WASTE SITE RECLASSIFICATION FORM

Operable Unit: 100-HR-1 **Control No.:** 2014-097

Waste Site Code(s)/Subsite Code(s): 100-H-51:3

Reclassification Category: Interim ☒ Final ☐

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

Approvals Needed: DOE ☒ Ecology ☒ EPA ☐

Description of current waste site condition:

The 100-H-51 Pipelines waste site, part of the 100-HR-1 Operable Unit, was added to the *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units* (Remaining Sites ROD), U.S. Environmental Protection Agency, Region 10, Seattle, Washington (EPA 1999), as a candidate site for confirmatory sampling via the *Explanation of Significant Differences for the 100 Area Remaining Sites Interim Remedial Action Record of Decision, Hanford Site, Benton County, Washington*, U.S. Environmental Protection Agency, Region 10, Seattle, Washington (EPA 2009). Subsequently, the 100-H-51 waste site was divided into six subsites and the 100-H-51:3, 184-H Brine Discharge Line subsite was recommended for remedial action.

Remedial action at the 100-H-51:3 subsite was performed on March 18, 2014. The remediation depth extended to approximately 1.5 m (5 ft) below ground surface resulting in approximately 520 bank cubic meters (680 bank cubic yards) of soil and debris being removed for disposal at the Environmental Restoration Disposal Facility (ERDF). The debris consisted of steel pipelines and concrete. Asphaltic material was observed in and around the pipeline excavation. Additionally, coal ash was also present within the pipeline remediation area. The waste material including the coal ash was staged in a combined staging pile area (SPA), and has since been loaded out and disposed at the ERDF. The waste SPA footprint will be addressed in the 100-H-28:2/100-H-42 closure document. No stained soil or anomalous materials were encountered during the remediation.

Verification sampling was conducted on August 4, 2014. The sampling was performed to determine if the waste site met the remedial action objectives (RAOs) and remedial action goals (RAGs) 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 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-51:3 subsite demonstrate that the site meets the RAOs and corresponding RAGs established in the 100 Area RDR/RAWP (DOE-RL 2009b) and the Remaining Sites ROD (EPA 1999) to support a reclassification to Interim Closed Out. These sampling and modeling results established that residual contaminant concentrations do not preclude any future uses (as bounded by the rural-residential scenario) and allow for unrestricted use of shallow zone soils (i.e., surface to 4.6 m [15 ft] deep). The results also demonstrate that residual contaminant concentrations are protective of groundwater and the Columbia River. Contamination above direct exposure levels was not observed in shallow zone soils and is concluded to not exist in deep zone soils; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone soil are not required. The basis for reclassification is described in detail in the *Remaining Sites Verification Package for the 100-H-51:3, 184-H Brine Discharge Line and 100-H-51:6, Carbon Steel Pipe Subsites* (attached).

WASTE SITE RECLASSIFICATION FORM

Operable Unit: 100-HR-1 **Control No.:** 2014-097

Waste Site Code(s)/Subsite Code(s): 100-H-51:3

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	3/17/15
DOE Federal Project Director (printed)	Signature	Date
N. Menard	Nina M. Menard	3/27/15
Ecology Project Manager (printed)	Signature	Date
NA		
EPA Project Manager (printed)	Signature	Date

WASTE SITE RECLASSIFICATION FORM

Operable Unit: 100-HR-1 **Control No.:** 2014-098

Waste Site Code(s)/Subsite Code(s): 100-H-51:6

Reclassification Category: Interim ☒ Final ☐

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

Approvals Needed: DOE ☒ Ecology ☒ EPA ☐

Description of current waste site condition:

The 100-H-51 Pipelines waste site, part of the 100-HR-1 Operable Unit, was added to the *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units* (Remaining Sites ROD), U.S. Environmental Protection Agency, Region 10, Seattle, Washington (EPA 1999), as a candidate site for confirmatory sampling via the *Explanation of Significant Differences for the 100 Area Remaining Sites Interim Remedial Action Record of Decision, Hanford Site, Benton County, Washington*, U.S. Environmental Protection Agency, Region 10, Seattle, Washington (EPA 2009). Subsequently, the 100-H-51 waste site was divided into six subsites and the 100-H-51:6, Carbon Steel Pipe subsite was recommended for remedial action.

Remedial action at the 100-H-51:6 subsite was performed on March 12 and 13, 2014. The remediation depth extended to approximately 0.3 to 0.9 m (1 to 3 ft) below ground surface, resulting in approximately 450 bank cubic meters (588 bank cubic yards) of soil and debris being removed for disposal at the Environmental Restoration Disposal Facility (ERDF). The debris consisted primarily of the steel pipeline. Asphaltic material was observed in and around the pipeline excavation. Coal ash was also present on the surface and within the pipeline excavation; therefore, no overburden soil was stockpiled for use as backfill material. The waste material including the coal ash was staged in a combined staging pile area (SPA), and has since been loaded out and disposed at ERDF. The waste SPA footprint will be addressed in the 100-H-43 closure document. No stained soil or anomalous materials were encountered during the remediation.

Verification sampling was conducted on August 4, 2014. The sampling was performed to determine if the waste site met the remedial action objectives (RAOs) and remedial action goals (RAGs) 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 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-51:6 subsite demonstrate that the site meets the RAOs and corresponding RAGs established in the 100 Area RDR/RAWP (DOE-RL 2009b) and the Remaining Sites ROD (EPA 1999) to support a reclassification to Interim Closed Out. These sampling and modeling results established that residual contaminant concentrations do not preclude any future uses (as bounded by the rural-residential scenario) and allow for unrestricted use of shallow zone soils (i.e., surface to 4.6 m [15 ft] deep). The results also demonstrate that residual contaminant concentrations are protective of groundwater and the Columbia River. Contamination above direct exposure levels was not observed in shallow zone soils and is concluded to not exist in deep zone soils; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone soil are not required. The basis for reclassification is described in detail in the *Remaining Sites Verification Package for the 100-H-51:3, 184-H Brine Discharge Line and 100-H-51:6, Carbon Steel Pipe Subsites* (attached).

