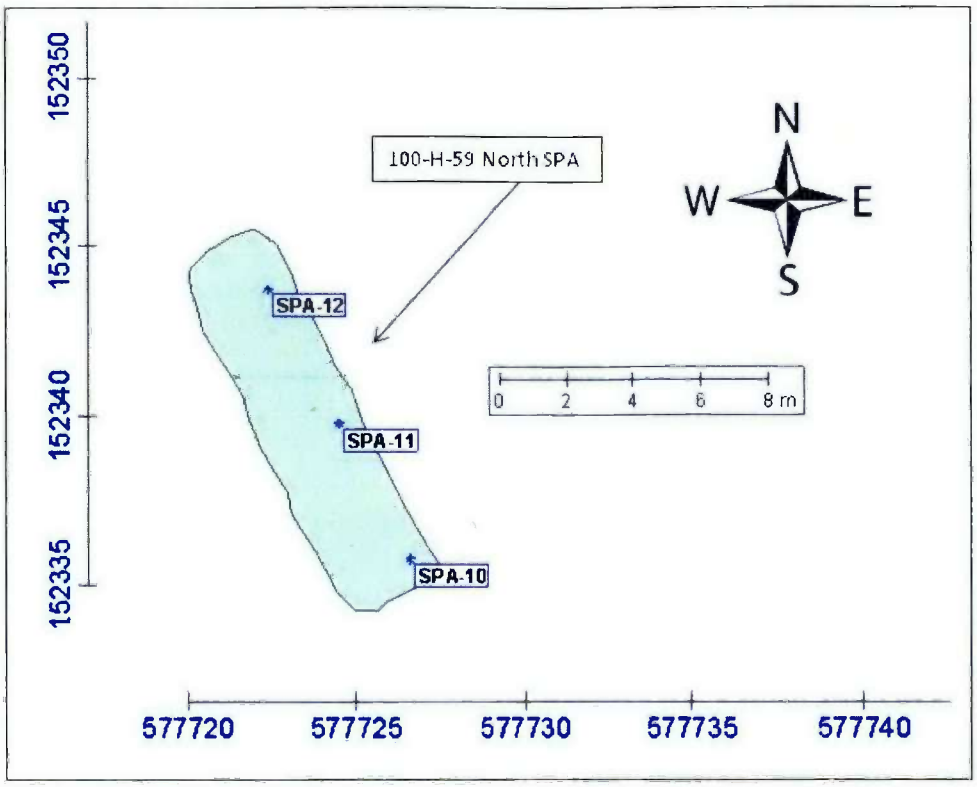


Figure 9. 100-H-59 South SPA Sample Locations.

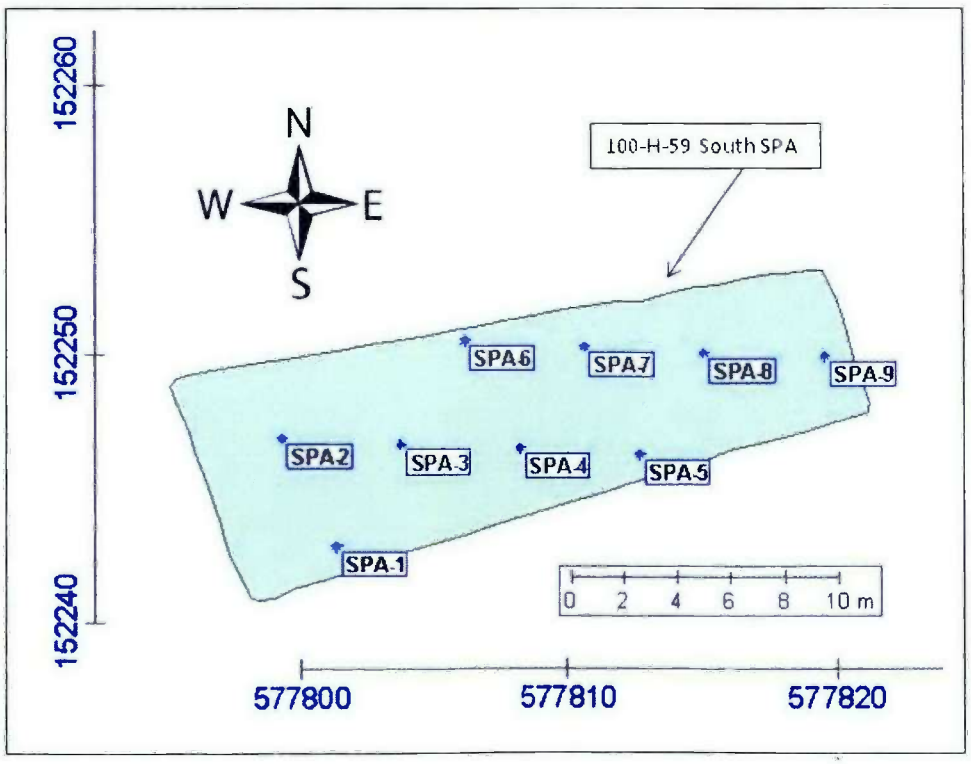


Table 3. Comparison of Contaminant Concentrations to Action Levels for the 100-H-59:1 Excavation Verification Samples.

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	0.0362 (<BG)	6.2	1,465	2,930	No	--
Europium-155	0.0488 (<BG)	125	-- [c]	-- [c]	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	8.3	20 [d]	20 [d]	20 [d]	No	--
Barium	80.9 (<BG)	5,600	200	400	No	--
Beryllium	0.049 <BG)	10.4 [e]	1.51 [d]	1.51 [d]	No	--
Boron [f]	2.7	7,200	320	-- [g]	No	--
Cadmium [h]	0.17 (<BG)	13.9 [e]	0.81 [d]	0.81 [d]	No	--
Chromium (total)	12.4 (<BG)	80,000	18.5 [d]	18.5 [d]	No	--
Cobalt	7.5 (<BG)	24	15.7 [d]	-- [g]	No	--
Copper	15.6 (<BG)	2,960	59.2	22.0 [d]	No	--
Lead	25.5	353	10.2 [d]	10.2 [d]	Yes	Yes [i]
Manganese	341 (<BG)	3,760	512 [d]	512 [d]	No	--
Mercury	0.0070 <BG)	24	0.33 [d]	0.33 [d]	No	--
Molybdenum [f]	0.33	400	8	-- [g]	No	--
Nickel	11.8 (<BG)	1,600	19.1 [d]	27.4	No	--
Vanadium	49.3 (<BG)	560	85.1 [d]	-- [g]	No	--
Zinc	43.0 (<BG)	24,000	480	67.8 [d]	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-59:1 Subsite Cleanup Verification 95% UCL Calculations* (Appendix C).

[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] Based on RESRAD modeling discussed in Appendix C of the 100 Area RDR/RAWP (DOE-RL 2009b), the residual concentration of lead is not expected to migrate more than 1.8 m (5.9 ft) vertically in 1,000 years (based on the lead K_d of 30 mL/g]). The vadose zone underlying the 100-H-59:1 subsite is approximately 10 m (33 ft) thick.

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

Table 4. Comparison of Contaminant Concentrations to Action Levels for the 100-H-59:1 Staging Pile Area Verification Samples.

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	0.0215 (<BG)	6.2	1,465	2,930	No	--
Europium-155	0.0412 (<BG)	125	-- [c]	-- [c]	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	6.9	20 [d]	20 [d]	20 [d]	No	--
Barium	74.2 (<BG)	5,600	200	400	No	--
Boron [e]	2.4	7,200	320	-- [f]	No	--
Cadmium [g]	0.15 (<BG)	13.9 [h]	0.81 [d]	0.81 [d]	No	--
Chromium (total)	12.1 (<BG)	80,000	18.5 [d]	18.5 [d]	No	--
Cobalt	7.1 (<BG)	24	15.7 [d]	-- [f]	No	--
Copper	14.7 (<BG)	2,960	59.2	22.0 [d]	No	--
Lead	21.5	353	10.2 [d]	10.2 [d]	Yes	Yes [i]
Manganese	326 (<BG)	3,760	512 [d]	512 [d]	No	--
Mercury	0.039 (<BG)	24	0.33 [d]	0.33 [d]	No	--
Molybdenum [e]	0.57	400	8	-- [f]	No	--
Nickel	13.5 (<BG)	1,600	19.1 [d]	27.4	No	--
Vanadium	48.0 (<BG)	560	85.1 [d]	-- [f]	No	--
Zinc	43.0 (<BG)	24,000	480	67.8 [d]	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-59:1 Subsite Cleanup Verification 95% UCL Calculations* (Appendix C).

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

[f] 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]).

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

[h] 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]).

[i] Based on RESRAD modeling discussed in Appendix C of the 100 Area RDR/RAWP (DOE-RL 2009b), the residual concentration of lead is not expected to migrate more than 1.8 m (5.9 ft) vertically in 1,000 years (based on the K_d of 30 mL/g]). The vadose zone underlying the 100-H-59:1 subsite is approximately 10 m (33 ft) thick.

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

DATA EVALUATION

This section demonstrates that contaminant concentrations at the 100-H-59:1 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 Nonradionuclide RAGs

Tables 3 and 4 compare the cleanup verification sample values for the 100-H-59:1 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 RAGs. All COPCs were quantified below groundwater and/or river protection soil RAGs with the exception of lead. However, based on the lead distribution coefficient (K_d) of 30 mL/g, lead is not expected to migrate more than 1.8 m (5.9 ft) vertically in 1,000 years based on RESidual RADioactivity (RESRAD) modeling discussed in Appendix C of the 100 Area RDR/RAWP (DOE-RL 2009b). The vadose zone beneath the 100-H-59:1 subsite is approximately 10 m (33 ft) thick. Therefore, the residual concentration of lead is predicted to be protective of groundwater and the Columbia River.

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-59:1 subsite is included in the *100-H-59:1 Subsite Cleanup Verification 95% UCL Calculations* in Appendix C 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 with the exception of lead, which fails all three parts of the three-part test to be protective of groundwater and the Columbia River. However, based on RESRAD modeling discussed in Appendix C of the 100 Area RDR/RAWP (DOE-RL 2009b), the residual concentrations of lead are not predicted to migrate more than 1.8 m (5.9 ft) vertically within 1,000 years (based on the lead K_d of 30 mL/g]). The vadose zone beneath the 100-H-59:1 subsite is approximately 10 m (33 ft) thick. Therefore, the residual concentrations of lead are predicted to be protective of groundwater and the Columbia River.

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 1×10^{-6}, and a cumulative carcinogenic risk of less than 1×10^{-5}. For the 100-H-59:1 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 1.8×10^{-3}, which is less than 1.0. No carcinogenic constituents met the criteria for evaluation; therefore, no calculations of excess carcinogenic risk were performed. The 100-H-59:1 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-59:1 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 1×10^{-6}, and a cumulative excess carcinogenic risk of less than 1×10^{-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 RESRAD modeling discussed in Appendix C of the 100 Area RDR/RAWP (DOE-RL 2009b). Based on this model and a vadose zone of approximately 10 m (33 ft) in thickness, a K_d of 7.2 or greater is required to show no predicted migration to groundwater in 1,000 years. Only one constituent (boron) was subject to the hazard quotient calculation, with a hazard quotient result of 8.4 x 10-3, which is less than 1. No carcinogenic constituents met the criteria for groundwater protection evaluation at the 100-H-59:1 subsite; therefore, no calculations of excess carcinogenic risk were 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 2014b), the field logbook (WCH 2014a), 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-59:1 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 WCH project-specific database for data evaluation prior to archival in HEIS and are summarized in Appendix C. The detailed DQA is presented in Appendix D.

SUMMARY FOR INTERIM CLOSURE

The 100-H-59:1 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-59:1 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.

REFERENCES

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WCH, 2014b, *Work Instruction for Verification Sampling of the 100-H-59, 100-H Area Railroad Track Soil Contamination Area Waste Site,* 0100H-WI-G0069, Rev. 0, Washington Closure Hanford, Richland, Washington.

WDOH, 1997, *Hanford Guidance for Radiological Cleanup*, WDOH/320-015, Rev. 1, Washington State Department of Health, Olympia, Washington.

APPENDIX A

ECOLOGICAL RISK COMPARISON TABLE

Table A-1. Maximum Contaminant Concentrations that Exceed Ecological Screening Levels for the 100-H-59:1 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								
Arsenic	6.5 [d]	--	--	7	18	--	43	46	8.3
Boron	--	0.5	--	--	--	--	--	--	2.7
Lead	10.2	50	500	118	120	1,700	11	56	25.5
Manganese	512	1,100 [e]	--	1,500	220	450	4,300	4,000	341 (<BG)
Vanadium	85.1	2	--	--	--	--	7.8	280	49.3 (<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] The Hanford Site background for arsenic is 6.5 mg/kg. An 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 *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, DOE/RL-96-17, Rev. 6, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

[e] 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

GLOBAL POSITIONAL ENVIRONMENTAL RADIOLOGICAL SURVEYOR (GPERS) SURVEYS

Figure B-1. 100-H-59:1 Subsite South Excavation GPERS Beta Track Map.

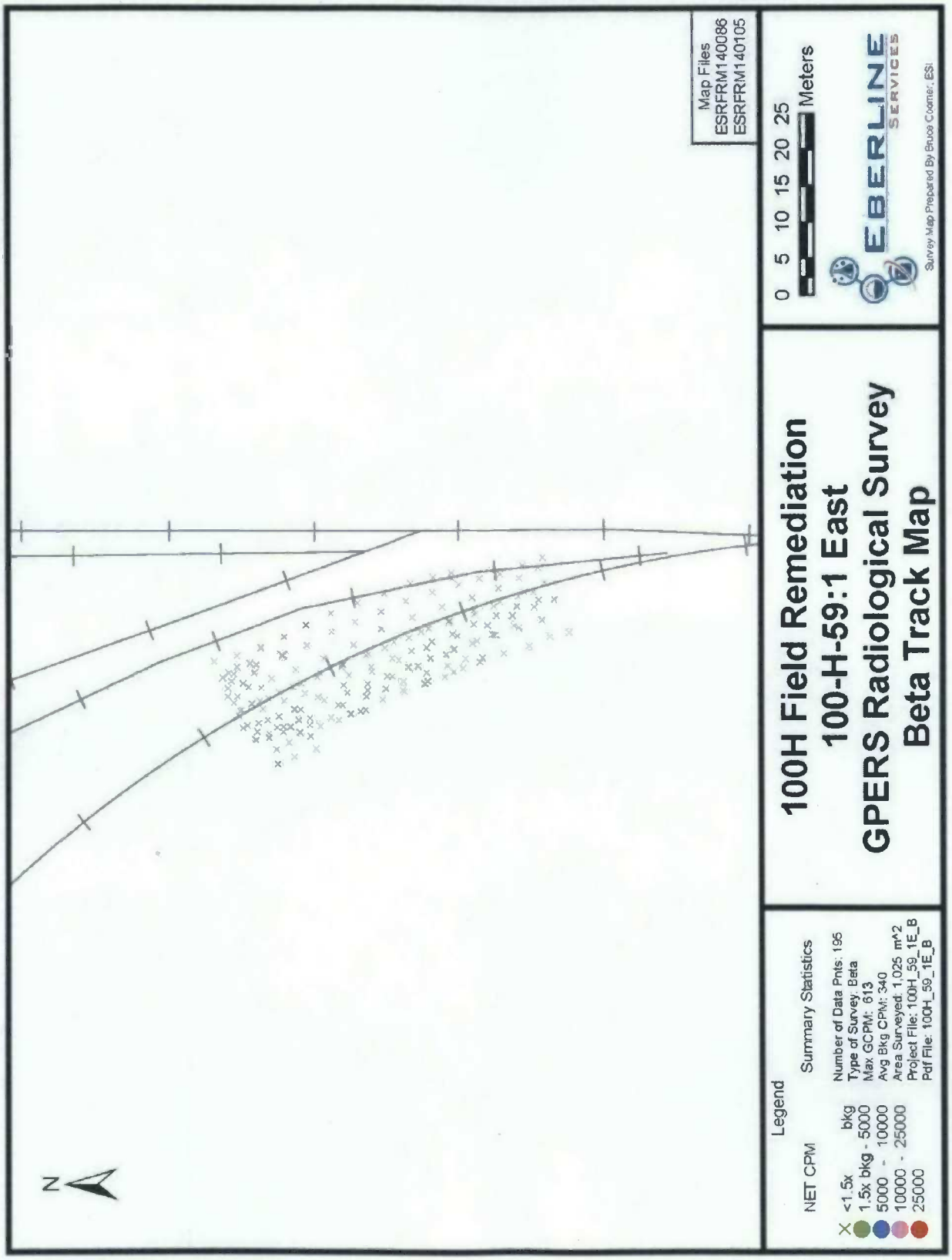


Figure B-2. 100-H-59:1 Subsite South Excavation GPERS Gamma Track Map.

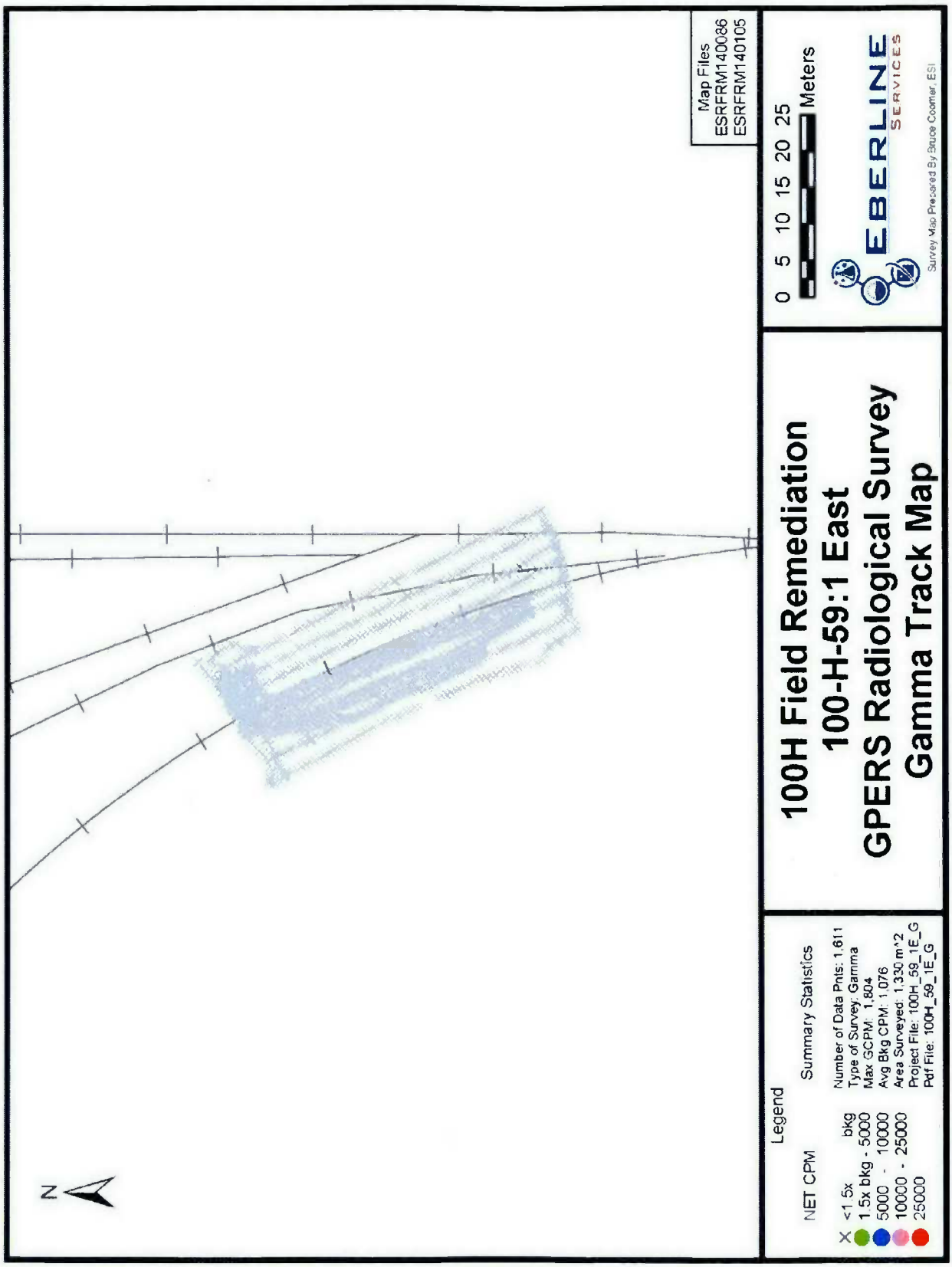


Figure B-3. 100-H-59:1 Subsite North Excavation GPERS Beta Track Map.