WASTE SITE RECLASSIFICATION FORM

Operable Unit: 100-HR-1 **Control No.:** 2014-098

Waste Site Code(s)/Subsite Code(s): 100-H-51:6

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	3/17/15
DOE Federal Project Director (printed)	Signature	Date
N. Menard	Nina M. Menard	3/27/15
Ecology Project Manager (printed)	Signature	Date
NA		
EPA Project Manager (printed)	Signature	Date

REMAINING SITES VERIFICATION PACKAGE FOR THE 100-H-51:3, 184-H BRINE DISCHARGE LINE AND 100-H-51:6, CARBON STEEL PIPE SUBSITES

Attachment to Waste Site Reclassification Forms 2014-097 and 2014-098

April 2015

REMAINING SITES VERIFICATION PACKAGE FOR THE 100-H-51:3, 184-H BRINE DISCHARGE LINE AND 100-H-51:6, CARBON STEEL PIPE SUBSITES

EXECUTIVE SUMMARY

The 100-H-51 Pipelines waste site, part of the 100-HR-1 Operable Unit, was added to the *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington* (Remaining Sites ROD) (EPA 1999) as a candidate site for confirmatory sampling via the *Explanation of Significant Differences for the 100 Area Remaining Sites Interim Remedial Action Record of Decision, Hanford Site, Benton County, Washington* (100 Area ESD) (EPA 2009). Subsequently, the 100-H-51 waste site was divided into six subsites. The 100-H-51:3, 184-H Brine Discharge Line and the 100-H-51:6, Carbon Steel Pipe subsites were identified for remediation based on confirmatory sampling results (WCH 2011a and WCH 2011b).

Remedial action at the 100-H-51:6 subsite was performed on March 12 and 13, 2014. The remediation depth extended to approximately 0.3 to 0.9 m (1 to 3 ft) below ground surface, resulting in approximately 450 bank cubic meters (588 bank cubic yards) of soil and debris being removed for disposal at the Environmental Restoration Disposal Facility (ERDF). Coal ash was present on the surface and within the pipeline excavation; therefore, no overburden soil was stockpiled for use as backfill material. The coal ash within the pipeline remediation was disposed at ERDF. The waste material was staged prior to loadout and will be addressed in the 100-H-43 closure document. No stained soil or anomalous materials were encountered during the remediation.

Remedial action at the 100-H-51:3 subsite was performed on March 18, 2014. The remediation depth extended to approximately 1.5 m (5 ft) below ground surface resulting in approximately 520 bank cubic meters (680 bank cubic yards) of soil and debris being removed for disposal at ERDF. Coal ash was also present within the pipeline remediation and was disposed at ERDF. The waste material was staged prior to loadout and will be addressed in the 100-H-28:2/100-H-42 closure document. No overburden soil was stockpiled for use as backfill material. No stained soil or anomalous materials were encountered during the remediation. Asphaltic material was observed in and around the pipeline excavations.

Verification sampling was conducted on August 4, 2014. A summary of the cleanup evaluation for the soil sampling results against the applicable remedial action goals (RAGs) is presented in Table ES-1. Polycyclic aromatic hydrocarbons (PAH) were detected in the verification samples above the RAGs; however, it was determined that the exceedances were related to the tar coating on the pipelines rather than the 100-H-51:3 and 100-H-51:6 pipeline processes. Therefore, PAH were excluded from further evaluation.

Table ES-1. Summary of Remedial Action Goals for the 100-H-51:3 and 100-H-51:6 Subsites. (2 Pages)

Regulatory Requirement	Remedial Action Goals	Results	Remedial Action Objectives Attained?
Direct Exposure – Radionuclides	Attain a dose rate of <15 mrem/yr above background over 1,000 years.	Radionuclides were not COPCs for the 100-H-51:3 and 100-H-51:6 subsites.	NA
Direct Exposure – Nonradionuclides	Attain individual COPC direct exposure RAGs.	All individual COPC concentrations are below the direct exposure criteria.	Yes
Risk Requirements – Nonradionuclides	Attain a hazard quotient of <1 for all individual noncarcinogens.	The hazard quotients for individual nonradionuclide COPCs are <1.	Yes
	Attain a cumulative hazard quotient of <1 for noncarcinogens.	The cumulative hazard quotient for the 100-H-51:3 and 100-H-51:6 subsites (1.0×10^{-1}) 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 RAGs.	Radionuclides were not COPCs for the 100-H-51:3 and 100-H-51:6 subsites.	NA
	Attain National Primary Drinking Water Regulations [a]: 4 mrem/yr (beta/gamma) dose standard to target receptor/organ.		
	Meet drinking water standards for alpha emitters: the more stringent of 15 pCi/L MCL or 1/25th of the derived concentration guide for DOE Order 5400.5 [b].		
	Meet total uranium standard of 30 µg/L (21.2 pCi/L) [c].		