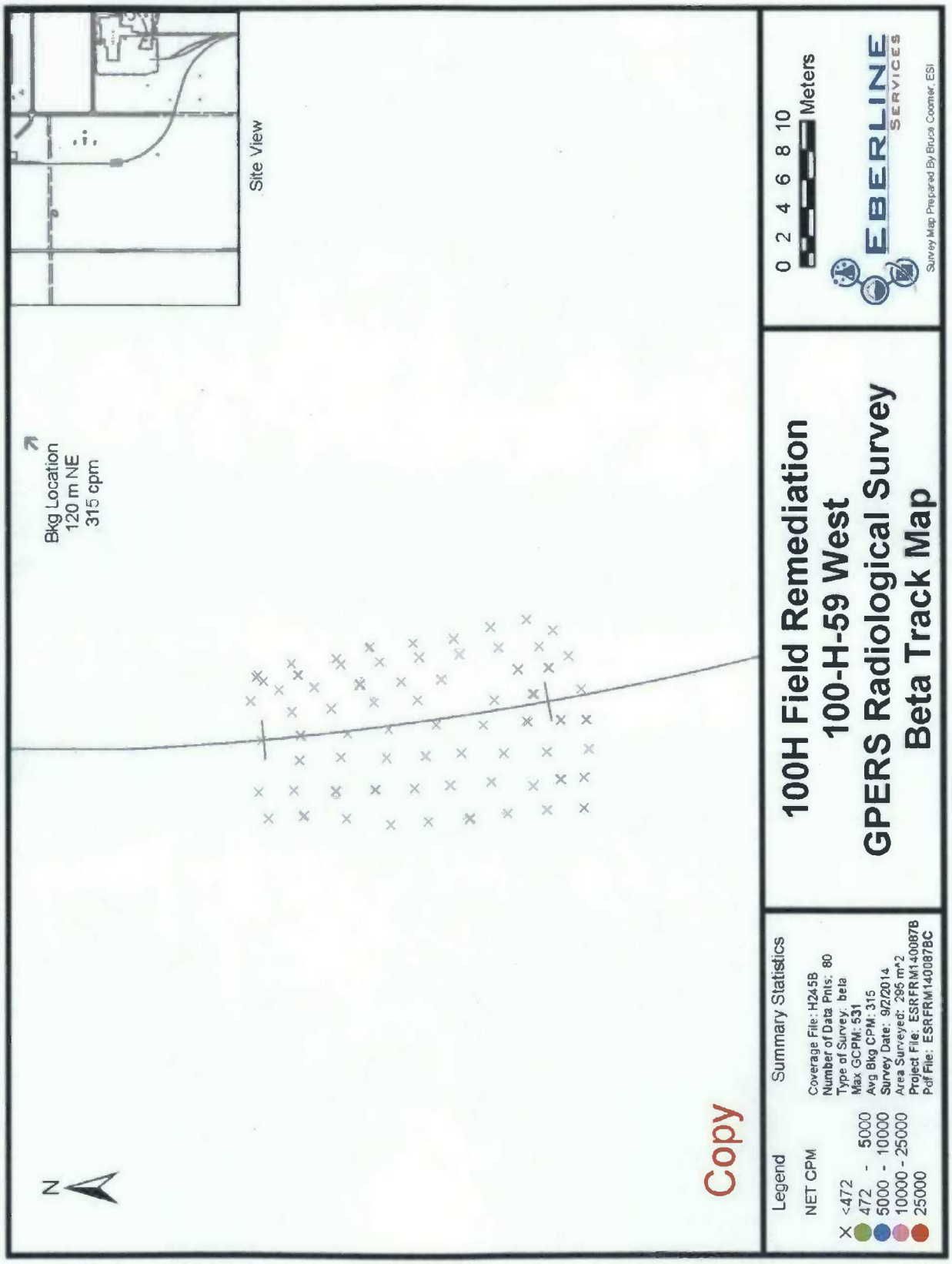


Figure B-4. 100-H-59:1 Subsite North Excavation GPERS Gamma Track Map.

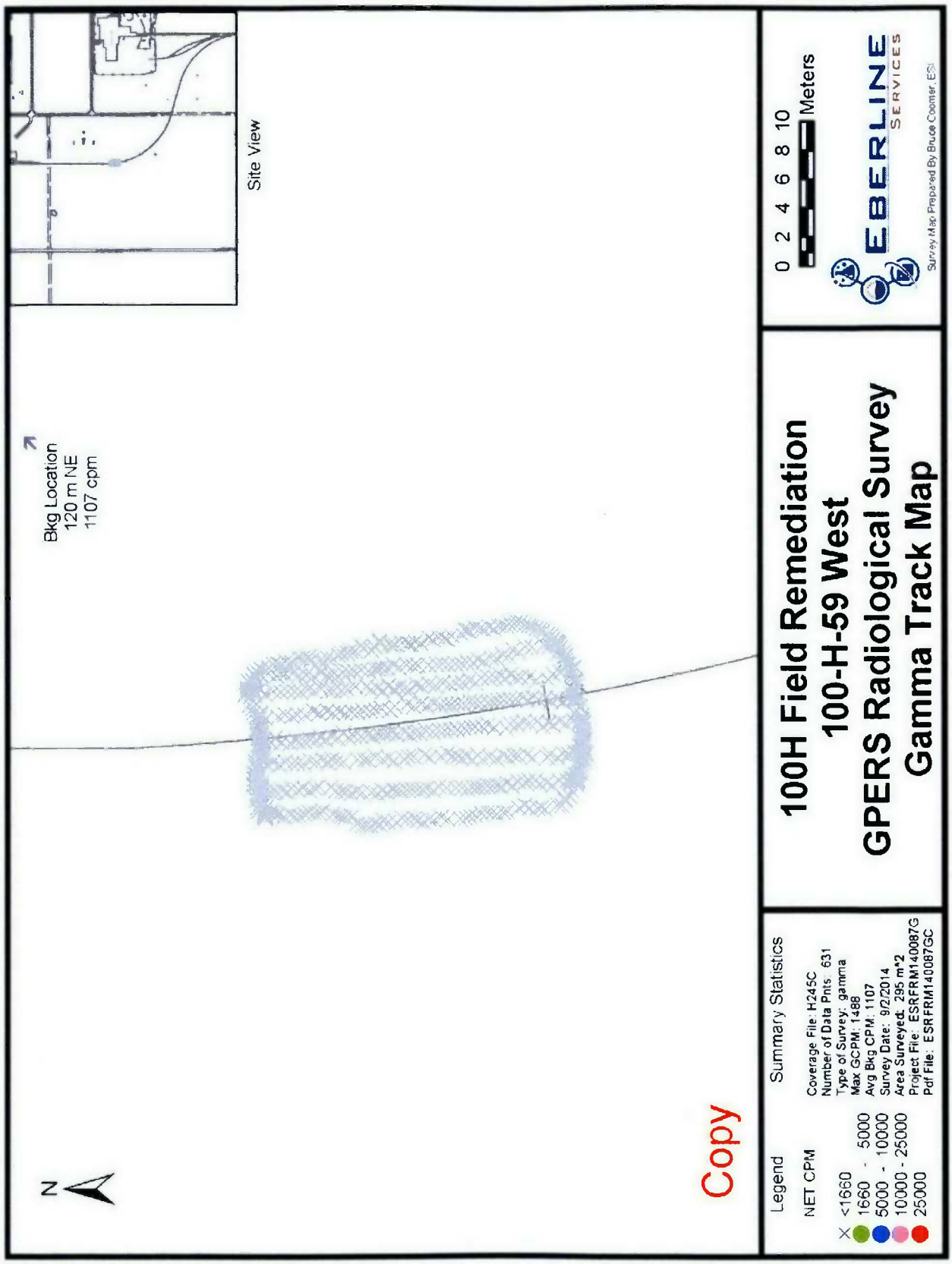


Figure B-5. 100-H-59:1 Subsite South SPA GPERS Beta Track Map.

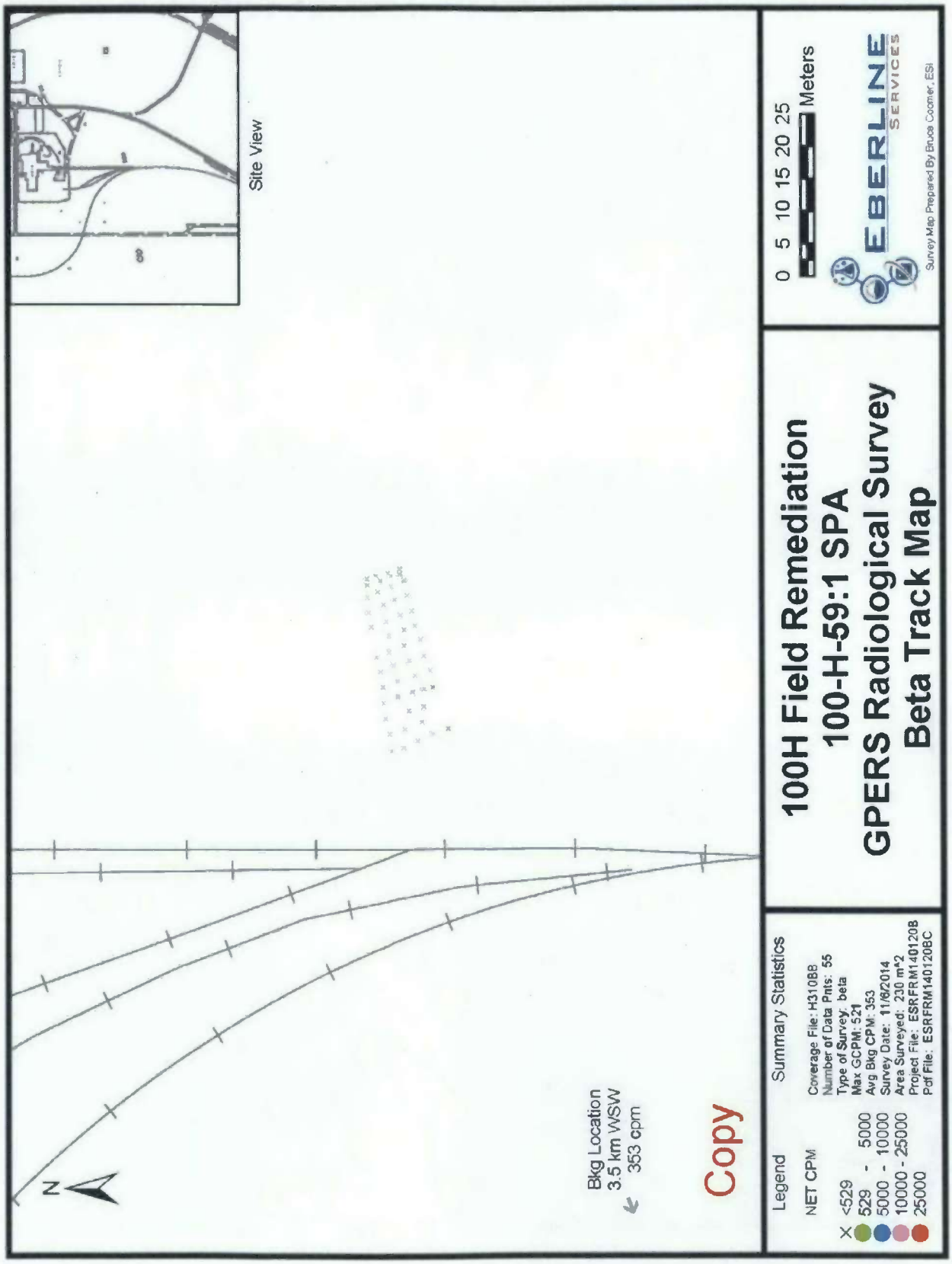


Figure B-6. 100-H-59:1 Subsite South SPA GPERS Gamma Track Map.

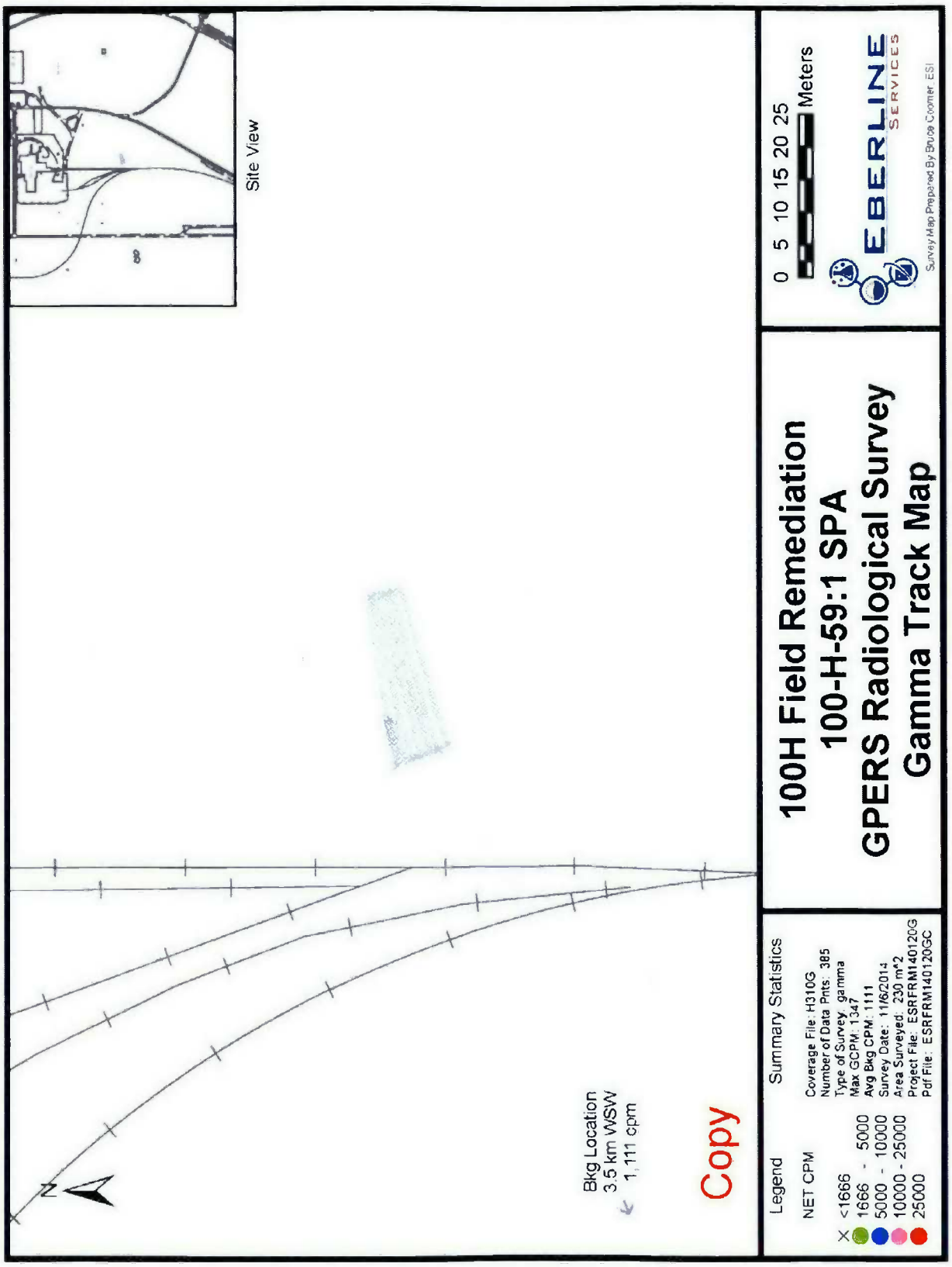


Figure B-7. 100-H-59:1 Subsite North SPA GPERS Beta Track Map.