Table ES-1. Summary of Remedial Action Goals for the 100-H-51:3 and 100-H-51:6 Subsites. (2 Pages)

Regulatory Requirement	Remedial Action Goals	Results	Remedial Action Objectives Attained?
Groundwater/River Protection – Nonradionuclides	Attain individual nonradionuclide groundwater and Columbia River cleanup requirements.	Barium, chromium, copper, lead, and nickel exceeded soil RAGs for groundwater and/or 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 concentrations of these contaminants 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 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), residual concentrations of barium, chromium, copper, lead, and nickel are predicted to migrate less than 2.6 m (8.5 ft) vertically in 1,000 years (based on the lowest soil-partitioning coefficient (K_d) of these contaminants [copper with a K_d of 22 mL/g]). The vadose zone underlying the soil beneath the excavation is approximately 9 m (30 ft) thick. Therefore, residual concentrations of these contaminants are predicted to be protective of groundwater and consequently are protective of the Columbia River.

COPC = contaminant of potential concern
DOE = U.S. Department of Energy
K_d = soil-partitioning coefficient
MCL = maximum contaminant level
NA = not applicable
PCB = polychlorinated biphenyl
RAG = remedial action goal
RDR/RAWP = Remedial Design Report/Remedial Action Work Plan
RESRAD = RESidual RADioactivity (dose model)

The results of the verification sampling were used to make reclassification decisions for the 100-H-51:3 and 100-H-51:6 subsites 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 and modeling support a reclassification of this site to Interim Closed Out. The current site conditions achieve the remedial action objectives and the corresponding RAGs established in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE-RL 2009b) and the 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 sampling and modeling results also demonstrate that residual contaminant concentrations support unrestricted future use of shallow zone soil (i.e., surface to 4.6 m [15 ft] deep), and contaminant levels remaining in the soil are protective of groundwater and the Columbia River. Contamination above direct exposure levels was not observed in shallow zone soils and is concluded to not exist in deep zone

soils; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone soil are not required.

Soil cleanup levels were established in the Remaining Sites ROD (EPA 1999) based in part on a limited ecological risk assessment. Although not required by the Remaining Sites ROD, a comparison against ecological risk screening levels has been made for the 100-H-51:3 and 100-H-51:6 subsites 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, barium, boron, copper, molybdenum, nickel, selenium, and vanadium. The U.S. Environmental Protection Agency ecological soil screening levels were exceeded for chromium, copper, manganese, nickel, selenium, 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 the concentrations of manganese and vanadium are below the Hanford Site background values, it is believed that the presence of these constituents does not pose a risk to ecological receptors. All exceedances will be evaluated in the context of additional lines of evidence for risk to ecological receptors as part of the final closeout decision for this site.

REMAINING SITES VERIFICATION PACKAGE FOR THE 100-H-51:3, 184-H BRINE DISCHARGE LINE AND 100-H-51:6, CARBON STEEL PIPE SUBSITES

STATEMENT OF PROTECTIVENESS

The 100-H-51:3 and 100-H-51:6 subsites cleanup 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* (Remaining Sites ROD) (EPA 1999).

The results of verification sampling and modeling show that residual soil 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.

Polycyclic aromatic hydrocarbons (PAH) were detected in the verification samples above the remedial action goals (RAGs); however, it was determined that the PAH were related to the tar coating on the pipelines rather than the 100-H-51:3 and 100-H-51:6 pipeline processes. Therefore, PAHs were excluded from further evaluation.

Soil cleanup levels were established in the Remaining Sites ROD (EPA 1999) based in part on a limited ecological risk assessment. Although not required by the Remaining Sites ROD, a comparison against ecological risk screening levels has been made for the 100-H-51:3 and 100-H-51:6 subsites 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, barium, boron, copper, molybdenum, nickel, selenium, and vanadium. The U.S. Environmental Protection Agency (EPA) ecological soil screening levels were exceeded for chromium, copper, manganese, nickel, selenium, 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 the concentrations of manganese and vanadium are below the Hanford Site background values, it is believed that the presence of these constituents does not pose a risk to ecological receptors. All exceedances will be evaluated in the context of additional lines of evidence for risk to ecological receptors as part of the final closeout decision for this site.

GENERAL SITE INFORMATION AND BACKGROUND

The 100-H-51:3 subsite consisted of two parallel pipelines that transported water from the 184-H Power House to the 184-H Salt Dissolving Pit and transported salt brine back to the Power House (Figure 1). The water pipeline was a 7.6-cm (3-in.)-diameter steel pipeline that transported filtered water from the 184-H Power House to the 184-H Salt Dissolving Pit and Brine Pump House. The salt brine pipeline was a 5.1-cm (2-in.)-diameter steel pipeline and was designed to transport salt brine from the 184-H Salt Dissolving Pit and Brine Pump House to the 184-H Power House. At the 184-H Salt Dissolving Pit and Brine Pump House, sodium chloride was dissolved, forming salt brine, and the brine was pumped back to the 184-H Power House where it was used to regenerate the zeolite ion exchange beds in the water softener tanks. The operation period of the 100-H-51:3 pipelines coincided with that of the 105-H Reactor and its support facilities, from 1949 to 1965.

The 100-H-51:6 subsite consisted of a section of 25.4-cm (10-in.)-diameter steel pipeline that started approximately 70 m (231 ft) south of the 100-H-51:5 subsite and ended near the 1713-H Building (Figure 1). This pipeline was suspected to have been part of an extensive temporary water system for construction of the 100-H Area in 1948.

CONFIRMATORY SAMPLING ACTIVITIES

Confirmatory sampling of the 100-H-51:3 subsite was performed in accordance with the *Work Instruction for Confirmatory Sampling of the 100-H-51:3, 184-H Brine Discharge Line* (WCH 2010c) on October 4 and 5, 2010, as described in the field logbook (WCH 2010a). A summary of the confirmatory samples collected is provided in Table 1 and the locations are shown in Figure 2.