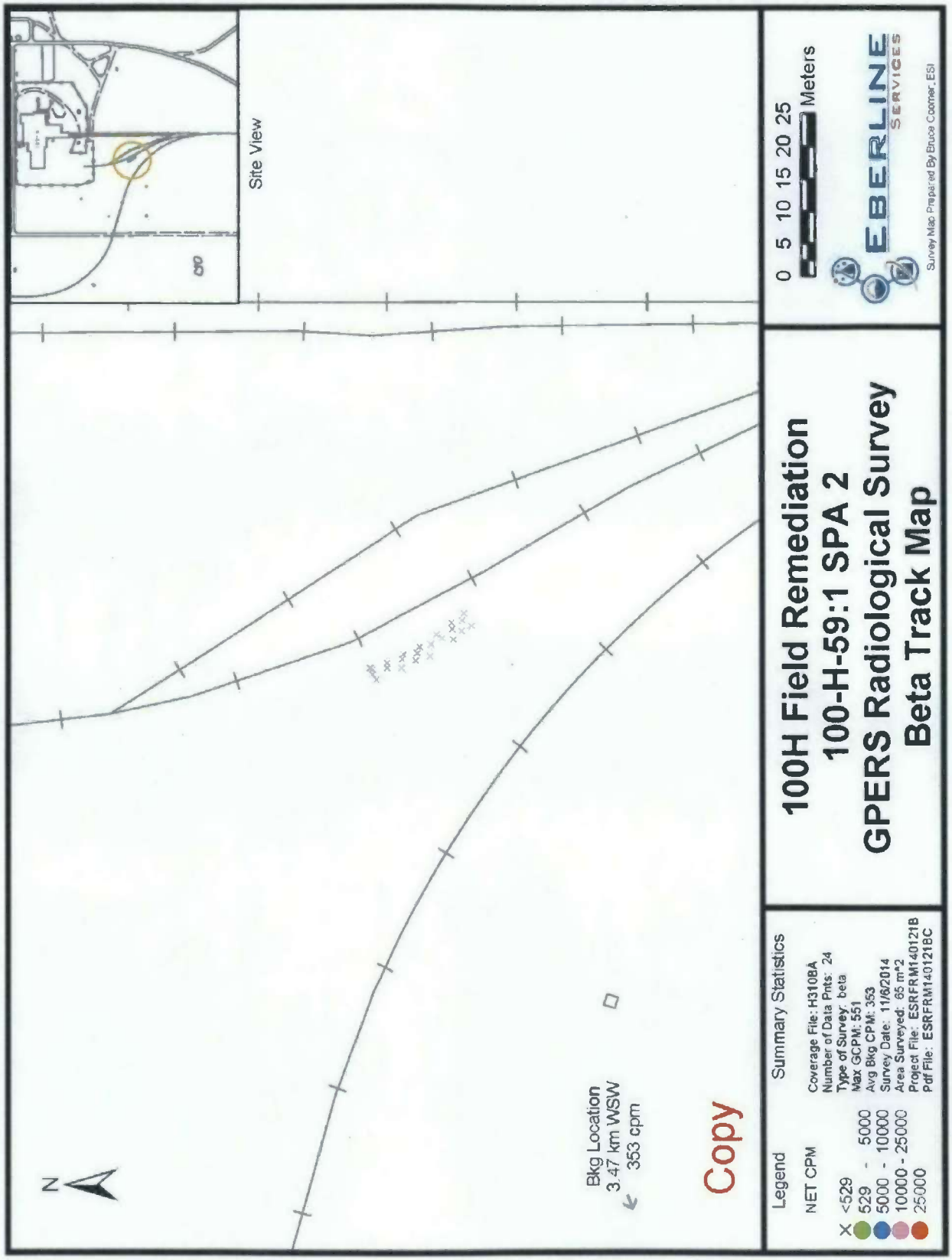
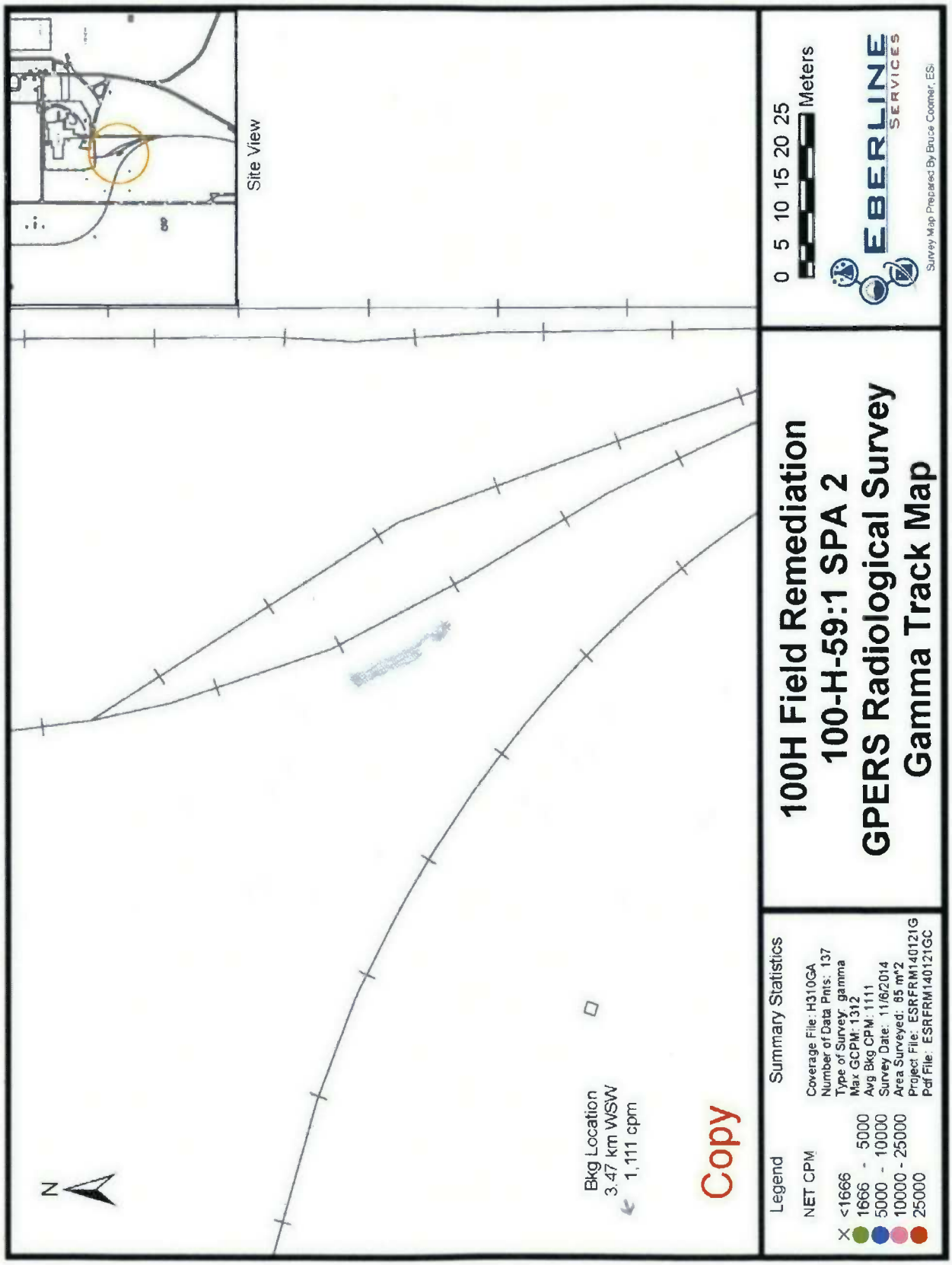


Figure B-8. 100-H-59:1 Subsite North SPA GPERS Gamma Track Map.



APPENDIX C

CALCULATIONS

APPENDIX C

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-59:1 Subsite Cleanup Verification 95% UCL Calculations, 0100H-CA-V0220, Rev. 0, Washington Closure Hanford, Richland, Washington.

100-H-59:1 Subsite Direct Contact Hazard Quotient, Carcinogenic Risk, and Sum of Fractions Calculations, 0100H-CA-V0221, Rev. 0, Washington Closure Hanford, Richland, Washington.

100-H-59:1 Subsite Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater, 0100H-CA-V0222, 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-V0220

Subject: 100-H-59:1 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 = 18 Attm. 1 = 4 Total = 23	J. D. Skoglie	I. B. Berezovskiy	R. J. Nielson	S. G. Wilkinson	6/1/15

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** 02/24/15	**Calc. No.** 0100H-CA-V0228	**Rev. No.** 0
Project 100-H Area Closure Operations	**Job No.** 14655	**Checked** I. B. Berezovskiy	**Date** 02/24/15
Subject 100-H-59:1 Subsite Cleanup Verification 95% UCL Calculations			**Sheet No.** 1 of 18

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 12- Calculation Sheet Verification Data - Excavation and Staging Pile Area
Sheet 13 to 16 - Ecology Software (MTCAStat) Results
Sheet 17 to 18 - Calculation Sheet Duplicate Analysis
Attachment 1 - 100-H-59:1 Verification Sampling Results (4 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-59:1 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-59:1 subsite underwent statistical sampling at two decision units for verification sampling that included the excavation and the staging pile 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.

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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 values were 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.

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Summary (continued)

QUALIFIER LIST

B = estimated result. Result is less than the RL but greater than the MDL
J = estimate
N = recovery is outside control limits
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
SPA = staging pile area
TDL = target detection limit
UCL = upper confidence limit
WAC = Washington Administrative Code

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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, staging pile 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		Staging Pile Area		Units
	95% UCL Result	Maximum Result	95% UCL Result	Maximum Result	
Cesium-137	0.0362	--	0.0215	--	pCi/g
Europium-155	0.0488	--	0.0412	--	pCi/g
Arsenic	8.3	--	6.9	--	mg/kg
Barium	80.9	--	74.2	--	mg/kg
Beryllium	--	0.049	--	--	mg/kg
Boron	2.7	--	2.4	--	mg/kg
Cadmium	0.17	--	0.15	--	mg/kg
Chromium	12.4	--	12.1	--	mg/kg
Cobalt	7.5	--	7.1	--	mg/kg
Copper	15.6	--	14.7	--	mg/kg
Lead	25.5	--	21.5	--	mg/kg
Manganese	341	--	326	--	mg/kg
Mercury	0.0070	--	0.039	--	mg/kg
Molybdenum	--	0.33	--	0.57	mg/kg
Nickel	11.8	--	13.5	--	mg/kg
Vanadium	49.3	--	48.0	--	mg/kg
Zinc	43.0	--	43.0	--	mg/kg
3 Part Test Evaluation:					
95% UCL or Maximum[a] > Cleanup Limit?	YES	NO	YES	NO	
> 10% above Cleanup Limit?	YES	NO	YES	NO	
Any sample > 2x Cleanup Limit?	YES	NO	YES	NO	

[a]The 95% UCL result or maximum value, depending on data censorship.

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

Analyte	Excavation	Staging Pile Area
	Duplicate Analysis	Duplicate Analysis
Potassium-40	7.2%	2.9%
Aluminum	14.1%	6.2%
Barium	14.9%	13.9%
Calcium	11.1%	5.9%
Chromium	19.9%	0.9%
Copper	9.9%	7.8%
Iron	17.8%	8.2%
Magnesium	17.5%	0.8%
Manganese	17.2%	0.3%
Silicon	6.4%	12.7%
Vanadium	18.5%	9.4%
Zinc	17.6%	1.3%

[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.

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Verification Data -Excavation

Sample Area	Sample Number	Sample Date	Cesium-137 pCi/g	Q	MDA	Europium-155 pCi/g	Q	MDA
EXC-10	J1V2R6	1/5/15	-0.00792	U	0.0324	0.0257	U	0.113
Duplicate of J1V2R6	J1V2R9	1/5/15	-0.00401	U	0.0332	-0.0163	U	0.114
EXC-1	J1V2P7	1/5/15	0.00410	U	0.0220	0.0380	U	0.0430
EXC-2	J1V2P8	1/5/15	0.0183	U	0.0262	0.0390	U	0.0451
EXC-3	J1V2P9	1/5/15	0.00275	U	0.0247	0.0440	U	0.0524
EXC-4	J1V2R0	1/5/15	0.0635	U	0.0384	0.0428	U	0.109
EXC-5	J1V2R1	1/5/15	-0.0143	U	0.0323	0.0448	U	0.0918
EXC-6	J1V2R2	1/5/15	0.0487		0.0237	0.0357	U	0.0499
EXC-7	J1V2R3	1/5/15	0.0617		0.0217	0.0553		0.0432
EXC-8	J1V2R4	1/5/15	0.0111	U	0.0321	-0.00312	U	0.112
EXC-9	J1V2R5	1/5/15	-0.0205	U	0.0348	0.0486	U	0.0952
EXC-11	J1V2R7	1/5/15	0.0779		0.0401	0.0657	U	0.111
EXC-12	J1V2R8	1/5/15	-0.00537	U	0.0426	0.0565	U	0.121

Statistical Computation Input Data

Sample Area	Sample Number	Sample Date	Cesium-137 pCi/g			Europium-155 pCi/g		
EXC-10	J1V2R6/ J1V2R9	1/5/15	-0.00597			0.00470		
EXC-1	J1V2P7	1/5/15	0.00410			0.0380		
EXC-2	J1V2P8	1/5/15	0.0183			0.0390		
EXC-3	J1V2P9	1/5/15	0.00275			0.0440		
EXC-4	J1V2R0	1/5/15	0.0635			0.0428		
EXC-5	J1V2R1	1/5/15	-0.0143			0.0448		
EXC-6	J1V2R2	1/5/15	0.0487			0.0357		
EXC-7	J1V2R3	1/5/15	0.0617			0.0553		
EXC-8	J1V2R4	1/5/15	0.0111			-0.00312		
EXC-9	J1V2R5	1/5/15	-0.0205			0.0486		
EXC-11	J1V2R7	1/5/15	0.0779			0.0657		
EXC-12	J1V2R8	1/5/15	-0.00537			0.0565		

Statistical Computations

	Cesium-137			Europium-155		
95% UCL based on	Radionuclide data set. Use nonparametric z-statistic.			Radionuclide data set. Use nonparametric z-statistic.		
N	12			12		
% < Detection limit	75%			92%		
Mean	0.0202			0.0393		
Standard deviation	0.0338			0.0200		
Z-statistic	1.64			1.64		
95% UCL on mean	0.0362			0.0488		
Maximum value	0.0779			0.0553		

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Verification Data -Excavation

Sample Area	Sample Number	Sample Date	Arsenic mg/kg	Arsenic Q	Arsenic PQL	Barium mg/kg	Barium Q	Barium PQL	Boron mg/kg	Boron Q	Boron PQL	Cadmium mg/kg	Cadmium Q	Cadmium PQL	Chromium mg/kg	Chromium Q	Chromium PQL	Cobalt mg/kg	Cobalt Q	Cobalt PQL	Copper mg/kg	Copper Q	Copper PQL	Lead mg/kg	Lead Q	Lead PQL
EXC-10	J1V2R6	1/5/15	6.1		0.61	72.7		0.070	2.2		0.91	0.17	B	0.038	12.7		0.054	7.4	X	0.093	14.9	X	0.20	9.5		0.25
Duplicate of J1V2R6	J1V2R9	1/5/15	5.7		0.66	62.6		0.075	2.0		0.97	0.13	B	0.041	10.4		0.058	6.1	X	0.099	13.5	X	0.22	8.3		0.27
EXC-1	J1V2P7	1/5/15	4.0		0.62	69.7		0.071	1.5	B	0.91	0.15	B	0.038	10.4		0.054	6.6	X	0.093	13.9	X	0.20	7.2		0.25
EXC-2	J1V2P8	1/5/15	4.8		0.67	69.2		0.077	1.5	B	1.0	0.16	B	0.042	10.9		0.059	7.2	X	0.10	15.4	X	0.22	9.9		0.27
EXC-3	J1V2P9	1/5/15	5.1		0.66	83.3		0.075	1.4	B	0.97	0.17	B	0.041	12.4		0.058	7.8	X	0.099	16.0	X	0.22	8.6		0.27
EXC-4	J1V2R0	1/5/15	7.7		0.63	70.4		0.072	2.2		0.93	0.14	B	0.039	11.3		0.055	6.3	X	0.095	16.0	X	0.21	33.7		0.26
EXC-5	J1V2R1	1/5/15	4.4		0.68	68.6		0.078	1.4	B	1.0	0.14	B	0.042	10.4		0.060	7.2	X	0.10	15.6	X	0.22	5.5		0.28
EXC-6	J1V2R2	1/5/15	14.0		0.61	71.7		0.070	2.9		0.91	0.15	B	0.038	11.7		0.054	6.2	X	0.092	11.8	X	0.20	66.1		0.25
EXC-7	J1V2R3	1/5/15	5.2		0.61	72.2		0.070	2.0		0.91	0.18	B	0.038	11.3		0.054	7.3	X	0.093	14.3	X	0.20	9.2		0.25
EXC-8	J1V2R4	1/5/15	12.4		0.67	91.7		0.077	1.7	B	0.99	0.19	B	0.041	15.6		0.059	8.3	X	0.10	17.0	X	0.22	8.9		0.27
EXC-9	J1V2R5	1/5/15	6.3		0.70	75.1		0.081	1.7	B	1.0	0.16	B	0.044	11.8		0.062	7.2	X	0.11	13.3	X	0.23	23.4		0.29
EXC-11	J1V2R7	1/5/15	4.4		0.64	61.6		0.073	1.8	B	0.95	0.14	B	0.040	10.5		0.056	6.0	X	0.097	12.0	X	0.21	13.3		0.26
EXC-12	J1V2R8	1/5/15	6.6		0.70	103		0.080	5.4		1.0	0.15	B	0.043	12.8		0.061	7.9	X	0.11	15.8	X	0.23	12.4		0.29

Statistical Computation Input Data

Sample Area	Sample Number	Sample Date	Arsenic mg/kg	Barium mg/kg	Boron mg/kg	Cadmium mg/kg	Chromium mg/kg	Cobalt mg/kg	Copper mg/kg	Lead mg/kg
EXC-10	J1V2R6/ J1V2R9	1/5/15	5.9	67.7	2.1	0.15	11.6	6.8	14.2	8.9
EXC-1	J1V2P7	1/5/15	4.0	69.7	1.5	0.15	10.4	6.6	13.9	7.2
EXC-2	J1V2P8	1/5/15	4.8	69.2	1.5	0.16	10.9	7.2	15.4	9.9
EXC-3	J1V2P9	1/5/15	5.1	83.3	1.4	0.17	12.4	7.8	16.0	8.6
EXC-4	J1V2R0	1/5/15	7.7	70.4	2.2	0.14	11.3	6.3	16.0	33.7
EXC-5	J1V2R1	1/5/15	4.4	68.6	1.4	0.14	10.4	7.2	15.6	5.5
EXC-6	J1V2R2	1/5/15	14.0	71.7	2.9	0.15	11.7	6.2	11.8	66.1
EXC-7	J1V2R3	1/5/15	5.2	72.2	2.0	0.18	11.3	7.3	14.3	9.2
EXC-8	J1V2R4	1/5/15	12.4	91.7	1.7	0.19	15.6	8.3	17.0	8.9
EXC-9	J1V2R5	1/5/15	6.3	75.1	1.7	0.16	11.8	7.2	13.3	23.4
EXC-11	J1V2R7	1/5/15	4.4	61.6	1.8	0.14	10.5	6.0	12.0	13.3
EXC-12	J1V2R8	1/5/15	6.6	103	5.4	0.15	12.8	7.9	15.8	12.4

Statistical Computations

	Arsenic	Barium	Boron	Cadmium	Chromium	Cobalt	Copper	Lead
95% UCL based on	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.	Large data set (n ≥ 10), 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.	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.
N	12	12	12	12	12	12	12	12
% < Detection limit	0%	0%	0%	0%	0%	0%	0%	0%
Mean	6.6	75.3	2.1	0.16	11.7	7.1	14.6	17.3
Standard deviation	3.4	11.7	1.1	0.016	1.4	0.72	1.6	17.3
95% UCL on mean	8.3	80.9	2.7	0.17	12.4	7.5	15.6	25.5
Maximum value	14.0	103	5.4	0.19	15.6	8.3	17.0	66.1
Most Stringent Cleanup Limit for nonradionuclide and RAG type (mg/kg)	20 DE, GW & River Protection	200 GW Protection	320 GW Protection	0.81 GW & River Protection	18.5 GW & River Protection	15.7 GW Protection	22.0 River Protection	10.2 GW & River Protection
WAC 173-340 3-PART TEST								
95% UCL > Cleanup Limit?	NO	NA	NO	NA	NA	NA	NA	YES
> 10% above Cleanup Limit?	NO	NA	NO	NA	NA	NA	NA	YES
Any sample > 2X Cleanup Limit?	NO	NA	NO	NA	NA	NA	NA	YES
WAC 173-340 Compliance?	The data set meets the 3-part test criteria when compared to the most stringent RAG.	Because all values are below background (132 mg/kg) the WAC 173-340 3-part test is not required.	The data set meets the 3-part test criteria when compared to the most stringent RAG.	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.	A detailed assessment will be performed. The data set meets the 3-part test criteria when compared to the direct exposure RAG.

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1 **100-H-59:1 Subsite Statistical Calculations**
2 **Verification Data -Excavation**

3	Sample	Sample	Sample	Manganese			Mercury			Nickel			Vanadium			Zinc		
4	Area	Number	Date	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
5	EXC-10	J1V2R6	1/5/15	328		0.093	0.0075	B	0.0053	11.8	X	0.11	46.6		0.087	41.5		0.37
6	Duplicate of J1V2R6	J1V2R9	1/5/15	276		0.099	0.0071	B	0.0053	10.2	X	0.12	38.7		0.093	34.8		0.40
7	EXC-1	J1V2P7	1/5/15	307		0.093	0.0062	B	0.0056	10.5	X	0.11	47.1		0.088	40.5		0.37
8	EXC-2	J1V2P8	1/5/15	309		0.10	0.0052	U	0.0052	11.3	X	0.13	46.9		0.096	41.9		0.40
9	EXC-3	J1V2P9	1/5/15	350		0.099	0.0078	B	0.0060	12.5	X	0.12	48.5		0.093	44.9		0.40
10	EXC-4	J1V2R0	1/5/15	302		0.095	0.0068	B	0.0052	10.6	X	0.12	43.0		0.089	41.8		0.38
11	EXC-5	J1V2R1	1/5/15	316		0.10	0.0063	B	0.0056	10.6	X	0.13	51.4		0.097	41.9		0.41
12	EXC-6	J1V2R2	1/5/15	288		0.092	0.0057	U	0.0057	10.7	X	0.11	40.9		0.087	39.3		0.37
13	EXC-7	J1V2R3	1/5/15	340		0.093	0.0059	B	0.0059	11.0	X	0.11	47.2		0.087	42.2		0.37
14	EXC-8	J1V2R4	1/5/15	387		0.10	0.0060	U	0.0060	12.4	X	0.12	56.1		0.095	46.1		0.40
15	EXC-9	J1V2R5	1/5/15	343		0.11	0.0068	B	0.0056	11.4	X	0.13	43.2		0.10	40.1		0.42
16	EXC-11	J1V2R7	1/5/15	275		0.097	0.0071	B	0.0057	9.9	X	0.12	35.9		0.091	34.5		0.38
17	EXC-12	J1V2R8	1/5/15	359		0.11	0.0085	B	0.0061	13.2	X	0.13	51.4		0.099	44.0		0.42

18 **Statistical Computation Input Data**

19	Sample	Sample	Sample	Manganese	Mercury	Nickel	Vanadium	Zinc
20	Area	Number	Date	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
21	EXC-10	J1V2R6/ J1V2R9	1/5/15	302	0.0073	11.0	42.7	38.2
22	EXC-1	J1V2P7	1/5/15	307	0.0062	10.5	47.1	40.5
23	EXC-2	J1V2P8	1/5/15	309	0.0026	11.3	46.9	41.9
24	EXC-3	J1V2P9	1/5/15	350	0.0078	12.5	48.5	44.9
25	EXC-4	J1V2R0	1/5/15	302	0.0068	10.6	43.0	41.8
26	EXC-5	J1V2R1	1/5/15	316	0.0063	10.6	51.4	41.9
27	EXC-6	J1V2R2	1/5/15	288	0.0029	10.7	40.9	39.3
28	EXC-7	J1V2R3	1/5/15	340	0.0059	11.0	47.2	42.2
29	EXC-8	J1V2R4	1/5/15	387	0.0030	12.4	56.1	46.1
30	EXC-9	J1V2R5	1/5/15	343	0.0068	11.4	43.2	40.1
31	EXC-11	J1V2R7	1/5/15	275	0.0071	9.9	35.9	34.5
32	EXC-12	J1V2R8	1/5/15	359	0.0085	13.2	51.4	44.0

33 **Statistical Computations**

34		Manganese	Mercury	Nickel	Vanadium	Zinc
35	95% UCL based on	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.
36	N	12	12	12	12	12
37	% < Detection limit	0%	25%	0%	0%	0%
38	Mean	324	0.0059	11.3	46.2	41.3
39	Standard deviation	27.1	0.0020	0.97	5.4	3.1
40	95% UCL on mean	341	0.0070	11.8	49.3	43.0
41	Maximum value	359	0.0085	13.2	56.1	46.1
42	**Most Stringent Cleanup Limit for nonradionuclide and RAG type (mg/kg)**	512 GW & River Protection	0.33 GW & River Protection	19.1 GW Protection	85.1 GW Protection	67.8 River Protection
43	**WAC 173-340 3-PART TEST**					
44	95% UCL > Cleanup Limit?	NA	NA	NA	NA	NA
45	> 10% above Cleanup Limit?	NA	NA	NA	NA	NA
46	Any sample > 2X Cleanup Limit?	NA	NA	NA	NA	NA
47	**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 (0.33 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-59:1 Subsite Cleanup Verification 95% UCL Calculations

Date 02/24/15
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Checked I. B. Berezovskiy

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100-H-59:1 Subsite Maximum Calculations

Verification Data - Excavation

Sample Area	Sample Number	Sample Date	Beryllium mg/kg	Beryllium Q	Beryllium PQL	Molybdenum mg/kg	Molybdenum Q	Molybdenum PQL
EXC-10	J1V2R6	1/5/15	0.031	U	0.031	0.24	U	0.24
Duplicate of J1V2R6	J1V2R9	1/5/15	0.033	U	0.033	0.26	U	0.26
EXC-1	J1V2P7	1/5/15	0.031	U	0.031	0.24	U	0.24
EXC-2	J1V2P8	1/5/15	0.034	U	0.034	0.26	U	0.26
EXC-3	J1V2P9	1/5/15	0.033	U	0.033	0.26	U	0.26
EXC-4	J1V2R0	1/5/15	0.031	U	0.031	0.25	U	0.25
EXC-5	J1V2R1	1/5/15	0.034	U	0.034	0.27	U	0.27
EXC-6	J1V2R2	1/5/15	0.030	U	0.030	0.24	U	0.24
EXC-7	J1V2R3	1/5/15	0.031	U	0.031	0.24	U	0.24
EXC-8	J1V2R4	1/5/15	0.049	B	0.033	0.33	B	0.26
EXC-9	J1V2R5	1/5/15	0.035	U	0.035	0.28	U	0.28
EXC-11	J1V2R7	1/5/15	0.033	B	0.032	0.25	U	0.25
EXC-12	J1V2R8	1/5/15	0.035	U	0.035	0.28	U	0.28

3-Part Test Evaluations

	Beryllium	Molybdenum
% < Detection limit	83%	92%
Maximum value	0.049	0.33
Most Stringent Cleanup Limit for nonradionuclide and RAG type (mg/kg)	1.51 GW & River Protection	8 GW Protection
3-PART TEST		
Maximum > Cleanup Limit?	NA	NO
> 10% above Cleanup Limit?	NA	NO
Any sample > 2X Cleanup Limit?	NA	NO
3-Part Test Compliance?	Because all values are below background (1.51 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-59:1 Subsite Cleanup Verification 95% UCL Calculations

Date 02/24/15
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100-H-59:1 Subsite Statistical Calculations
Verification Data - Staging Pile Area

Sample Area	Sample Number	Sample Date	Cesium-137 pCi/g	Q	MDA	Europium-155 pCi/g	Q	MDA
SPA-6	J1V2T5	1/5/15	0.00489	U	0.0278	0.0574	U	0.0641
Duplicate of J1V2T5	J1V2V2	1/5/15	-0.0000116	U	0.0247	0.0329	U	0.0616
SPA-1	J1V2T0	1/5/15	-0.00375	U	0.0229	0.0287	U	0.0439
SPA-2	J1V2T1	1/5/15	0.0115	U	0.0232	0.0307	U	0.0445
SPA-3	J1V2T2	1/5/15	-0.00193	U	0.0204	0.0357	U	0.0436
SPA-4	J1V2T3	1/5/15	0.00509	U	0.0295	-0.0134	U	0.0998
SPA-5	J1V2T4	1/5/15	0.00911	U	0.0252	0.0112	U	0.0722
SPA-7	J1V2T6	1/5/15	0.0000763	U	0.0229	0.0448	U	0.0452
SPA-8	J1V2T7	1/5/15	-0.00160	U	0.0200	0.0616		0.0359
SPA-9	J1V2T8	1/5/15	0.0210	U	0.0254	0.0421		0.0386
SPA-10	J1V2T9	1/5/15	0.00310	U	0.0216	0.0598	U	0.0465
SPA-11	J1V2V0	1/5/15	0.0357	U	0.0322	-0.0182	U	0.0975
SPA-12	J1V2V1	1/5/15	0.0641		0.0251	0.0526	U	0.0724

Statistical Computation Input Data

Sample Area	Sample Number	Sample Date	Cesium-137 pCi/g			Europium-155 pCi/g		
SPA-6	J1V2T5/ J1V2V2	1/5/15	0.00244			0.0314		
SPA-1	J1V2T0	1/5/15	-0.00375			0.0220		
SPA-2	J1V2T1	1/5/15	0.0115			0.0223		
SPA-3	J1V2T2	1/5/15	-0.00193			0.0218		
SPA-4	J1V2T3	1/5/15	0.00509			0.0499		
SPA-5	J1V2T4	1/5/15	0.00911			0.0361		
SPA-7	J1V2T6	1/5/15	0.0000763			0.0226		
SPA-8	J1V2T7	1/5/15	-0.00160			0.0616		
SPA-9	J1V2T8	1/5/15	0.0210			0.0421		
SPA-10	J1V2T9	1/5/15	0.00310			0.0233		
SPA-11	J1V2V0	1/5/15	0.0357			0.0488		
SPA-12	J1V2V1	1/5/15	0.0641			0.0362		

Statistical Computations

	Cesium-137			Europium-155		
95% UCL based on	Radionuclide data set. Use nonparametric z-statistic.			Radionuclide data set. Use nonparametric z-statistic.		
N	12			12		
% < Detection limit	92%			83%		
Mean	0.0121			0.0348		
Standard deviation	0.0199			0.0134		
Z-statistic	1.64			1.64		
95% UCL on mean	0.0215			0.0412		
Maximum value	0.0641			0.0616		

CALCULATION SHEET

Washington Closure Hanford

Originator J. D. Skoglie
Project 100-H Area Closure Operations
Subject 100-H-59:1 Subsite Cleanup Verification 95% UCL Calculations

Date 02/24/15
Job No. 14655

Calc. No. 0100H-CA-V0220
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1 **100-H-59:1 Subsite Statistical Calculations**
2 **Verification Data - Staging Pile Area**

3	Sample	Sample	Sample	Arsenic			Barium			Boron			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	SPA-6	J1V2T5	1/5/15	6.0		0.67	86.2		0.077	1.9	B	0.99	0.13	B	0.042	10.9		0.059	6.7	X	0.10	12.3		0.22	16.1	X	0.27
6	Duplicate of J1V2T5	J1V2V2	1/5/15	6.3		0.66	75.0		0.076	3.9		0.98	0.14	B	0.041	10.8		0.058	6.5	X	0.10	13.3		0.22	15.3	X	0.27
7	SPA-1	J1V2T0	1/5/15	5.8		0.64	72.4		0.074	2.8		0.95	0.15	B	0.040	13.7		0.056	7.4	X	0.097	15.6		0.21	15.7	X	0.26
8	SPA-2	J1V2T1	1/5/15	5.7		0.67	79.1		0.077	2.3		0.99	0.15	B	0.042	10.1		0.059	6.8	X	0.10	14.0		0.22	14.2	X	0.27
9	SPA-3	J1V2T2	1/5/15	5.7		0.71	65.2		0.082	2.2		1.1	0.13	B	0.044	15.8		0.062	6.7	X	0.11	12.8		0.23	13.9	X	0.29
10	SPA-4	J1V2T3	1/5/15	5.7		0.62	74.2		0.071	1.9		0.92	0.14	B	0.038	11.1		0.054	6.3	X	0.094	13.1		0.20	15.6	X	0.25
11	SPA-5	J1V2T4	1/5/15	6.8		0.67	69.3		0.077	1.7	B	0.99	0.15	B	0.041	11.4		0.058	6.7	X	0.10	13.7		0.22	17.8	X	0.27
12	SPA-7	J1V2T6	1/5/15	6.9		0.61	71.6		0.070	1.6	B	0.90	0.14	B	0.038	10.6		0.053	7.6	X	0.092	14.4		0.20	13.5	X	0.25
13	SPA-8	J1V2T7	1/5/15	7.0		0.61	72.8		0.070	1.7	B	0.91	0.14	B	0.038	10.1		0.054	7.0	X	0.093	12.8		0.20	19.8	X	0.25
14	SPA-9	J1V2T8	1/5/15	9.6		0.61	74.0		0.071	2.9		0.91	0.15	B	0.038	11.2		0.054	6.4	X	0.093	14.2		0.20	35.0	X	0.25
15	SPA-10	J1V2T9	1/5/15	6.8		0.67	62.2		0.078	1.8	B	1.0	0.16	B	0.042	10.6		0.059	7.2	X	0.10	16.1		0.22	4.8	X	0.28
16	SPA-11	J1V2V0	1/5/15	2.9		0.65	54.1		0.075	1.4	B	0.96	0.12	B	0.040	9.5		0.057	5.8	X	0.098	12.2		0.21	7.0	X	0.27
17	SPA-12	J1V2V1	1/5/15	4.4		0.67	69.8		0.077	1.7	B	0.99	0.16	B	0.041	10.4		0.059	7.3	X	0.10	15.9		0.22	9.1	X	0.27

18 **Statistical Computation Input Data**

19	Sample	Sample	Sample	Arsenic	Barium	Boron	Cadmium	Chromium	Cobalt	Copper	Lead
20	Area	Number	Date	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
21	SPA-6	J1V2T5/ J1V2V2	1/5/15	6.2	80.6	2.9	0.14	10.9	6.6	12.8	15.7
22	SPA-1	J1V2T0	1/5/15	5.8	72.4	2.8	0.15	13.7	7.4	15.6	15.7
23	SPA-2	J1V2T1	1/5/15	5.7	79.1	2.3	0.15	10.1	6.8	14.0	14.2
24	SPA-3	J1V2T2	1/5/15	5.7	65.2	2.2	0.13	15.8	6.7	12.8	13.9
25	SPA-4	J1V2T3	1/5/15	5.7	74.2	1.9	0.14	11.1	6.3	13.1	15.6
26	SPA-5	J1V2T4	1/5/15	6.8	69.3	1.7	0.15	11.4	6.7	13.7	17.8
27	SPA-7	J1V2T6	1/5/15	6.9	71.6	1.6	0.14	10.6	7.6	14.4	13.5
28	SPA-8	J1V2T7	1/5/15	7.0	72.8	1.7	0.14	10.1	7.0	12.8	19.8
29	SPA-9	J1V2T8	1/5/15	9.6	74.0	2.9	0.15	11.2	6.4	14.2	35.0
30	SPA-10	J1V2T9	1/5/15	6.8	62.2	1.8	0.16	10.6	7.2	16.1	4.8
31	SPA-11	J1V2V0	1/5/15	2.9	54.1	1.4	0.12	9.5	5.8	12.2	7.0
32	SPA-12	J1V2V1	1/5/15	4.4	69.8	1.7	0.16	10.4	7.3	15.9	9.1

33 **Statistical Computations**

34		Arsenic	Barium	Boron	Cadmium	Chromium	Cobalt	Copper	Lead
35	95% UCL based on	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.	Large data set (n ≥ 10), use MTCAStat normal 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.	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.
36	N	12	12	12	12	12	12	12	12
37	% < Detection limit	0%	0%	0%	0%	0%	0%	0%	0%
38	Mean	6.6	70.4	2.1	0.14	11.3	6.8	14.0	15.2
39	Standard deviation	1.7	7.3	0.54	0.012	1.8	0.51	1.3	7.6
40	95% UCL on mean	6.9	74.2	2.4	0.15	12.1	7.1	14.7	21.5
41	Maximum value	9.6	86.2	3.9	0.16	15.8	7.6	16.1	35.0
42	**Most Stringent Cleanup Limit for nonradionuclide and RAG type (mg/kg)**	20 DE, GW & River Protection	200 GW Protection	320 GW Protection	0.81 GW & River Protection	18.5 GW & River Protection	15.7 GW Protection	22.0 River Protection	10.2 GW & River Protection
43	**WAC 173-340 3-PART TEST**								
44	95% UCL > Cleanup Limit?	NO	NA	NO	NA	NA	NA	NA	YES
45	> 10% above Cleanup Limit?	NO	NA	NO	NA	NA	NA	NA	YES
46	Any sample > 2X Cleanup Limit?	NO	NA	NO	NA	NA	NA	NA	YES
47	**WAC 173-340 Compliance?**	The data set meets the 3-part test criteria when compared to the most stringent RAG.	Because all values are below background (132 mg/kg) the WAC 173-340 3-part test is not required.	The data set meets the 3-part test criteria when compared to the most stringent RAG.	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.	A detailed assessment will be performed. The data set meets the 3-part test criteria when compared to the direct exposure RAG.

CALCULATION SHEET

Washington Closure Hanford
Originator J. D. Skoglie
Project 100-H Area Closure Operations
Subject 100-H-59:1 Subsite Cleanup Verification 95% UCL Calculations

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1 **100-H-59:1 Subsite Statistical Calculations**
2 **Verification Data - Staging Pile Area**

3	Sample	Sample	Sample	Manganese			Mercury			Nickel			Vanadium			Zinc		
4	Area	Number	Date	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
5	SPA-6	J1V2T5	1/5/15	308		0.10	0.096		0.0057	10.7	X	0.12	40.6		0.095	39.5		0.40
6	Duplicate of J1V2T5	J1V2V2	1/5/15	309		0.10	0.090		0.0053	11.6	X	0.12	44.6		0.094	39.0		0.40
7	SPA-1	J1V2T0	1/5/15	340		0.097	0.0096	B	0.0052	12.7	X	0.12	48.3		0.091	43.6		0.39
8	SPA-2	J1V2T1	1/5/15	340		0.10	0.0094	B	0.0052	11.5	X	0.12	44.8		0.095	40.3		0.40
9	SPA-3	J1V2T2	1/5/15	291		0.11	0.017		0.0054	21.9	X	0.13	44.7		0.10	37.7		0.43
10	SPA-4	J1V2T3	1/5/15	306		0.094	0.0084	B	0.0055	10.3	X	0.12	43.6		0.088	39.8		0.37
11	SPA-5	J1V2T4	1/5/15	305		0.10	0.0099	B	0.0051	11.6	X	0.12	45.9		0.095	40.6		0.40
12	SPA-7	J1V2T6	1/5/15	366		0.092	0.016		0.0052	11.1	X	0.11	49.3		0.086	52.9		0.37
13	SPA-8	J1V2T7	1/5/15	333		0.093	0.028		0.0052	11.4	X	0.11	47.8		0.087	40.1		0.37
14	SPA-9	J1V2T8	1/5/15	286		0.093	0.0091	B	0.0058	11.3	X	0.11	44.3		0.087	41.7		0.37
15	SPA-10	J1V2T9	1/5/15	279		0.10	0.0056	U	0.0056	10.8	X	0.13	51.8		0.096	38.0		0.41
16	SPA-11	J1V2V0	1/5/15	257		0.098	0.0051	B	0.0051	9.3	X	0.12	42.0		0.092	35.5		0.39
17	SPA-12	J1V2V1	1/5/15	303		0.10	0.0052	U	0.0052	10.8	X	0.12	50.7		0.095	42.4		0.40