Confirmatory sampling of the 100-H-51:6 subsite was performed in accordance with the *Work Instruction for Confirmatory Sampling of the 100-H-53 Carbon Steel Pipe and the 100-H-51:5, Discovery Pipeline* (WCH 2010d) on November 15, 2010, as described in the field logbook (WCH 2010b). Originally, the 100-H-51:6 pipeline was included as part of the 100-H-51:5 pipeline subsite; however, following the confirmatory sampling event, it was determined the southern segment of 100-H-51:5 was a separate pipeline. Therefore, the 100-H-51:5 pipeline subsite was divided into two subsites and the southern segment became the 100-H-51:6 Carbon Steel Pipe subsite.

No sample was collected from 100-H-51:6 Location #6 (Table 2, Figure 3). An "elbow" was expected to be present at the south end of the southern segment; however, when the pipeline was exposed, a "T" was observed. This was suspected to be a different pipeline; therefore, the pipeline was not breached and no sample was collected at this location. The "T" was later determined to be part of a 15.2-cm (6-in.) cast iron water supply line that is a continuation of the 100-H-35, 100-H Clean Water Pipelines. Two additional sample locations (#7 and #8) were added along the north/south segment of the 100-H-51:6 pipeline. A summary of the confirmatory samples collected is provided in Table 2 and the locations are shown in Figure 3.

Figure 1. 100-H-51:3 and 100-H-51:6 Waste Site Location Map.

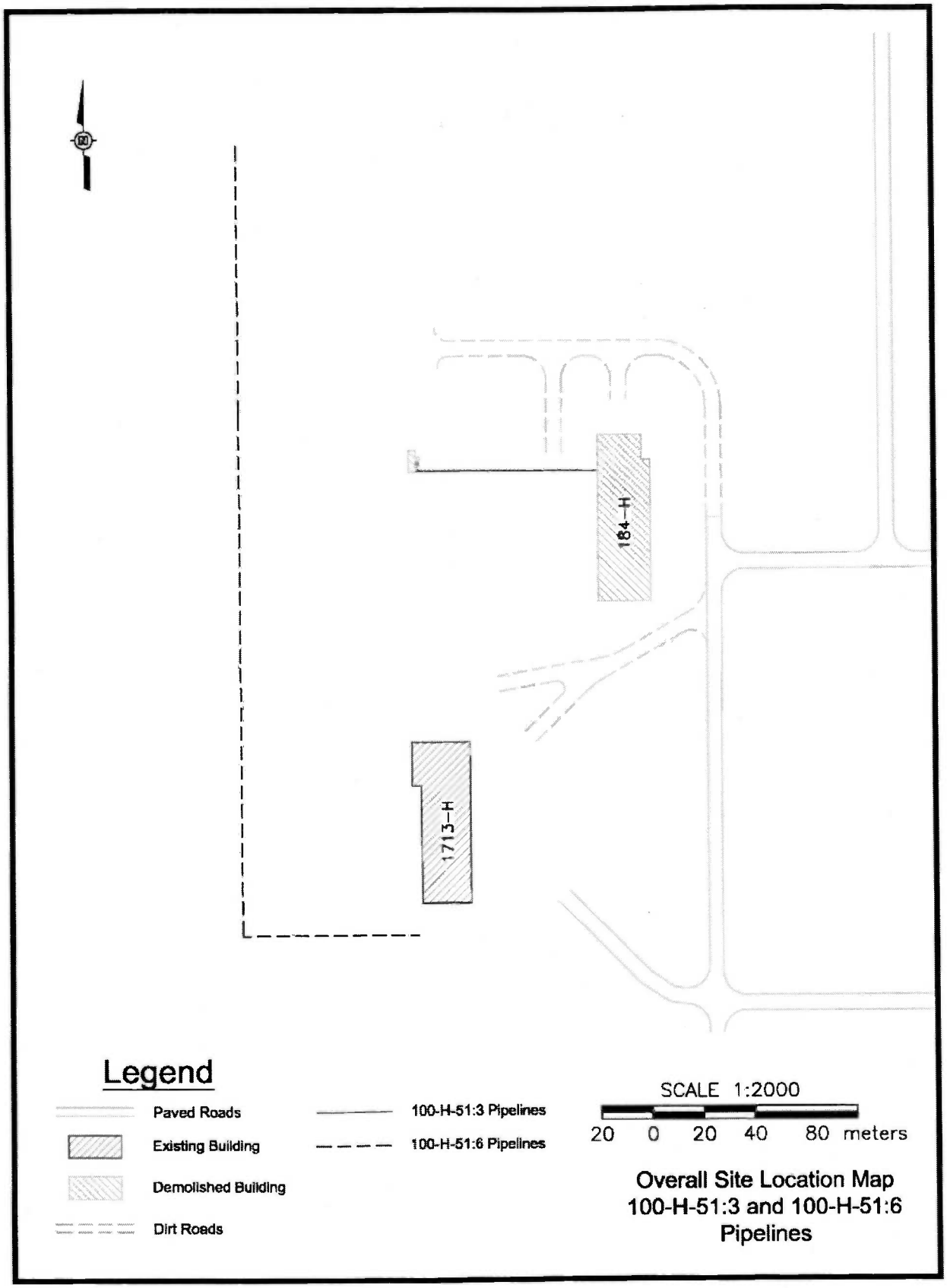


Table 1. 100-H-51:3 Confirmatory Sampling Summary.

Sample Location	Sample Description	HEIS Sample Number	WSP Coordinates		Sample Analysis
			Northing (m)	Easting (m)	
Test pit 1	Soil underlying pipeline	J1C360	151696.9	577689.5	ICP metals [a], mercury, hexavalent chromium, IC anions [b], nitrate/nitrite, PAH
Duplicate of Test pit 1		J1C361	151696.9	577689.5	
Test pit 2	Soil underlying pipeline	J1C362	151843.1	577774.7	
Test pit 3	Soil underlying pipeline	J1C364	152936.0	577527.4	
Equipment blank	Silica sand	J1C363	NA	NA	ICP metals [a], mercury

[a] Sample analysis for ICP metals included antimony, arsenic, barium, beryllium, boron, cadmium, chromium (total), cobalt, copper, lead, manganese, molybdenum, nickel, selenium, silver, vanadium, and zinc.
[b] IC anions included bromide, chloride, fluoride, nitrate, nitrite, phosphate, and sulfate in the analytical results package.

HEIS = Hanford Environmental Information System
IC = ion chromatography
ICP = inductively coupled plasma
NA = not applicable
PAH = polycyclic aromatic hydrocarbons
WSP = Washington State Plane

Table 2. 100-H-51:6 Confirmatory Sampling Summary.

Sample Location	Sample Description	HEIS Sample Number	WSP Coordinates		Sample Analysis
			Northing (m)	Easting (m)	
4	Pipe contents	J1CNX1	153064	577385	ICP metals [a], mercury, PAH, PCB, TPH, GEA, gross alpha, gross beta
4	Pipe contents	J1CNX5			Hexavalent chromium
4	Soil underlying pipe	J1CNV9			ICP metals[a], mercury, PAH, TPH, GEA, gross alpha, gross beta
4	Soil underlying pipe, duplicate of J1CNV9	J1CNW0			
6	Pipe contents	No sample [b]	152753	577386	ICP metals [a], mercury, PAH, hexavalent chromium, GEA, gross alpha, gross beta
6	Soil underlying pipe	No sample [b]			
3	Surface soil sample	J1CNW1	153064	577378	
5	Surface soil sample	J1CNW2	153064	577392	
7	Soil below pipe	J1JW30	152830	577386	
8	Soil below pipe	J1JW31	152998	577385	
7	Pipe scale	J1JW32	152830	577386	ICP metals [a], mercury, PAH, GEA, gross alpha, gross beta
8	Pipe scale	J1JW33	152998	577385	
7	Pipe scale	J1JW34	152830	577386	Hexavalent chromium
8	Pipe scale	J1JW35	152998	577385	Hexavalent chromium
EB	Silica sand	J1CNV8	NA	NA	ICP metals [a], mercury, PAH

[a] Sample analysis for ICP metals included antimony, arsenic, barium, beryllium, boron, cadmium, chromium (total), cobalt, copper, lead, manganese, molybdenum, nickel, selenium, silver, vanadium, and zinc.
[b] No sample was collected from Location 6. After the pipeline was exposed, it was determined to be the wrong pipeline. The confirmatory sampling team expected to find an "elbow" segment; however, the exposed segment of pipeline was a "T" shape. Therefore, the pipeline was backfilled and no sample was collected.

EB = equipment blank
HEIS = Hanford Environmental Information System
ICP = inductively coupled plasma
GEA = gamma energy analysis
NA = not applicable
PAH = polycyclic aromatic hydrocarbons
PCB = polychlorinated biphenyl
TPH = total petroleum hydrocarbons
WSP = Washington State Plane

Figure 2. 100-H-51:3 Waste Site Confirmatory Sampling Locations.