18 **Statistical Computation Input Data**

19	Sample	Sample	Sample	Manganese	Mercury	Nickel	Vanadium	Zinc
20	Area	Number	Date	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
21	SPA-6	J1V2T5/ J1V2V2	1/5/15	309	0.093	11.2	42.6	39.3
22	SPA-1	J1V2T0	1/5/15	340	0.010	12.7	48.3	43.6
23	SPA-2	J1V2T1	1/5/15	340	0.0094	11.5	44.8	40.3
24	SPA-3	J1V2T2	1/5/15	291	0.017	21.9	44.7	37.7
25	SPA-4	J1V2T3	1/5/15	306	0.0084	10.3	43.6	39.8
26	SPA-5	J1V2T4	1/5/15	305	0.010	11.6	45.9	40.6
27	SPA-7	J1V2T6	1/5/15	366	0.016	11.1	49.3	52.9
28	SPA-8	J1V2T7	1/5/15	333	0.028	11.4	47.8	40.1
29	SPA-9	J1V2T8	1/5/15	286	0.0091	11.3	44.3	41.7
30	SPA-10	J1V2T9	1/5/15	279	0.0028	10.8	51.8	38.0
31	SPA-11	J1V2V0	1/5/15	257	0.0051	9.3	42.0	35.5
32	SPA-12	J1V2V1	1/5/15	303	0.0026	10.8	50.7	42.4

33 **Statistical Computations**

34		Manganese	Mercury	Nickel	Vanadium	Zinc
35	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), lognormal and normal distribution rejected, use z-statistic.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.
36	N	12	12	12	12	12
37	% < Detection limit	0%	17%	0%	0%	0%
38	Mean	314	0.018	12.0	46.3	41.0
39	Standard deviation	33.3	0.025	3.2	3.2	4.3
40	95% UCL on mean	326	0.039	13.5	48.0	43.0
41	Maximum value	366	0.096	21.9	51.8	52.9
42	**Most Stringent Cleanup Limit for nonradionuclide and RAG type (mg/kg)**	512 GW & River Protection	0.33 GW & River Protection	19.1 GW Protection	85.1 GW Protection	67.8 River Protection
43	**WAC 173-340 3-PART TEST**					
44	95% UCL > Cleanup Limit?	NA	NA	NO	NA	NA
45	> 10% above Cleanup Limit?	NA	NA	NO	NA	NA
46	Any sample > 2X Cleanup Limit?	NA	NA	NO	NA	NA
47	**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 (0.33 mg/kg) the WAC 173-340 3-part test is not required.	The data set meets the 3-part test criteria when compared to the most stringent RAG.	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-59:1 Subsite Cleanup Verification 95% UCL Calculations

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1 **100-H-59:1 Subsite Maximum Calculations**
2 **Verification Data - Staging Pile Area**

3	Sample	Sample	Sample	Molybdenum		
4	Area	Number	Date	mg/kg	Q	PQL
5	OB-1	J19Y78	5/11/10	0.26	U	0.26
6	Duplicate of J19Y78	J19Y90	5/11/10	0.26	U	0.26
7	OB-2	J19Y79	5/11/10	0.25	U	0.25
8	OB-3	J19Y80	5/11/10	0.26	U	0.26
9	OB-4	J19Y84	5/11/10	0.28	U	0.28
10	OB-5	J19Y85	5/11/10	0.24	U	0.24
11	OB-6	J19Y86	5/11/10	0.26	U	0.26
12	OB-7	J19Y83	5/11/10	0.24	U	0.24
13	OB-8	J19Y82	5/11/10	0.24	U	0.24
14	OB-9	J19Y81	5/11/10	0.24	U	0.24
15	OB-10	J19Y87	5/11/10	0.57	B	0.27
16	OB-11	J19Y88	5/11/10	0.26	U	0.26
17	OB-12	J19Y89	5/11/10	0.26	U	0.26

18 **3-Part Test Evaluations**

19		Molybdenum
20	% < Detection limit	92%
21	Maximum value	0.57
22	**Most Stringent Cleanup Limit for nonradionuclide and RAG type (mg/kg)**	8 GW Protection
23	**3-PART TEST**	
24	Maximum > Cleanup Limit?	NO
25	> 10% above Cleanup Limit?	NO
26	Any sample > 2X Cleanup Limit?	NO
27	**3-Part Test Compliance?**	The data set meets the 3-part test criteria when compared to the most stringent RAG.

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Washington Closure Hanford

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Ecology Software (MTCAStat) Results, 100-H-59:1 Subsite Excavation

Arsenic 95% UCL Calculation

DATA	ID
5.9	J1V2R6/ J1V2R9
4.0	J1V2P7
4.8	J1V2P8
5.1	J1V2P9
7.7	J1V2R0
4.4	J1V2R1
14.0	J1V2R2
5.2	J1V2R3
12.4	J1V2R4
6.3	J1V2R5
4.4	J1V2R7
6.6	J1V2R8

Number of samples		Uncensored values	
Uncensored	12	Mean	6.7
Censored		Lognormal mean	6.7
Detection limit or PQL		Std. devn.	3.2
Method detection limit		Median	5.6
TOTAL	12	Min.	4.0
		Max.	14.0

Lognormal distribution? r-squared is: 0.874
Normal distribution? r-squared is: 0.763
Recommendations:
Reject BOTH lognormal and normal distributions

UCL (based on Z-statistic) is 8.3

Barium 95% UCL Calculation

DATA	ID
67.7	J1V2R6/ J1V2R9
69.7	J1V2P7
69.2	J1V2P8
83.3	J1V2P9
70.4	J1V2R0
68.6	J1V2R1
71.7	J1V2R2
72.2	J1V2R3
91.7	J1V2R4
75.1	J1V2R5
61.6	J1V2R7
103	J1V2R8

Number of samples		Uncensored values	
Uncensored	12	Mean	75.3
Censored		Lognormal mean	75.4
Detection limit or PQL		Std. devn.	11.7
Method detection limit		Median	71.1
TOTAL	12	Min.	61.6
		Max.	103

Lognormal distribution? r-squared is: 0.857
Normal distribution? r-squared is: 0.816
Recommendations:
Reject BOTH lognormal and normal distributions

UCL (based on Z-statistic) is 80.9

Boron 95% UCL Calculation

DATA	ID
2.1	J1V2R6/ J1V2R9
1.5	J1V2P7
1.5	J1V2P8
1.4	J1V2P9
2.2	J1V2R0
1.4	J1V2R1
2.9	J1V2R2
2.0	J1V2R3
1.7	J1V2R4
1.7	J1V2R5
1.8	J1V2R7
5.4	J1V2R8

Number of samples		Uncensored values	
Uncensored	12	Mean	2.1
Censored		Lognormal mean	2.1
Detection limit or PQL		Std. devn.	1.1
Method detection limit		Median	1.8
TOTAL	12	Min.	1.4
		Max.	5.4

Lognormal distribution? r-squared is: 0.794
Normal distribution? r-squared is: 0.627
Recommendations:
Reject BOTH lognormal and normal distributions

UCL (based on Z-statistic) is 2.7

Cadmium 95% UCL Calculation

DATA	ID
0.15	J1V2R6/ J1V2R9
0.15	J1V2P7
0.16	J1V2P8
0.17	J1V2P9
0.14	J1V2R0
0.14	J1V2R1
0.15	J1V2R2
0.18	J1V2R3
0.19	J1V2R4
0.16	J1V2R5
0.14	J1V2R7
0.15	J1V2R8

Number of samples		Uncensored values	
Uncensored	12	Mean	0.16
Censored		Lognormal mean	0.16
Detection limit or PQL		Std. devn.	0.016
Method detection limit		Median	0.15
TOTAL	12	Min.	0.14
		Max.	0.19

Lognormal distribution? r-squared is: 0.904
Normal distribution? r-squared is: 0.888
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 0.17

Chromium 95% UCL Calculation

DATA	ID
11.6	J1V2R6/ J1V2R9
10.4	J1V2P7
10.9	J1V2P8
12.4	J1V2P9
11.3	J1V2R0
10.4	J1V2R1
11.7	J1V2R2
11.3	J1V2R3
15.6	J1V2R4
11.8	J1V2R5
10.5	J1V2R7
12.8	J1V2R8

Number of samples		Uncensored values	
Uncensored	12	Mean	11.7
Censored		Lognormal mean	11.7
Detection limit or PQL		Std. devn.	1.4
Method detection limit		Median	11.4
TOTAL	12	Min.	10.4
		Max.	15.6

Lognormal distribution? r-squared is: 0.840
Normal distribution? r-squared is: 0.790
Recommendations:
Reject BOTH lognormal and normal distributions

UCL (based on Z-statistic) is 12.4

Cobalt 95% UCL Calculation

DATA	ID
6.8	J1V2R6/ J1V2R9
6.6	J1V2P7
7.2	J1V2P8
7.8	J1V2P9
6.3	J1V2R0
7.2	J1V2R1
6.2	J1V2R2
7.3	J1V2R3
8.3	J1V2R4
7.2	J1V2R5
6.0	J1V2R7
7.9	J1V2R8

Number of samples		Uncensored values	
Uncensored	12	Mean	7.1
Censored		Lognormal mean	7.1
Detection limit or PQL		Std. devn.	0.72
Method detection limit		Median	7.2
TOTAL	12	Min.	6.0
		Max.	8.3

Lognormal distribution? r-squared is: 0.971
Normal distribution? r-squared is: 0.970
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 7.5

Copper 95% UCL Calculation

DATA	ID
14.2	J1V2R6/ J1V2R9
13.9	J1V2P7
15.4	J1V2P8
16.0	J1V2P9
16.0	J1V2R0
15.6	J1V2R1
11.8	J1V2R2
14.3	J1V2R3
17.0	J1V2R4
13.3	J1V2R5
12.0	J1V2R7
15.8	J1V2R8

Number of samples		Uncensored values	
Uncensored	12	Mean	14.6
Censored		Lognormal mean	14.6
Detection limit or PQL		Std. devn.	1.6
Method detection limit		Median	14.9
TOTAL	12	Min.	11.8
		Max.	17.0

Lognormal distribution? r-squared is: 0.929
Normal distribution? r-squared is: 0.944
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 15.6

Lead 95% UCL Calculation

DATA	ID
8.9	J1V2R6/ J1V2R9
7.2	J1V2P7
9.9	J1V2P8
8.6	J1V2P9
33.7	J1V2R0
5.5	J1V2R1
66.1	J1V2R2
9.2	J1V2R3
8.9	J1V2R4
23.4	J1V2R5
13.3	J1V2R7
12.4	J1V2R8

Number of samples		Uncensored values	
Uncensored	12	Mean	17.3
Censored		Lognormal mean	16.7
Detection limit or PQL		Std. devn.	17.3
Method detection limit		Median	9.6
TOTAL	12	Min.	5.5
		Max.	66.1

Lognormal distribution? r-squared is: 0.856
Normal distribution? r-squared is: 0.634
Recommendations:
Reject BOTH lognormal and normal distributions

UCL (based on Z-statistic) is 25.5

Manganese 95% UCL Calculation

DATA	ID
302	J1V2R6/ J1V2R9
307	J1V2P7
309	J1V2P8
350	J1V2P9
302	J1V2R0
316	J1V2R1
288	J1V2R2
340	J1V2R3
387	J1V2R4
343	J1V2R5
275	J1V2R7
359	J1V2R8

Number of samples		Uncensored values	
Uncensored	12	Mean	323
Censored		Lognormal mean	323
Detection limit or PQL		Std. devn.	32.6
Method detection limit		Median	313
TOTAL	12	Min.	275
		Max.	387

Lognormal distribution? r-squared is: 0.969
Normal distribution? r-squared is: 0.959
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 341

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Mercury 95% UCL Calculation

DATA	ID
0.0073	J1V2R6/ J1V2R9
0.0062	J1V2P7
0.0026	J1V2P8
0.0078	J1V2P9
0.0068	J1V2R0
0.0063	J1V2R1
0.0029	J1V2R2
0.0059	J1V2R3
0.0030	J1V2R4
0.0068	J1V2R5
0.0071	J1V2R7
0.0085	J1V2R8

Number of samples		Uncensored values	
Uncensored	12	Mean	0.0059
Censored		Lognormal mean	0.0060
Detection limit or PQL		Std. devn.	0.0020
Method detection limit		Median	0.0066
TOTAL	12	Min.	0.0026
		Max.	0.0085

Lognormal distribution? r-squared is: 0.791
Normal distribution? r-squared is: 0.866
Recommendations:
Reject BOTH lognormal and normal distributions

UCL (based on Z-statistic) is 0.0070

Nickel 95% UCL Calculation

DATA	ID
11.0	J1V2R6/ J1V2R9
10.5	J1V2P7
11.3	J1V2P8
12.5	J1V2P9
10.6	J1V2R0
10.6	J1V2R1
10.7	J1V2R2
11.0	J1V2R3
12.4	J1V2R4
11.4	J1V2R5
9.9	J1V2R7
13.2	J1V2R8

Number of samples		Uncensored values	
Uncensored	12	Mean	11.3
Censored		Lognormal mean	11.3
Detection limit or PQL		Std. devn.	0.97
Method detection limit		Median	11.0
TOTAL	12	Min.	9.9
		Max.	13.2

Lognormal distribution? r-squared is: 0.927
Normal distribution? r-squared is: 0.912
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 11.8

Vanadium 95% UCL Calculation

DATA	ID
42.7	J1V2R6/ J1V2R9
47.1	J1V2P7
46.9	J1V2P8
48.5	J1V2P9
43.0	J1V2R0
51.4	J1V2R1
40.9	J1V2R2
47.2	J1V2R3
56.1	J1V2R4
43.2	J1V2R5
35.9	J1V2R7
51.4	J1V2R8

Number of samples		Uncensored values	
Uncensored	12	Mean	46.2
Censored		Lognormal mean	46.2
Detection limit or PQL		Std. devn.	5.4
Method detection limit		Median	47.0
TOTAL	12	Min.	35.9
		Max.	56.1

Lognormal distribution? r-squared is: 0.963
Normal distribution? r-squared is: 0.971
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 49.3

Zinc 95% UCL Calculation

DATA	ID
38.2	J1V2R6/ J1V2R9
40.5	J1V2P7
41.9	J1V2P8
44.9	J1V2P9
41.8	J1V2R0
41.9	J1V2R1
39.3	J1V2R2
42.2	J1V2R3
46.1	J1V2R4
40.1	J1V2R5
34.5	J1V2R7
44.0	J1V2R8

Number of samples		Uncensored values	
Uncensored	12	Mean	41.3
Censored		Lognormal mean	41.3
Detection limit or PQL		Std. devn.	3.1
Method detection limit		Median	41.9
TOTAL	12	Min.	34.5
		Max.	46.1

Lognormal distribution? r-squared is: 0.936
Normal distribution? r-squared is: 0.953
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 43.0

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Arsenic 95% UCL Calculation

DATA	ID
6.2	J1V2T5/ J1V2V2
5.8	J1V2T0
5.7	J1V2T1
5.7	J1V2T2
5.7	J1V2T3
6.8	J1V2T4
6.9	J1V2T6
7.0	J1V2T7
9.6	J1V2T8
6.8	J1V2T9
2.9	J1V2V0
4.4	J1V2V1

Number of samples		Uncensored values	
Uncensored	12	Mean	6.1
Censored		Lognormal mean	6.2
Detection limit or PQL		Std. devn.	1.6
Method detection limit		Median	6.0
TOTAL	12	Min.	2.9
		Max.	9.6

Lognormal distribution? r-squared is: 0.845
Normal distribution? r-squared is: 0.888
Recommendations:
Reject BOTH lognormal and normal distributions

UCL (based on Z-statistic) is 6.9

Barium 95% UCL Calculation

DATA	ID
80.6	J1V2T5/ J1V2V2
72.4	J1V2T0
79.1	J1V2T1
65.2	J1V2T2
74.2	J1V2T3
69.3	J1V2T4
71.6	J1V2T6
72.8	J1V2T7
74.0	J1V2T8
62.2	J1V2T9
54.1	J1V2V0
69.8	J1V2V1

Number of samples		Uncensored values	
Uncensored	12	Mean	70.4
Censored		Lognormal mean	70.5
Detection limit or PQL		Std. devn.	7.3
Method detection limit		Median	72.0
TOTAL	12	Min.	54.1
		Max.	80.6

Lognormal distribution? r-squared is: 0.895
Normal distribution? r-squared is: 0.926
Recommendations:
Use normal distribution.

UCL (based on t-statistic) is 74.2

Boron 95% UCL Calculation

DATA	ID
2.9	J1V2T5/ J1V2V2
2.8	J1V2T0
2.3	J1V2T1
2.2	J1V2T2
1.9	J1V2T3
1.7	J1V2T4
1.6	J1V2T6
1.7	J1V2T7
2.9	J1V2T8
1.8	J1V2T9
1.4	J1V2V0
1.7	J1V2V1

Number of samples		Uncensored values	
Uncensored	12	Mean	2.1
Censored		Lognormal mean	2.1
Detection limit or PQL		Std. devn.	0.54
Method detection limit		Median	1.9
TOTAL	12	Min.	1.4
		Max.	2.9

Lognormal distribution? r-squared is: 0.918
Normal distribution? r-squared is: 0.886
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 2.4

Cadmium 95% UCL Calculation

DATA	ID
0.14	J1V2T5/ J1V2V2
0.15	J1V2T0
0.15	J1V2T1
0.13	J1V2T2
0.14	J1V2T3
0.15	J1V2T4
0.14	J1V2T6
0.14	J1V2T7
0.15	J1V2T8
0.16	J1V2T9
0.12	J1V2V0
0.16	J1V2V1

Number of samples		Uncensored values	
Uncensored	12	Mean	0.14
Censored		Lognormal mean	0.14
Detection limit or PQL		Std. devn.	0.012
Method detection limit		Median	0.15
TOTAL	12	Min.	0.12
		Max.	0.16

Lognormal distribution? r-squared is: 0.930
Normal distribution? r-squared is: 0.940
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 0.15

Chromium 95% UCL Calculation

DATA	ID
10.9	J1V2T5/ J1V2V2
13.7	J1V2T0
10.1	J1V2T1
15.8	J1V2T2
11.1	J1V2T3
11.4	J1V2T4
10.6	J1V2T6
10.1	J1V2T7
11.2	J1V2T8
10.6	J1V2T9
9.5	J1V2V0
10.4	J1V2V1

Number of samples		Uncensored values	
Uncensored	12	Mean	11.3
Censored		Lognormal mean	11.3
Detection limit or PQL		Std. devn.	1.8
Method detection limit		Median	10.7
TOTAL	12	Min.	9.5
		Max.	15.8

Lognormal distribution? r-squared is: 0.806
Normal distribution? r-squared is: 0.754
Recommendations:
Reject BOTH lognormal and normal distributions

UCL (based on Z-statistic) is 12.1

Cobalt 95% UCL Calculation

DATA	ID
6.6	J1V2T5/ J1V2V2
7.4	J1V2T0
6.8	J1V2T1
6.7	J1V2T2
6.3	J1V2T3
6.7	J1V2T4
7.6	J1V2T6
7.0	J1V2T7
6.4	J1V2T8
7.2	J1V2T9
5.8	J1V2V0
7.3	J1V2V1

Number of samples		Uncensored values	
Uncensored	12	Mean	6.8
Censored		Lognormal mean	6.8
Detection limit or PQL		Std. devn.	0.51
Method detection limit		Median	6.8
TOTAL	12	Min.	5.8
		Max.	7.6

Lognormal distribution? r-squared is: 0.969
Normal distribution? r-squared is: 0.978
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 7.1

Copper 95% UCL Calculation

DATA	ID
12.8	J1V2T5/ J1V2V2
15.6	J1V2T0
14.0	J1V2T1
12.8	J1V2T2
13.1	J1V2T3
13.7	J1V2T4
14.4	J1V2T6
12.8	J1V2T7
14.2	J1V2T8
16.1	J1V2T9
12.2	J1V2V0
15.9	J1V2V1