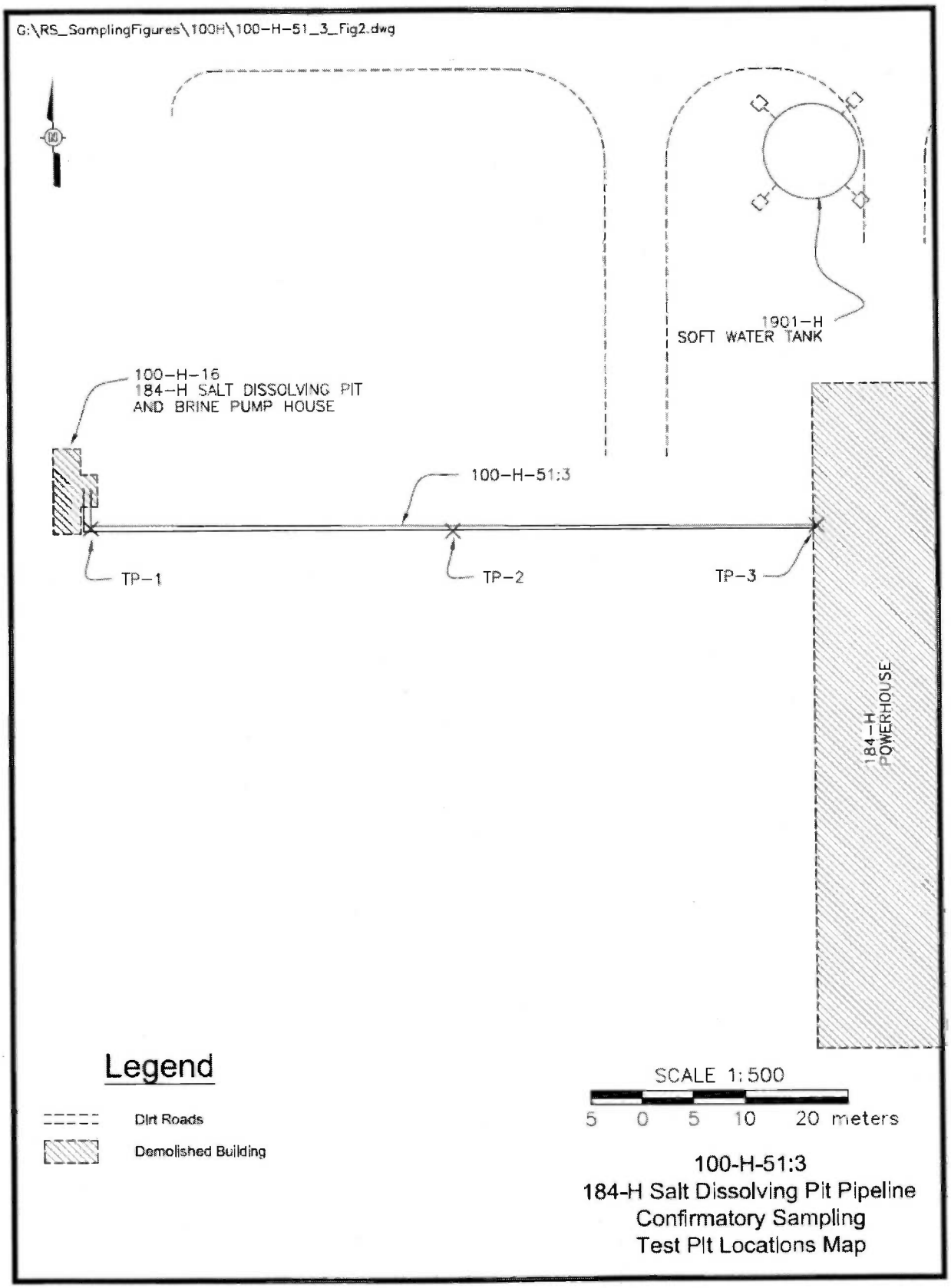
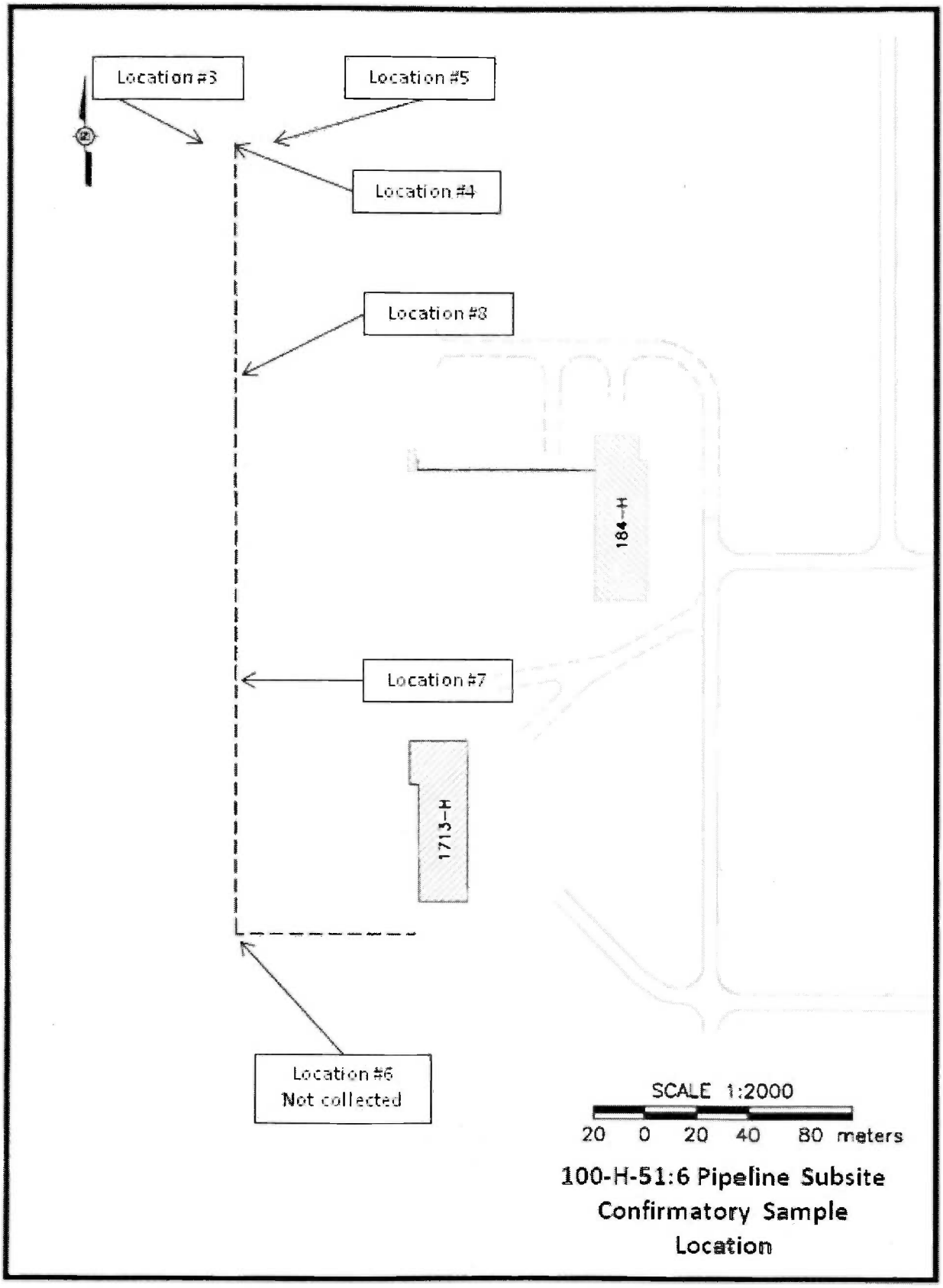


Figure 3. 100-H-51:6 Waste Site Confirmatory Sampling Locations.



Contaminants of Potential Concern for Confirmatory Sampling at 100-H-51:3

The COPCs identified for confirmatory sampling at the 100-H-51:3 subsite were determined based on the waste source and brine pit process and included arsenic, barium, cadmium, chromium (total), lead, mercury, selenium, silver, hexavalent chromium, sulfate, chlorine, nitrate, nitrite, and PAH. Although not considered COPCs, aluminum, antimony, beryllium, boron, cobalt, copper, manganese, molybdenum, nickel, vanadium, and zinc were evaluated by performing analyses for the constituents of the expanded inductively coupled plasma (ICP) metals list.

No radiological activity was detected during confirmatory sampling; therefore, radionuclides were not included as COPCs. Field screening did not detect volatile organic compounds (VOCs) and oily soil or evidence of burning was not observed during field activities; therefore, VOC analysis and total petroleum hydrocarbons (TPH) were not requested. Suspect asbestos-containing material was not identified during field activities; therefore, asbestos analysis was not requested.

Contaminants of Potential Concern for Confirmatory Sampling at 100-H-51:6

The COPCs for confirmatory sampling at the 100-H-51:6 subsite were determined based on the pipeline being associated with raw water intake. The primary COPCs were identified as metals present in raw river water and potentially deposited in minute quantities in scale within the pipelines. Mercury was included because it was prevalent in water monitoring and pumping equipment. Hexavalent chromium and radionuclides were included due to evidence of upstream discharges of process effluent. In addition, polychlorinated biphenyls (PCBs) and TPH were added because of the possible electrical box or transformer located a few meters south of the temporary water storage tank. The analysis for PAH was also requested.

Field screening did not detect VOCs; therefore, VOC analysis was not requested. Additionally, suspect asbestos-containing material was not identified during field activities; therefore, asbestos analysis was not requested.

Confirmatory Sample Results

An evaluation of the sample results shows that the 100-H-51:3 subsite exceeded the direct exposure RAGs for benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and benzo(k)fluoranthene. Additionally, groundwater protection and/or Columbia River protection RAGs were exceeded for chromium, zinc, chrysene, and fluoranthene. Based on these results, the 100-H-51:3 subsite was recommended for remediation (WCH 2011a). The confirmatory sampling data are provided in Appendix B.

An evaluation of the sample results for the 100-H-51:6 subsite show that the direct exposure RAG was exceeded for benzo(a)pyrene. Additionally, groundwater protection and/or Columbia River protection RAGs were exceeded for cadmium, chromium (total), copper, manganese, molybdenum, nickel, zinc, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, and dibenz(a,h,)anthracene. Based on these results,

the 100-H-51:6 subsite was recommended for remediation (WCH 2011b). The confirmatory sampling data are provided in Appendix B.

Although PAHs were detected in the confirmatory samples, it is likely the PAHs were attributed to the tar coating on the pipelines rather than the pipeline processes. As described in the General Site Information and Background section, the processes of both the 100-H-51:3 and 100-H-51:6 subsites do not suggest that PAHs would be present.

REMEDIAL ACTION SUMMARY

Remedial action at the 100-H-51:3 pipeline subsite was performed on March 18, 2014. The remediation extended to approximately 1.5 m (5 ft) below ground surface resulting in approximately 520 bank cubic meters (680 bank cubic yards) of soil and debris being removed for disposal at the Environmental Restoration Disposal Facility (ERDF). The debris consisted of the 5.1-cm and 7.6-cm (2-in. and 3-in.)-diameter steel pipelines, concrete, and near surface demolition debris. Coal ash was also present in the pipeline area; as a result, no overburden soil was stockpiled for use as backfill. The waste material including the coal ash was staged in a waste staging pile area (SPA), and has since been loaded out and disposed at ERDF. The waste SPA was used for multiple waste sites and the SPA footprint will be addressed in the 100-H-28:2/100-H-42 verification work instruction and closure document. No stained soil or anomalous materials were encountered during the remediation. Asphaltic material was observed in and around the pipeline excavation. A post-remediation photograph is provided in Figure 4.

Remedial action at the 100-H-51:6 pipeline subsite was performed on March 12 and 13, 2014. The depth of the remediation ranged from approximately 0.3 to 0.9 m (1 to 3 ft) below ground surface, resulting in approximately 450 bank cubic meters (588 bank cubic yards) of soil and debris being removed for disposal at ERDF. The debris consisted primarily of a 25.4-cm (10-in.)-diameter steel pipeline. Coal ash was also present on the surface; therefore, no overburden soil was stockpiled for use as backfill. The waste material including the coal ash was staged in a SPA and has since been loaded out to ERDF. The SPA was used for multiple waste sites and the SPA footprint will be addressed in the 100-H-43 verification work instruction and closure document. No stained soil or anomalous materials were encountered during the remediation. Asphaltic material was observed in and around the pipeline excavation. A post-remediation photograph is provided in Figure 5.

A post-remediation boundary survey was conducted following remedial action activities. The survey is provided in Figure 6. The pipeline was very shallow, and the ends of the pipeline were exposed on the ground surface. The entire segment of the pipeline was removed and disposed. An aerial photograph of the remediated waste site is provided in Figure 7.