Number of samples		Uncensored values	
Uncensored	12	Mean	14.0
Censored		Lognormal mean	14.0
Detection limit or PQL		Std. devn.	1.3
Method detection limit		Median	13.9
TOTAL	12	Min.	12.2
		Max.	16.1

Lognormal distribution? r-squared is: 0.938
Normal distribution? r-squared is: 0.929
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 14.7

Lead 95% UCL Calculation

DATA	ID
15.7	J1V2T5/ J1V2V2
15.7	J1V2T0
14.2	J1V2T1
13.9	J1V2T2
15.6	J1V2T3
17.8	J1V2T4
13.5	J1V2T6
19.8	J1V2T7
35.0	J1V2T8
4.8	J1V2T9
7.0	J1V2V0
9.1	J1V2V1

Number of samples		Uncensored values	
Uncensored	12	Mean	15.2
Censored		Lognormal mean	15.4
Detection limit or PQL		Std. devn.	7.6
Method detection limit		Median	14.9
TOTAL	12	Min.	4.8
		Max.	35.0

Lognormal distribution? r-squared is: 0.910
Normal distribution? r-squared is: 0.831
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 21.5

Manganese 95% UCL Calculation

DATA	ID
309	J1V2T5/ J1V2V2
340	J1V2T0
340	J1V2T1
291	J1V2T2
306	J1V2T3
305	J1V2T4
366	J1V2T6
333	J1V2T7
286	J1V2T8
279	J1V2T9
257	J1V2V0
303	J1V2V1

Number of samples		Uncensored values	
Uncensored	12	Mean	310
Censored		Lognormal mean	310
Detection limit or PQL		Std. devn.	31
Method detection limit		Median	306
TOTAL	12	Min.	257
		Max.	366

Lognormal distribution? r-squared is: 0.972
Normal distribution? r-squared is: 0.969
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 326

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Job No. 14655

Calc. No. 0100H-CA-V0220
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Ecology Software (MTCAStat) Results, 100-H-59:1 Subsite Staging Pile Area

Mercury 95% UCL Calculation

DATA	ID
0.093	J1V2T5/ J1V2V2
0.010	J1V2T0
0.0094	J1V2T1
0.017	J1V2T2
0.0084	J1V2T3
0.010	J1V2T4
0.016	J1V2T6
0.028	J1V2T7
0.0091	J1V2T8
0.0028	J1V2T9
0.0051	J1V2V0
0.0026	J1V2V1

Number of samples		Uncensored values	
Uncensored	12	Mean	0.018
Censored		Lognormal mean	0.017
Detection limit or PQL		Std. devn.	0.025
Method detection limit		Median	0.010
TOTAL	12	Min.	0.0026
		Max.	0.093

Lognormal distribution? r-squared is: 0.921
Normal distribution? r-squared is: 0.540
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 0.039

Nickel 95% UCL Calculation

DATA	ID
11.2	J1V2T5/ J1V2V2
12.7	J1V2T0
11.5	J1V2T1
21.9	J1V2T2
10.3	J1V2T3
11.6	J1V2T4
11.1	J1V2T6
11.4	J1V2T7
11.3	J1V2T8
10.8	J1V2T9
9.3	J1V2V0
10.8	J1V2V1

Number of samples		Uncensored values	
Uncensored	12	Mean	12.0
Censored		Lognormal mean	12.0
Detection limit or PQL		Std. devn.	3.2
Method detection limit		Median	11.2
TOTAL	12	Min.	9.3
		Max.	21.9

Lognormal distribution? r-squared is: 0.623
Normal distribution? r-squared is: 0.527
Recommendations:
Reject BOTH lognormal and normal distributions

UCL (based on Z-statistic) is 13.5

Vanadium 95% UCL Calculation

DATA	ID
42.6	J1V2T5/ J1V2V2
48.3	J1V2T0
44.8	J1V2T1
44.7	J1V2T2
43.6	J1V2T3
45.9	J1V2T4
49.3	J1V2T6
47.8	J1V2T7
44.3	J1V2T8
51.8	J1V2T9
42.0	J1V2V0
50.7	J1V2V1

Number of samples		Uncensored values	
Uncensored	12	Mean	46.3
Censored		Lognormal mean	46.3
Detection limit or PQL		Std. devn.	3.2
Method detection limit		Median	45.4
TOTAL	12	Min.	42.0
		Max.	51.8

Lognormal distribution? r-squared is: 0.966
Normal distribution? r-squared is: 0.961
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 48.0

Zinc 95% UCL Calculation

DATA	ID
39.3	J1V2T5/ J1V2V2
43.6	J1V2T0
40.3	J1V2T1
37.7	J1V2T2
39.8	J1V2T3
40.6	J1V2T4
52.9	J1V2T6
40.1	J1V2T7
41.7	J1V2T8
38.0	J1V2T9
35.5	J1V2V0
42.4	J1V2V1

Number of samples		Uncensored values	
Uncensored	12	Mean	41.0
Censored		Lognormal mean	41.0
Detection limit or PQL		Std. devn.	4.3
Method detection limit		Median	40.2
TOTAL	12	Min.	35.5
		Max.	52.9

Lognormal distribution? r-squared is: 0.836
Normal distribution? r-squared is: 0.787
Recommendations:
Reject BOTH lognormal and normal distributions

UCL (based on Z-statistic) is 43.0

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Duplicate Analysis - 100-H-59:1 Subsite Excavation

Sampling Area	Sample Number	Sample Date	Potassium-40			Aluminum			Arsenic			Barium			Boron			Cadmium			Calcium			Chromium			Cobalt		
			pCi/g	Q	MDA	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-10	J1V2R6	1/5/15	14.4		0.280	9520		1.4	6.1		0.61	72.7		0.070	2.2		0.91	0.17	B	0.038	6820		13.0	12.7		0.054	7.4	X	0.093
Duplicate of J1V2R6	J1V2R9	1/5/15	13.4		0.257	8270		1.5	5.7		0.66	62.6		0.075	2.0		0.97	0.13	B	0.041	6100		14.0	10.4		0.058	6.1	X	0.099

Analysis:

TDL			0.5			5			10			2			2			0.2			100			1			2		
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)			Yes (calc RPD)			No-Stop (acceptable)			Yes (calc RPD)			No-Stop (acceptable)			No-Stop (acceptable)			Yes (calc RPD)			Yes (calc RPD)			No-Stop (acceptable)		
	RPD		7.2%			14.1%						14.9%									11.1%			19.9%					
	Difference > 2 TDL?		Not applicable			Not applicable			No - acceptable			Not applicable			No - acceptable			No - acceptable			Not applicable			Not applicable			No - acceptable		

Duplicate Analysis - 100-H-59:1 Subsite Excavation

Sampling Area	HEIS Number	Sample Date	Copper			Iron			Lead			Magnesium			Manganese			Mercury			Nickel			Potassium			Silicon		
			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-10	J1V2R6	1/5/15	14.9	X	0.20	20200		3.5	9.5		0.25	5100		3.4	328		0.093	0.0075	B	0.0053	11.8	X	0.11	1530		37.9	349	JN	5.2
Duplicate of J1V2R6	J1V2R9	1/5/15	13.5	X	0.22	16900		3.8	8.3		0.27	4280		3.7	276		0.099	0.0071	B	0.0053	10.2	X	0.12	1340		40.7	372	JN	5.6

Analysis:

TDL			1			5			5			75			5			0.2			4			400			2		
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)			Yes (calc RPD)			No-Stop (acceptable)			Yes (calc RPD)			Yes (calc RPD)			No-Stop (acceptable)			No-Stop (acceptable)			No-Stop (acceptable)			Yes (calc RPD)		
	RPD		9.9%			17.8%						17.5%			17.2%												6.4%		
	Difference > 2 TDL?		Not applicable			Not applicable			No - acceptable			Not applicable			Not applicable			No - acceptable			No - acceptable			No - acceptable			Not applicable		

Duplicate Analysis - 100-H-59:1 Subsite Excavation

Sampling Area	HEIS Number	Sample Date	Sodium			Vanadium			Zinc		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-10	J1V2R6	1/5/15	234		54.6	46.6		0.087	41.5		0.37
Duplicate of J1V2R6	J1V2R9	1/5/15	206		58.6	38.7		0.093	34.8		0.40

Analysis:

TDL			50			2.5			1		
Duplicate Analysis	Both > PQL?		Yes (continue)			Yes (continue)			Yes (continue)		
	Both >5xTDL?		No-Stop (acceptable)			Yes (calc RPD)			Yes (calc RPD)		
	RPD					18.5%			17.6%		
	Difference > 2 TDL?		No - acceptable			Not applicable			Not applicable		

CALCULATION SHEET

Washington Closure Hanford

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Project 100-H Area Closure Operations
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Date 02/24/15
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Duplicate Analysis - 100-H-59:1 Subsite Staging Pile Area

Sampling Area	Sample Number	Sample Date	Potassium-40			Aluminum			Arsenic			Barium			Boron			Cadmium			Calcium			Chromium			Cobalt		
			pCi/g	Q	MDA	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
SPA-6	J1V2T5	1/5/15	13.8		0.224	7520		1.6	6.0		0.67	86.2		0.077	1.9	B	0.99	0.13	B	0.042	7390		14.3	10.9		0.059	6.7	X	0.10
Duplicate of J1V2T5	J1V2V2	1/5/15	13.4		0.213	8000		1.6	6.3		0.66	75.0		0.076	3.9		0.98	0.14	B	0.041	7840		14.2	10.8		0.058	6.5	X	0.10

Analysis:

TDL		0.5	5	10	2	2	0.2	100	1	2
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)	Yes (calc RPD)	No-Stop (acceptable)	Yes (calc RPD)	No-Stop (acceptable)	No-Stop (acceptable)	Yes (calc RPD)	Yes (calc RPD)	No-Stop (acceptable)
	RPD	2.9%	6.2%		13.9%			5.9%	0.9%	
	Difference > 2 TDL?	Not applicable	Not applicable	No - acceptable	Not applicable	No - acceptable	No - acceptable	Not applicable	Not applicable	No - acceptable

Duplicate Analysis - 100-H-59:1 Subsite Staging Pile Area

Sampling Area	HEIS Number	Sample Date	Copper			Iron			Lead			Magnesium			Manganese			Mercury			Nickel			Potassium			Silicon		
			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
SPA-6	J1V2T5	1/5/15	12.3		0.22	17600		3.9	16.1	X	0.27	4690		3.8	308		0.10	0.096		0.0057	10.7	X	0.12	1300		41.6	244	N	5.7
Duplicate of J1V2T5	J1V2V2	1/5/15	13.3		0.22	19100		3.8	15.3	X	0.27	4730		3.7	309		0.10	0.090		0.0053	11.6	X	0.12	1280		41.1	277	N	5.7

Analysis:

TDL		1	5	5	75	5	0.2	4	400	2
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)	Yes (calc RPD)	No-Stop (acceptable)	Yes (calc RPD)	Yes (calc RPD)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	Yes (calc RPD)
	RPD	7.8%	8.2%		0.8%	0.3%				12.7%
	Difference > 2 TDL?	Not applicable	Not applicable	No - acceptable	Not applicable	Not applicable	No - acceptable	No - acceptable	No - acceptable	Not applicable

Duplicate Analysis - 100-H-59:1 Subsite Staging Pile Area

Sampling Area	HEIS Number	Sample Date	Sodium			Vanadium			Zinc		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
SPA-6	J1V2T5	1/5/15	197		59.8	40.6		0.095	39.5		0.40
Duplicate of J1V2T5	J1V2V2	1/5/15	235		59.2	44.6		0.094	39.0		0.40

Analysis:

TDL		50	2.5	1
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	No-Stop (acceptable)	Yes (calc RPD)	Yes (calc RPD)
	RPD		9.4%	1.3%
	Difference > 2 TDL?	No - acceptable	Not applicable	Not applicable

Attachment 1. 100-H-59:1 Subsite Verification Sample Results (Radionuclides).

Sample Location	HEIS Number	Sample Date	Americium-241			Barium-133			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-10	J1V2R6	1/5/15	-0.0877	U	0.159	0.122	U	0.0497	-0.00792	U	0.0324	0.0149	U	0.0332	-0.0867	U	0.0880
Duplicate of J1V2R6	J1V2R9	1/5/15	-0.0148	U	0.165	0.133	U	0.0502	-0.00401	U	0.0332	-0.00613	U	0.0290	0.0507	U	0.0890
EXC-1	J1V2P7	1/5/15	-0.0112	U	0.0283	0.00598	U	0.0191	0.00410	U	0.0220	-0.00410	U	0.0219	-0.0279	U	0.0411
EXC-2	J1V2P8	1/5/15	0.00890	U	0.0286	-0.00381	U	0.0204	0.0183	U	0.0262	0.00304	U	0.0261	0.00423	U	0.0481
EXC-3	J1V2P9	1/5/15	-0.00278	U	0.0356	-0.00549	U	0.0217	0.00275	U	0.0247	0.00656	U	0.0253	-0.0216	U	0.0525
EXC-4	J1V2R0	1/5/15	-0.0975	U	0.149	0.105	U	0.0454	0.0635	U	0.0384	0.00350	U	0.0304	0.0407	U	0.0837
EXC-5	J1V2R1	1/5/15	-0.0159	U	0.116	-0.00148	U	0.0368	-0.0143	U	0.0323	-0.00545	U	0.0361	-0.0520	U	0.0832
EXC-6	J1V2R2	1/5/15	-0.00604	U	0.0328	-0.00874	U	0.0204	0.0487		0.0237	-0.0116	U	0.0229	-0.0154	U	0.0498
EXC-7	J1V2R3	1/5/15	0.0199	U	0.0311	0.00389	U	0.0207	0.0617		0.0217	0.00361	U	0.0253	-0.00856	U	0.0481
EXC-8	J1V2R4	1/5/15	-0.00775	U	0.161	0.126	U	0.0490	0.0111	U	0.0321	-0.0101	U	0.0285	0.0469	U	0.0888
EXC-9	J1V2R5	1/5/15	0.00126	U	0.123	-0.00593	U	0.0382	-0.0205	U	0.0348	-0.00983	U	0.0335	-0.0188	U	0.0923
EXC-11	J1V2R7	1/5/15	0.0334	U	0.143	0.0338	U	0.0476	0.0779		0.0401	-0.00352	U	0.0391	-0.0278	U	0.104
EXC-12	J1V2R8	1/5/15	0.0210	U	0.127	-0.00500	U	0.0466	-0.00537	U	0.0426	-0.00804	U	0.0447	-0.00059	U	0.116
SPA-6	J1V2T5	1/5/15	-0.0227	U	0.0412	-0.00215	U	0.0275	0.00489	U	0.0278	0.00280	U	0.0268	0.0101	U	0.0638
Duplicate of J1V2T5	J1V2V2	1/5/15	-0.00538	U	0.0423	-0.00618	U	0.0252	-0.0000116	U	0.0247	-9.26E-05	U	0.0254	-0.0275	U	0.0577
SPA-1	J1V2T0	1/5/15	-0.00984	U	0.0305	0.00202	U	0.0217	-0.00375	U	0.0229	0.00234	U	0.0276	-0.0384	U	0.0473
SPA-2	J1V2T1	1/5/15	-0.00352	U	0.0282	0.00906	U	0.0209	0.0115	U	0.0232	-0.00937	U	0.0231	0.00242	U	0.0465
SPA-3	J1V2T2	1/5/15	0.0145	U	0.0292	0.000762	U	0.0189	-0.00193	U	0.0204	0.00595	U	0.0243	-0.00726	U	0.0464
SPA-4	J1V2T3	1/5/15	0.0225	U	0.142	0.127	U	0.0450	0.00509	U	0.0295	0.0117	U	0.0296	-0.00951	U	0.0831
SPA-5	J1V2T4	1/5/15	-0.0628	U	0.178	0.00465	U	0.0263	0.00911	U	0.0252	0.00855	U	0.0250	-0.00576	U	0.0612
SPA-7	J1V2T6	1/5/15	0.00534	U	0.0297	-0.00383	U	0.0203	0.0000763	U	0.0229	-0.00409	U	0.0255	-0.00071	U	0.0471
SPA-8	J1V2T7	1/5/15	0.00869	U	0.0234	0.00573	U	0.0184	-0.00160	U	0.0200	-0.000712	U	0.0237	-0.00462	U	0.0416
SPA-9	J1V2T8	1/5/15	0.00469	U	0.0277	-0.00761	U	0.0183	0.0210	U	0.0254	-0.00250	U	0.0240	0.00476	U	0.0453
SPA-10	J1V2T9	1/5/15	-0.0128	U	0.0275	-0.00854	U	0.0189	0.00310	U	0.0216	-0.000549	U	0.0227	0.0235	U	0.0464
SPA-11	J1V2V0	1/5/15	-0.00298	U	0.141	0.128	U	0.0456	0.0357	U	0.0322	-0.0133	U	0.0246	0.0673	U	0.0810
SPA-12	J1V2V1	1/5/15	0.00673	U	0.171	-0.00437	U	0.0251	0.0641		0.0251	0.000675	U	0.0232	0.0141	U	0.0601

Sample Location	HEIS Number	Sample Date	Europium-154			Europium-155			Potassium-40			Silver-108 metastable		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
EXC-10	J1V2R6	1/5/15	-0.0184	U	0.0988	0.0257	U	0.113	14.4		0.280	-0.00383	U	0.0276
Duplicate of J1V2R6	J1V2R9	1/5/15	-0.00779	U	0.0927	-0.0163	U	0.114	13.4		0.257	-0.0158	U	0.0256
EXC-1	J1V2P7	1/5/15	-0.0188	U	0.0718	0.0380	U	0.0430	13.1		0.186	-0.000492	U	0.0146
EXC-2	J1V2P8	1/5/15	0.0272	U	0.0870	0.0390	U	0.0451	13.3		0.185	-0.00199	U	0.0158
EXC-3	J1V2P9	1/5/15	0.0219	U	0.0912	0.0440	U	0.0524	13.6		0.193	-0.00403	U	0.0169
EXC-4	J1V2R0	1/5/15	0.0299	U	0.103	0.0428	U	0.109	14.3		0.257	0.00178	U	0.0250
EXC-5	J1V2R1	1/5/15	-0.0717	U	0.105	0.0448	U	0.0918	13.5		0.269	0.00261	U	0.0271
EXC-6	J1V2R2	1/5/15	0.0319	U	0.0843	0.0357	U	0.0499	14.5		0.187	0.000688	U	0.0161
EXC-7	J1V2R3	1/5/15	0.00247	U	0.0829	0.0553		0.0432	13.5		0.235	0.0127	U	0.0150
EXC-8	J1V2R4	1/5/15	-0.0718	U	0.0969	-0.00312	U	0.112	14.1		0.232	-0.00810	U	0.0263
EXC-9	J1V2R5	1/5/15	0.00516	U	0.122	0.0486	U	0.0952	14.9		0.332	-0.000367	U	0.0290
EXC-11	J1V2R7	1/5/15	-0.0189	U	0.134	0.0657	U	0.111	14.9		0.331	-0.000387	U	0.0314
EXC-12	J1V2R8	1/5/15	-0.000371	U	0.153	0.0565	U	0.121	14.0		0.352	-0.00244	U	0.0315
SPA-6	J1V2T5	1/5/15	-0.0167	U	0.0805	0.0574	U	0.0641	13.8		0.224	-0.00835	U	0.0185
Duplicate of J1V2T5	J1V2V2	1/5/15	-0.0312	U	0.0776	0.0329	U	0.0616	13.4		0.213	0.00278	U	0.0195
SPA-1	J1V2T0	1/5/15	0.0199	U	0.0921	0.0287	U	0.0439	13.6		0.186	-0.00347	U	0.0161
SPA-2	J1V2T1	1/5/15	0.0289	U	0.0817	0.0307	U	0.0445	13.2		0.210	-0.00167	U	0.0146
SPA-3	J1V2T2	1/5/15	-0.000655	U	0.0797	0.0357	U	0.0436	13.3		0.127	-0.00534	U	0.0144
SPA-4	J1V2T3	1/5/15	-0.0113	U	0.0932	-0.0134	U	0.0998	14.3		0.243	-0.00748	U	0.0233
SPA-5	J1V2T4	1/5/15	0.0136	U	0.0839	0.0112	U	0.0722	12.6		0.229	0.00130	U	0.0183
SPA-7	J1V2T6	1/5/15	-0.0612	U	0.0759	0.0448	U	0.0452	14.2		0.230	0.0000974	U	0.0155
SPA-8	J1V2T7	1/5/15	-0.00814	U	0.0780	0.0616		0.0359	13.5		0.233	-0.00195	U	0.0138
SPA-9	J1V2T8	1/5/15	-0.00437	U	0.0833	0.0421		0.0386	13.4		0.191	0.000129	U	0.0150
SPA-10	J1V2T9	1/5/15	-0.0198	U	0.0763	0.0598	U	0.0465	11.6		0.197	0.00241	U	0.0154
SPA-11	J1V2V0	1/5/15	-0.00771	U	0.0867	-0.0182	U	0.0975	12.5		0.207	-0.00536	U	0.0227
SPA-12	J1V2V1	1/5/15	0.0130	U	0.0783	0.0526	U	0.0724	12.9		0.156	0.0000637	U	0.0180

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)

C = </= 5x the blank concentration

HEIS = Hanford Environmental Information System

J = estimate

MDA = minimum dection allowed

N = recovery is outside control limits

PQL = practical quantitation limit

Q = qualifier

U = undetected

X = >40% difference between the primary and confirmation detector results.

Attachment	1	Sheet No.	1 of 4
Originator	J. D. Skoglie	Date	2/24/15
Checked	I. B. Berezovskiy	Date	2/24/15
Calc. No.	0100H-CA-V0220	Rev. No.	0
		Job No.	14655

Attachment 1. 100-H-59:1 Subsite Verification Sample Results (Metals and Physical).

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-10	J1V2R6	1/5/15	9520		1.4	0.35	UJ	0.35	6.1		0.61	72.7		0.070	0.031	U	0.031
Duplicate of J1V2R6	J1V2R9	1/5/15	8270		1.5	0.38	UJ	0.38	5.7		0.66	62.6		0.075	0.033	U	0.033
EXC-1	J1V2P7	1/5/15	8230		1.4	0.35	UJ	0.35	4.0		0.62	69.7		0.071	0.031	U	0.031
EXC-2	J1V2P8	1/5/15	8430		1.6	0.39	UJ	0.39	4.8		0.67	69.2		0.077	0.034	U	0.034
EXC-3	J1V2P9	1/5/15	9970		1.5	0.38	UJ	0.38	5.1		0.66	83.3		0.075	0.033	U	0.033
EXC-4	J1V2R0	1/5/15	8350		1.5	0.36	UJ	0.36	7.7		0.63	70.4		0.072	0.031	U	0.031
EXC-5	J1V2R1	1/5/15	8680		1.6	0.39	UJ	0.39	4.4		0.68	68.6		0.078	0.034	U	0.034
EXC-6	J1V2R2	1/5/15	7920		1.4	0.35	UJ	0.35	14.0		0.61	71.7		0.070	0.030	U	0.030
EXC-7	J1V2R3	1/5/15	9460		1.4	0.35	UJ	0.35	5.2		0.61	72.2		0.070	0.031	U	0.031
EXC-8	J1V2R4	1/5/15	10900		1.6	0.38	UJ	0.38	12.4		0.67	91.7		0.077	0.049	B	0.033
EXC-9	J1V2R5	1/5/15	9250		1.7	0.40	UJ	0.40	6.3		0.70	75.1		0.081	0.035	U	0.035
EXC-11	J1V2R7	1/5/15	8040		1.5	0.37	UJ	0.37	4.4		0.64	61.6		0.073	0.033	B	0.032
EXC-12	J1V2R8	1/5/15	10500		1.6	0.40	UJ	0.40	6.6		0.70	103		0.080	0.035	U	0.035
SPA-6	J1V2T5	1/5/15	7520		1.6	0.39	U	0.39	6.0		0.67	86.2		0.077	0.033	U	0.033
Duplicate of J1V2T5	J1V2V2	1/5/15	8000		1.6	0.38	U	0.38	6.3		0.66	75.0		0.076	0.033	U	0.033
SPA-1	J1V2T0	1/5/15	9320		1.5	0.37	U	0.37	5.8		0.64	72.4		0.074	0.032	U	0.032
SPA-2	J1V2T1	1/5/15	7740		1.6	0.39	U	0.39	5.7		0.67	79.1		0.077	0.033	U	0.033
SPA-3	J1V2T2	1/5/15	7600		1.7	0.41	U	0.41	5.7		0.71	65.2		0.082	0.035	U	0.035
SPA-4	J1V2T3	1/5/15	8170		1.5	0.36	U	0.36	5.7		0.62	74.2		0.071	0.031	U	0.031
SPA-5	J1V2T4	1/5/15	8010		1.6	0.38	U	0.38	6.8		0.67	69.3		0.077	0.033	U	0.033
SPA-7	J1V2T6	1/5/15	7790		1.4	0.35	U	0.35	6.9		0.61	71.6		0.070	0.030	U	0.030
SPA-8	J1V2T7	1/5/15	7500		1.4	0.35	U	0.35	7.0		0.61	72.8		0.070	0.031	U	0.031
SPA-9	J1V2T8	1/5/15	8160		1.4	0.35	U	0.35	9.6		0.61	74.0		0.071	0.031	U	0.031
SPA-10	J1V2T9	1/5/15	7080		1.6	0.39	U	0.39	6.8		0.67	62.2		0.078	0.034	U	0.034
SPA-11	J1V2V0	1/5/15	6470		1.5	0.37	U	0.37	2.9		0.65	54.1		0.075	0.032	U	0.032
SPA-12	J1V2V1	1/5/15	7780		1.6	0.38	U	0.38	4.4		0.67	69.8		0.077	0.033	U	0.033
Equipment Blank	J1V2V3	1/5/15	145		1.3	0.33	U	0.33	0.57	U	0.57	1.5		0.066	0.031	B	0.028

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-10	J1V2R6	1/5/15	2.2		0.91	0.17	B	0.038	6820		13.0	12.7		0.054	7.4	X	0.093
Duplicate of J1V2R6	J1V2R9	1/5/15	2.0		0.97	0.13	B	0.041	6100		14.0	10.4		0.058	6.1	X	0.099
EXC-1	J1V2P7	1/5/15	1.5	B	0.91	0.15	B	0.038	4700		13.1	10.4		0.054	6.6	X	0.093
EXC-2	J1V2P8	1/5/15	1.5	B	1.0	0.16	B	0.042	5170		14.3	10.9		0.059	7.2	X	0.10
EXC-3	J1V2P9	1/5/15	1.4	B	0.97	0.17	B	0.041	4380		14.0	12.4		0.058	7.8	X	0.099
EXC-4	J1V2R0	1/5/15	2.2		0.93	0.14	B	0.039	4940		13.4	11.3		0.055	6.3	X	0.095
EXC-5	J1V2R1	1/5/15	1.4	B	1.0	0.14	B	0.042	5440		14.5	10.4		0.060	7.2	X	0.10
EXC-6	J1V2R2	1/5/15	2.9		0.91	0.15	B	0.038	3930		13.0	11.7		0.054	6.2	X	0.092
EXC-7	J1V2R3	1/5/15	2.0		0.91	0.18	B	0.038	4340		13.1	11.3		0.054	7.3	X	0.093
EXC-8	J1V2R4	1/5/15	1.7	B	0.99	0.19	B	0.041	4290		14.2	15.6		0.059	8.3	X	0.10
EXC-9	J1V2R5	1/5/15	1.7	B	1.0	0.16	B	0.044	5780		15.0	11.8		0.062	7.2	X	0.11
EXC-11	J1V2R7	1/5/15	1.8	B	0.95	0.14	B	0.040	4870		13.6	10.5		0.056	6.0	X	0.097
EXC-12	J1V2R8	1/5/15	5.4		1.0	0.15	B	0.043	8020		14.9	12.8		0.061	7.9	X	0.11
SPA-6	J1V2T5	1/5/15	1.9	B	0.99	0.13	B	0.042	7390		14.3	10.9		0.059	6.7	X	0.10
Duplicate of J1V2T5	J1V2V2	1/5/15	3.9		0.98	0.14	B	0.041	7840		14.2	10.8		0.058	6.5	X	0.10
SPA-1	J1V2T0	1/5/15	2.8		0.95	0.15	B	0.040	6320		13.7	13.7		0.056	7.4	X	0.097
SPA-2	J1V2T1	1/5/15	2.3		0.99	0.15	B	0.042	5290		14.3	10.1		0.059	6.8	X	0.10
SPA-3	J1V2T2	1/5/15	2.2		1.1	0.13	B	0.044	6640		15.1	15.8		0.062	6.7	X	0.11
SPA-4	J1V2T3	1/5/15	1.9		0.92	0.14	B	0.038	6270		13.2	11.1		0.054	6.3	X	0.094
SPA-5	J1V2T4	1/5/15	1.7	B	0.99	0.15	B	0.041	6350		14.2	11.4		0.058	6.7	X	0.10
SPA-7	J1V2T6	1/5/15	1.6	B	0.90	0.14	B	0.038	6330		13.0	10.6		0.053	7.6	X	0.092
SPA-8	J1V2T7	1/5/15	1.7	B	0.91	0.14	B	0.038	11000		13.1	10.1		0.054	7.0	X	0.093
SPA-9	J1V2T8	1/5/15	2.9		0.91	0.15	B	0.038	7010		13.1	11.2		0.054	6.4	X	0.093
SPA-10	J1V2T9	1/5/15	1.8	B	1.0	0.16	B	0.042	6800		14.4	10.6		0.059	7.2	X	0.10
SPA-11	J1V2V0	1/5/15	1.4	B	0.96	0.12	B	0.04	3790		13.9	9.5		0.057	5.8	X	0.098
SPA-12	J1V2V1	1/5/15	1.7	B	0.99	0.16	B	0.041	5180		14.2	10.4		0.059	7.3	X	0.10
Equipment Blank	J1V2V3	1/5/15	0.85	U	0.85	0.035	U	0.035	36.6	BC	12.2	0.17		0.050	0.14	BX	0.086

Attachment	1	Sheet No.	2 of 4
Originator	J. D. Skoglie	Date	2/24/15
Checked	I. B. Berezovskiy	Date	2/24/15
Calc. No.	0100H-CA-V0220	Rev. No.	0
		Job No.	14655

Attachment 1. 100-H-59:1 Subsite Verification Sample Results (Metals and Physical).

Sample Location	HEIS Number	Sample Date	Copper			Iron			Lead			Magnesium			Manganese		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-10	J1V2R6	1/5/15	14.9	X	0.20	20200		3.5	9.5		0.25	5100		3.4	328		0.093
Duplicate of J1V2R6	J1V2R9	1/5/15	13.5	X	0.22	16900		3.8	8.3		0.27	4280		3.7	276		0.099
EXC-1	J1V2P7	1/5/15	13.9	X	0.20	19500		3.5	7.2		0.25	4340		3.4	307		0.093
EXC-2	J1V2P8	1/5/15	15.4	X	0.22	19800		3.9	9.9		0.27	4620		3.8	309		0.10
EXC-3	J1V2P9	1/5/15	16.0	X	0.22	21400		3.8	8.6		0.27	4840		3.7	350		0.099
EXC-4	J1V2R0	1/5/15	16.0	X	0.21	18100		3.6	33.7		0.26	4210		3.5	302		0.095
EXC-5	J1V2R1	1/5/15	15.6	X	0.22	20400		3.9	5.5		0.28	4570		3.8	316		0.10
EXC-6	J1V2R2	1/5/15	11.8	X	0.20	17300		3.5	66.1		0.25	4120		3.4	288		0.092
EXC-7	J1V2R3	1/5/15	14.3	X	0.20	20500		3.5	9.2		0.25	4520		3.4	340		0.093
EXC-8	J1V2R4	1/5/15	17.0	X	0.22	24000		3.8	8.9		0.27	4880		3.7	387		0.10
EXC-9	J1V2R5	1/5/15	13.3	X	0.23	19200		4.0	23.4		0.29	4620		3.9	343		0.11
EXC-11	J1V2R7	1/5/15	12.0	X	0.21	16200		3.7	13.3		0.26	3980		3.6	275		0.097
EXC-12	J1V2R8	1/5/15	15.8	X	0.23	22100		4.0	12.4		0.29	5460		3.9	359		0.11
SPA-6	J1V2T5	1/5/15	12.3		0.22	17600		3.9	16.1	X	0.27	4690		3.8	308		0.10
Duplicate of J1V2T5	J1V2V2	1/5/15	13.3		0.22	19100		3.8	15.3	X	0.27	4730		3.7	309		0.10
SPA-1	J1V2T0	1/5/15	15.6		0.21	20200		3.7	15.7	X	0.26	5320		3.6	340		0.097
SPA-2	J1V2T1	1/5/15	14.0		0.22	18500		3.9	14.2	X	0.27	4370		3.8	340		0.10
SPA-3	J1V2T2	1/5/15	12.8		0.23	18700		4.1	13.9	X	0.29	5210		4.0	291		0.11
SPA-4	J1V2T3	1/5/15	13.1		0.20	18300		3.6	15.6	X	0.25	4440		3.5	306		0.094
SPA-5	J1V2T4	1/5/15	13.7		0.22	19200		3.8	17.8	X	0.27	4610		3.7	305		0.10
SPA-7	J1V2T6	1/5/15	14.4		0.20	20700		3.5	13.5	X	0.25	4490		3.4	366		0.092
SPA-8	J1V2T7	1/5/15	12.8		0.20	19000		3.5	19.8	X	0.25	4730		3.4	333		0.093
SPA-9	J1V2T8	1/5/15	14.2		0.20	18200		3.5	35.0	X	0.25	4470		3.4	286		0.093
SPA-10	J1V2T9	1/5/15	16.1		0.22	18900		3.9	4.8	X	0.28	4390		3.8	279		0.10
SPA-11	J1V2V0	1/5/15	12.2		0.21	16200		3.7	7.0	X	0.27	3970		3.6	257		0.098
SPA-12	J1V2V1	1/5/15	15.9		0.22	19800		3.8	9.1	X	0.27	4350		3.7	303		0.10
Equipment Blank	J1V2V3	1/5/15	0.47	B	0.19	509		3.3	0.38	BX	0.23	24.5	C	3.2	4.6		0.086

Sample Location	HEIS Number	Sample Date	Mercury			Molybdenum			Nickel			Potassium			Selenium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-10	J1V2R6	1/5/15	0.0075	B	0.0053	0.24	U	0.24	11.8	X	0.11	1530		37.9	0.80	U	0.80
Duplicate of J1V2R6	J1V2R9	1/5/15	0.0071	B	0.0053	0.26	U	0.26	10.2	X	0.12	1340		40.7	0.85	U	0.85
EXC-1	J1V2P7	1/5/15	0.0062	B	0.0056	0.24	U	0.24	10.5	X	0.11	1450		38.2	0.80	U	0.80
EXC-2	J1V2P8	1/5/15	0.0052	U	0.0052	0.26	U	0.26	11.3	X	0.13	1310		41.7	0.87	U	0.87
EXC-3	J1V2P9	1/5/15	0.0078	B	0.006	0.26	U	0.26	12.5	X	0.12	1590		40.7	0.85	U	0.85
EXC-4	J1V2R0	1/5/15	0.0068	B	0.0052	0.25	U	0.25	10.6	X	0.12	1550		38.9	0.82	U	0.82
EXC-5	J1V2R1	1/5/15	0.0063	B	0.0056	0.27	U	0.27	10.6	X	0.13	1470		42.1	0.88	U	0.88
EXC-6	J1V2R2	1/5/15	0.0057	U	0.0057	0.24	U	0.24	10.7	X	0.11	1480		37.9	0.79	U	0.79
EXC-7	J1V2R3	1/5/15	0.0059	B	0.0059	0.24	U	0.24	11.0	X	0.11	1880		38.0	0.80	U	0.80
EXC-8	J1V2R4	1/5/15	0.0060	U	0.0060	0.33	B	0.26	12.4	X	0.12	1990		41.4	0.87	U	0.87
EXC-9	J1V2R5	1/5/15	0.0068	B	0.0056	0.28	U	0.28	11.4	X	0.13	1420		43.7	0.92	U	0.92
EXC-11	J1V2R7	1/5/15	0.0071	B	0.0057	0.25	U	0.25	9.9	X	0.12	1390		39.6	0.83	U	0.83
EXC-12	J1V2R8	1/5/15	0.0085	B	0.0061	0.28	U	0.28	13.2	X	0.13	1510		43.4	0.91	U	0.91
SPA-6	J1V2T5	1/5/15	0.096		0.0057	0.26	U	0.26	10.7	X	0.12	1300		41.6	0.87	U	0.87
Duplicate of J1V2T5	J1V2V2	1/5/15	0.090		0.0053	0.26	U	0.26	11.6	X	0.12	1280		41.1	0.86	U	0.86
SPA-1	J1V2T0	1/5/15	0.0096	B	0.0052	0.25	U	0.25	12.7	X	0.12	1750		39.7	0.83	U	0.83
SPA-2	J1V2T1	1/5/15	0.0094	B	0.0052	0.26	U	0.26	11.5	X	0.12	1270		41.6	0.87	U	0.87
SPA-3	J1V2T2	1/5/15	0.017		0.0054	0.28	U	0.28	21.9	X	0.13	1270		44.0	0.92	U	0.92
SPA-4	J1V2T3	1/5/15	0.0084	B	0.0055	0.24	U	0.24	10.3	X	0.12	1440		38.4	0.81	U	0.81
SPA-5	J1V2T4	1/5/15	0.0099	B	0.0051	0.26	U	0.26	11.6	X	0.12	1590		41.4	0.87	U	0.87
SPA-7	J1V2T6	1/5/15	0.016		0.0052	0.24	U	0.24	11.1	X	0.11	1300		37.7	0.79	U	0.79
SPA-8	J1V2T7	1/5/15	0.028		0.0052	0.24	U	0.24	11.4	X	0.11	1390		38.0	0.80	U	0.80
SPA-9	J1V2T8	1/5/15	0.0091	B	0.0058	0.24	U	0.24	11.3	X	0.11	1340		38.1	0.80	U	0.80
SPA-10	J1V2T9	1/5/15	0.0056	U	0.0056	0.57	B	0.27	10.8	X	0.13	855		41.8	0.88	U	0.88
SPA-11	J1V2V0	1/5/15	0.0051	B	0.0051	0.26	U	0.26	9.3	X	0.12	1340		40.3	0.85	U	0.85
SPA-12	J1V2V1	1/5/15	0.0052	U	0.0052	0.26	U	0.26	10.8	X	0.12	1130		41.4	0.87	U	0.87
Equipment Blank	J1V2V3	1/5/15	0.0054	U	0.0054	0.22	U	0.22	0.20	BX	0.11	35.4	U	35.4	0.74	U	0.74

Attachment	1	Sheet No.	3 of 4
Originator	J. D. Skoglie	Date	2/24/15
Checked	I. B. Berezovskiy	Date	2/24/15
Calc. No.	0100H-CA-V0220	Rev. No.	0
		Job No.	14655

Attachment 1. 100-H-59:1 Subsite Verification Sample Results (Metals and Physical).

Sample Location	HEIS Number	Sample Date	Silicon			Silver			Sodium			Vanadium			Zinc		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-10	J1V2R6	1/5/15	349	JN	5.2	0.15	U	0.15	234		54.6	46.6		0.087	41.5		0.37
Duplicate of J1V2R6	J1V2R9	1/5/15	372	JN	5.6	0.16	U	0.16	206		58.6	38.7		0.093	34.8		0.40
EXC-1	J1V2P7	1/5/15	315	JN	5.3	0.15	U	0.15	206		55.0	47.1		0.088	40.5		0.37
EXC-2	J1V2P8	1/5/15	301	JN	5.8	0.16	U	0.16	218		60.0	46.9		0.096	41.9		0.40
EXC-3	J1V2P9	1/5/15	395	JN	5.6	0.16	U	0.16	209		58.6	48.5		0.093	44.9		0.40
EXC-4	J1V2R0	1/5/15	334	JN	5.4	0.15	U	0.15	207		55.9	43.0		0.089	41.8		0.38
EXC-5	J1V2R1	1/5/15	416	JN	5.8	0.16	U	0.16	205		60.6	51.4		0.097	41.9		0.41
EXC-6	J1V2R2	1/5/15	360	JN	5.2	0.15	U	0.15	192		54.5	40.9		0.087	39.3		0.37
EXC-7	J1V2R3	1/5/15	408	JN	5.2	0.15	U	0.15	183		54.7	47.2		0.087	42.2		0.37
EXC-8	J1V2R4	1/5/15	381	JN	5.7	0.16	U	0.16	244		59.6	56.1		0.095	46.1		0.40
EXC-9	J1V2R5	1/5/15	409	JN	6.0	0.17	U	0.17	216		62.8	43.2		0.10	40.1		0.42
EXC-11	J1V2R7	1/5/15	384	JN	5.5	0.15	U	0.15	175		57.0	35.9		0.091	34.5		0.38
EXC-12	J1V2R8	1/5/15	412	JN	6.0	0.17	U	0.17	302		62.4	51.4		0.099	44.0		0.42
SPA-6	J1V2T5	1/5/15	244	N	5.7	0.16	U	0.16	197		59.8	40.6		0.095	39.5		0.40
Duplicate of J1V2T5	J1V2V2	1/5/15	277	N	5.7	0.16	U	0.16	235		59.2	44.6		0.094	39.0		0.40
SPA-1	J1V2T0	1/5/15	283	N	5.5	0.16	U	0.16	239		57.2	48.3		0.091	43.6		0.39
SPA-2	J1V2T1	1/5/15	235	N	5.7	0.16	U	0.16	264		59.9	44.8		0.095	40.3		0.40
SPA-3	J1V2T2	1/5/15	287	N	6.1	0.17	U	0.17	234		63.3	44.7		0.10	37.7		0.43
SPA-4	J1V2T3	1/5/15	262	N	5.3	0.15	U	0.15	223		55.3	43.6		0.088	39.8		0.37
SPA-5	J1V2T4	1/5/15	259	N	5.7	0.16	U	0.16	210		59.5	45.9		0.095	40.6		0.40
SPA-7	J1V2T6	1/5/15	247	N	5.2	0.15	U	0.15	220		54.3	49.3		0.086	52.9		0.37
SPA-8	J1V2T7	1/5/15	230	N	5.2	0.15	U	0.15	223		54.7	47.8		0.087	40.1		0.37
SPA-9	J1V2T8	1/5/15	243	N	5.3	0.15	U	0.15	255		54.8	44.3		0.087	41.7		0.37
SPA-10	J1V2T9	1/5/15	239	N	5.8	0.16	U	0.16	217		60.2	51.8		0.096	38.0		0.41
SPA-11	J1V2V0	1/5/15	326	N	5.6	0.16	U	0.16	191		58.0	42.0		0.092	35.5		0.39
SPA-12	J1V2V1	1/5/15	255	N	5.7	0.16	U	0.16	243		59.6	50.7		0.095	42.4		0.40
Equipment Blank	J1V2V3	1/5/15	92.6	N	4.9	0.14	U	0.14	50.9	U	50.9	0.39	B	0.081	1.1	C	0.34

Sample Location	HEIS Number	Sample Date	Percent moisture (wet sample)		
			%	Q	PQL
EXC-10	J1V2R6	1/5/15	8.4		0.10
Duplicate of J1V2R6	J1V2R9	1/5/15	8.5		0.10
EXC-1	J1V2P7	1/5/15	6.7		0.10
EXC-2	J1V2P8	1/5/15	6.3		0.10
EXC-3	J1V2P9	1/5/15	8.4		0.10
EXC-4	J1V2R0	1/5/15	6.7		0.10
EXC-5	J1V2R1	1/5/15	4.5		0.10
EXC-6	J1V2R2	1/5/15	5.9		0.10
EXC-7	J1V2R3	1/5/15	8.5		0.10
EXC-8	J1V2R4	1/5/15	9.9		0.10
EXC-9	J1V2R5	1/5/15	9.7		0.10
EXC-11	J1V2R7	1/5/15	10.7		0.10
EXC-12	J1V2R8	1/5/15	10.8		0.10
SPA-6	J1V2T5	1/5/15	6.0		0.10
Duplicate of J1V2T5	J1V2V2	1/5/15	6.0		0.10
SPA-1	J1V2T0	1/5/15	6.2		0.10
SPA-2	J1V2T1	1/5/15	5.3		0.10
SPA-3	J1V2T2	1/5/15	7.7		0.10
SPA-4	J1V2T3	1/5/15	6.4		0.10
SPA-5	J1V2T4	1/5/15	6.5		0.10
SPA-7	J1V2T6	1/5/15	5.5		0.10
SPA-8	J1V2T7	1/5/15	6.1		0.10
SPA-9	J1V2T8	1/5/15	7.2		0.10
SPA-10	J1V2T9	1/5/15	6.6		0.10
SPA-11	J1V2V0	1/5/15	5.8		0.10
SPA-12	J1V2V1	1/5/15	6.6		0.10
Equipment Blank	J1V2V3	1/5/15	0.13		0.10

Attachment	1	Sheet No.	4 of 4
Originator	J. D. Skoglie	Date	2/24/15
Checked	I. B. Berezovskiy	Date	2/24/15
Calc. No.	0100H-CA-V0220	Rev. No.	0
		Job No.	14655

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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-V0221

Subject: 100-H-59:1 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	6/11/15

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:	3/12/2015	Calc. No.:	0100H-CA-V0220	Rev.:	0
Project:	100-H Area Closure Operations	Job No:	14655	Checked:	I. B. Berezovskiy	Date:	3/12/2015
Subject:	100-H-59:1 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-59:1 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 remedial action goals (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 Area,* 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-59:1 Subsite Cleanup Verification 95% UCL Calculations*, Calculation Number 0100H-CA-V0220, 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).

Washington Closure Hanford CALCULATION SHEET

Originator:	J. D. Skoglie	Date:	3/12/2015	Calc. No.:	0100H-CA-V0224	Rev.:	0
Project:	100-H Area Closure Operations	Job No:	14655	Checked:	I. B. Berezovskiy	Date:	3/12/2015
Subject:	100-H-59:1 Subsite Direct Contact Hazard Quotient, Carcinogenic Risk, and Sum of Fractions Calculations					Sheet No. 2 of 5	

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

Summation of Fractions

The sum-of-fractions compares the radionuclide cleanup verification results from the 100-H-59:1 subsite excavation and staging pile area to 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-59:1 subsite underwent statistical sampling at 2 decision units for verification sampling; an excavation and staging pile area. The direct contact hazard quotient and carcinogenic risk calculations for the 100-H-59:1 subsite was conservatively calculated for the entire data set using the greater of the maximum and the statistical verification soil sample results (WCH 2015). Of the contaminants of potential concern (COPCs) for this site, boron and molybdenum require HQ and risk calculations because these analytes were detected and a Washington State or Hanford Site background value is not available. Lead was detected above background; however, lead does not have a reference dose for calculation of a hazard quotient because toxic effects of lead are correlated with blood-lead levels rather than exposure levels or daily intake. Additionally, arsenic was detected above background; however, the arsenic standard is not toxicity based. All other site nonradionuclide COPCs were either not detected or were quantified below background levels. An example of the HQ and risk calculations is presented below:

1) For example, the statistical value for boron is 2.7 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 3.8×10^{-4}. Comparing this value, and all other individual values, to the requirement of <1.0, this criterion is met.

2) After the HQ 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 1.8×10^{-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, then multiplied by 1.0×10^{-6}. There were not any detected COPCs without a background value or above the Washington State or Hanford Site background value and that had a carcinogenic RAG associated with it. Therefore, the requirement of $<1 \times 10^{-6}$, has been met. Because there were not any individual carcinogenic risk values, the cumulative excess cancer risk requirement of $<1 \times 10^{-5}$, has also been met.

Washington Closure Hanford CALCULATION SHEET

Originator:	J. D. Skoglie	Date:	3/18/2015	Calc. No.:	0100H-CA-V0221	Rev.:	0
Project:	100-H Area Closure Operations	Job No:	14655	Checked:	I. B. Berezovskiy	Date:	3/18/2015
Subject:	100-H-59:1 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-59:1 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 cesium-137 (0.0362 pCi/g) is divided by the soil activity equivalent of 6.2 pCi/g equivalent to a 15 mrem/yr dose, resulting in a fraction of 0.00584.

2) The fractions for the remaining COPCs are determined and summed. The sum of these fractions equals 0.00623. The sum of fractions is then multiplied by 15 mrem/yr to determine the total equivalent dose of 0.0934 mrem/yr for the 100-H-59:1 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 hazard quotient and excess cancer risk calculations.

Summation of Fractions

As demonstrated by the summation of the fractions, the maximum cumulative dose values contributed by the residual radionuclide populations (0.0934 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:	3/18/2015	Calc. No.:	0100H-CA-V0221	Rev.:	0
Project:	100-H Area Closure Operations	Job No:	14655	Checked:	I. B. Berezovskiy	Date:	3/18/2015
Subject:	100-H-59:1 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-59:1 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					
Arsenic [c]	8.3	20	--	--	--
Boron	2.7	7200	3.8E-04	--	--
Lead [d]	25.5	353	--	--	--
Molybdenum	0.57	400	1.4E-03	--	--
Totals					
Cumulative Hazard Quotient:			**1.8E-03**		
Cumulative Excess Cancer Risk:					**0.0E+00**

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] = 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 RDR/RAWP (DOE-RL 2009b).

[d] = Value for the noncarcinogenic RAG calculated using Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children, EPA/540/R 93/081, Publication No. 9285.7, U.S. Environmental Protection Agency, Washington, D.C.

-- = not applicable

RAG = remedial action goal

Table 2. Attainment of Radionuclide Direct Exposure Remedial Action Goals at the 100-H-59:1 Subsite.

COPC	95% UCL Statistical or Maximum Values (pCi/g)	Soil Activity for 15 mrem/yr Dose (pCi/g) [a]	Fraction
Cesium-137	0.0362	6.2	0.00584
Europium-155	0.0488	125	0.000390
		Sum of Fractions	0.00623
		Equivalent Dose (mrem/yr)	0.0934

[a] Single radionuclide 15 mrem/yr dose-equivalence values and methodology are presented in the *100 Area RDR/RAWP* (DOE-RL 2009b).

COPC = contaminant of potential concern

Washington Closure Hanford CALCULATION SHEET

Originator:	J. D. Skoglie	Date:	3/12/2015	Calc. No.:	0100H-CA-V0221	Rev.:	0
Project:	100-H Area Closure Operations	Job No:	14655	Checked:	I. B. Berezovskiy	Date:	3/12/2015
Subject:	100-H-59:1 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-59:1 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-59:1 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-V0222

Subject: 100-H-59:1 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. G. Wilkinson	6/11/15

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:	3/2/2015	Calc. No.:	0100H-CA-V0222	Rev.:	-r0
Project:	100-H Area Closure Operations	Job No:	14655	Checked:	I. B. Berezovskiy	Date:	3/2/2015
Subject:	100-H-59:1 Subsite Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater					Sheet No.	1 of 3

6/15/15

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-59:1 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-59:1 Subsite Cleanup Verification 95% UCL Calculations*, 0100H-CA-V0220, 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:	3/2/2015	Calc. No.:	0100H-CA-V0222	Rev.:	0
Project:	100-H Area Closure Operations	Job No:	14655	Checked:	I. B. Berezovskiy	Date:	3/2/2015
Subject:	100-H-59:1 Subsite Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater					Sheet No.	2 of 3

METHODOLOGY:

The 100-H-59:1 subsite is comprised of two decision units for verification sampling; an excavation and staging pile area. Hazard quotient and carcinogenic risk calculations for potential impact to groundwater at the 100-H-59:1 subsite were conservatively calculated for the entire waste site using the greater of the statistical or maximum value for each analyte in all decision units from the 95% UCL calculation (WCH 2015). Based on the generic site RESRAD model (BHI 2005) and a vadose zone of approximately 10 m (33 ft) thickness, a K_d of 7.2 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 is included because no Washington State or Hanford background value has been established and the distribution coefficients are less than that necessary to show no migration to groundwater in 1,000 years using this model. Additionally, arsenic was detected above background; however, the standard for this contaminant is not toxicity based, therefore a groundwater HQ is not calculated. All other site nonradionuclide COPCs were not detected, quantified below background levels, or has a K_d greater than or equal to 7.2 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 maximum value for boron is 2.7 mg/kg, divided by the noncarcinogenic RAG value of 320 mg/kg is 8.4×10^{-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-59:1 subsite is 8.4×10^{-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 1×10^{-6}. There were not any constituents with a carcinogenic RAG, therefore, comparing zero to the requirement of $<1 \times 10^{-6}$, this criterion is met. The criterion for 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.

Washington Closure Hanford, Inc. CALCULATION SHEET

Originator:	J. D. Skoglie	Date:	3/2/2015	Calc. No.:	0100H-CA-V0222	Rev.:	0
Project:	100-H Area Closure Operations	Job No:	14655	Checked:	I. B. Berezovskiy	Date:	3/2/2015
Subject:	100-H-59:1 Subsite Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater					Sheet No. 3 of 3	

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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 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.

Table 1. Hazard Quotient and Excess Cancer Risk Results for the 100-H-59:1 Subsite.

Contaminants of Potential Concern[a]	Maximum or Statistical Value[a] (mg/kg)	Noncarcinogen RAG[b] (mg/kg)	Hazard Quotient	Carcinogen RAG[b] (mg/kg)	Carcinogen Risk
Metals					
Arsenic[c]	8.3	20	--	0.667	--
Boron	2.7	320	8.4E-03	--	--
Totals					
Cumulative Hazard Quotient:			**8.4E-03**		
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.

[c] = 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 RDR/RAWP (DOE-RL 2009b).

-- = not applicable

RAG = remedial action goal

CONCLUSION:

This calculation demonstrates that the 100-H-59:1 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 D

DATA QUALITY ASSESSMENT

APPENDIX D

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 2014b). 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 2014b), the field logbook (WCH 2014a), 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 (BHI 2000) 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-59:1 subsite were provided by the laboratory in two sample delivery groups (SDGs): JP0887 and JP0888. The SDG JP0887 was submitted for third-party validation. No major deficiencies were identified in the analytical data set. Minor deficiencies are discussed for the 100-H-59:1 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 JP0887

This SDG comprises 13 statistical soil samples (J1V2P7 through J1V2P9, J1V2R0 through J1V2R9) from the 100-H-59:1 subsite excavation area. This SDG includes one field duplicate pair (J1V2R6, J1V2R9). These samples were analyzed for inductively coupled plasma (ICP) metals, mercury, and by gamma energy analysis. SDG JP08878 was submitted for third-party validation. Minor deficiencies are as follows.

In the ICP metals analysis, serial dilution of a digestate indicates physical and chemical interferences are present for cobalt, copper and nickel. The laboratory has qualified the associated sample data with "X" flags. These data may be considered estimated. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, low levels of calcium, copper, and magnesium were detected in the method blank. These detections are less than half of the reporting limit and will have no significant impact on the field sample data. The data are usable for decision-making purposes.

In the ICP metals analysis, matrix spike recoveries for antimony (53%) and silicon (11%) are outside quality control (QC) limits. Third-party validation qualified the associated antimony and silicon data as estimated with "J" flags. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, the laboratory control sample recovery for silicon (9%) is outside the QC limits. Third-party validation qualified the associated silicon data as estimated with "J" flags. Estimated data are usable for decision-making purposes.

SDG JP0888

This SDG comprises 13 statistical soil samples (J1V2T0 through J1V2T9, J1V2V0 through J1V2V2) from the 100-H-59:1 subsite excavation area and one equipment blank (J1V2V3). This SDG includes one field duplicate pair (J1V2T5, J1V2V2). These samples were analyzed for ICP metals, mercury, and by gamma energy analysis. Minor deficiencies are as follows.

In the ICP metals analysis, serial dilution of a digestate indicates physical and chemical interferences are present for cobalt, lead and nickel. The laboratory has qualified the associated sample data with "X" flags. These data may be considered estimated. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, low levels of calcium, magnesium, and zinc were detected in the method blank. These detections are less than half of the reporting limit and will have no significant impact on the field sample data. The data are usable for decision-making purposes.

In the ICP metals analysis, the laboratory control sample recovery for silicon (9%) is outside the QC limits. The laboratory has qualified the associated data with "N" flags. These data may be considered estimated. Estimated data are usable for decision-making purposes.

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 (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 2014a) are shown in Table D-1. The main and QA/QC sample results are presented in Appendix C.

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

Sample Area	Main Sample	Duplicate Sample
Excavation area	J1V2R6	J1V2R9
Staging pile area	J1V2T5	J1V2V2

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 five 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 C provides details on duplicate pair evaluation and RPD calculation.

None of the duplicate RPDs calculated for 100-H-59:1 data set are above the duplicate acceptance criteria of 30%. The data are usable for decision-making purposes.

A secondary check of the data variability is used when one or both of the samples being evaluated (main and duplicate) is less than five times the target detection limit. In these cases, a control limit of ±2 times the target detection limit is used (Appendix C) to indicate that a visual check of the data is required by the reviewer. None of the data were indicated for this check. A visual inspection of all of the data is also performed. No additional major or minor deficiencies are noted. The data are usable 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-59:1 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-59:1 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 the Environmental Restoration 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 C.

REFERENCES

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

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

EPA, 2006, *Guidance on Systematic Planning using the Data Quality Objectives Process*, EPA QA/G-4, EPA/240/B-06/001, U.S. Environmental Protection Agency, Office of Environmental Information, Washington, D.C.

WCH, 2014a, *100H Field Remediation and Sampling*, Logbook EL-1627-09, pp. 2-8, Washington Closure Hanford, Richland, Washington.

WCH, 2014b, *Work Instruction for Verification Sampling of the 100-H-59, 100-H Area Railroad Track Soil Contamination Area Waste Site,* 0100H-WI-G0069, Rev. 0, Washington Closure Hanford, Richland, Washington.