Due to the above ground pump-and-treat pipelines crossing over the top of a portion of the northern segment of the 100-H-51:6 subsite, remediation of the 100-H-51:6 pipeline in this area was conducted by pulling the pipe through and out of the trench. Soils from above and below the pipeline could not be removed. The pump-and-treat lines are visible in the aerial photograph provided in Figure 7.

Figure 4. Photograph of the 100-H-51:3 Excavation, Dated January 16, 2015.

Figure 5. Photograph of the 100-H-51:6 Excavation, Dated January 16, 2015.

Figure 6. 100-H-51:3 and 100-H-51:6 Post-Remediation Boundary Survey.

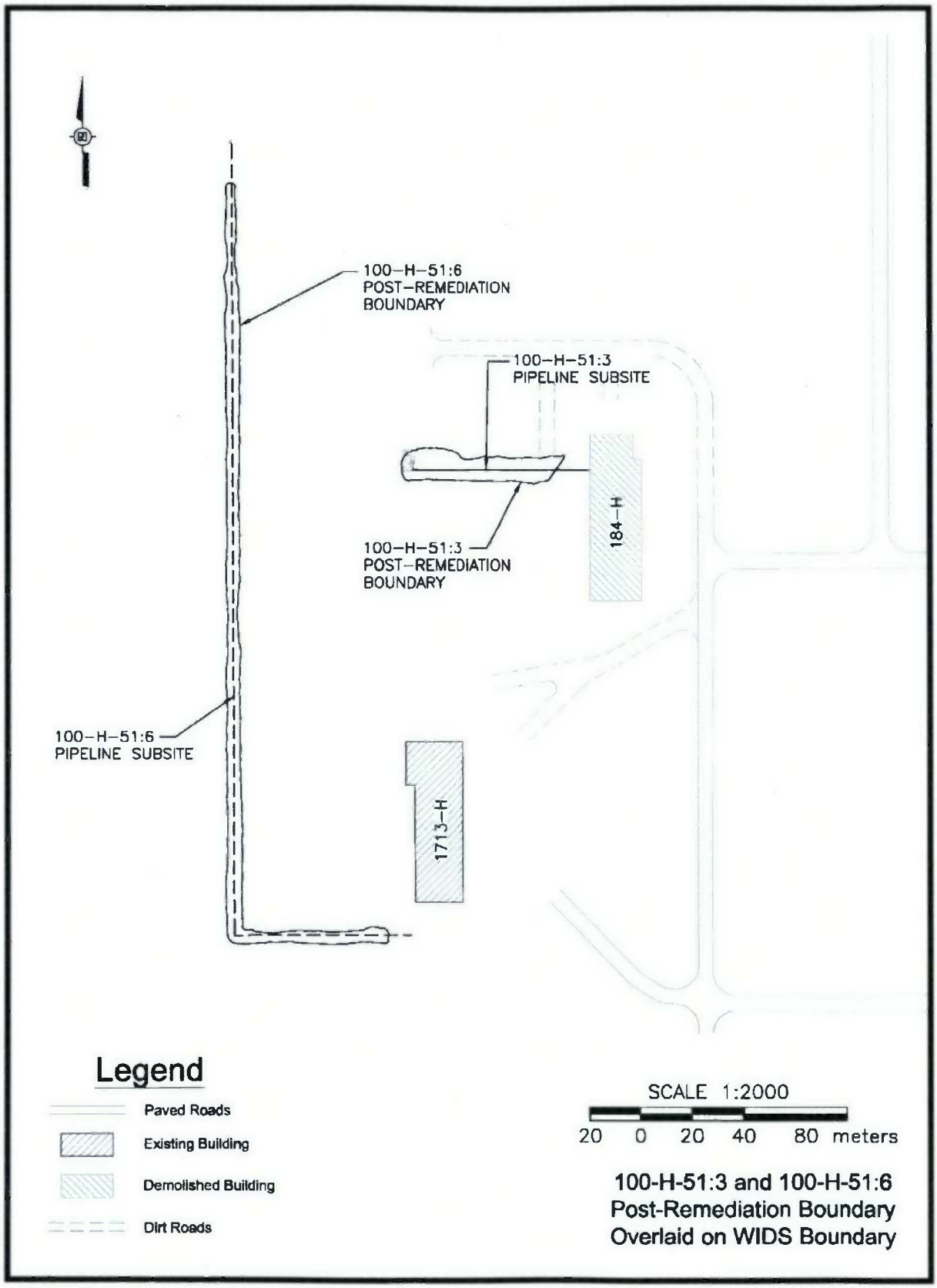


Figure 7. 100-H Area Aerial Photograph Dated April 15, 2014, Identifying the 100-H-51:3 and 100-H-51:6 Excavations.

No in-process soil samples were collected from the 100-H-51:3 or the 100-H-51:6 subsites.

VERIFICATION SAMPLING ACTIVITIES

Verification soil sampling was conducted on August 4, 2014, per the *Work Instruction for Verification Sampling of the 100-H-51:3, 184-H Brine Discharge Line and 100-H-51:6, Carbon Steel Pipe Waste Sites* (WCH 2014b). 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 RAGs for the 100-H-51:3 and 100-H-51:6 subsites. The following subsections provide additional discussion of the information used to develop the verification sampling design. The statistical results of verification sampling are also summarized to support interim closure of the site.

100-H-51:3 Contaminants of Potential Concern

The COPCs for verification sampling at the 100-H-51:3 subsite were determined based on the confirmatory sampling results (Appendix B). Chromium (total), zinc, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h,)anthracene, fluoranthene, and indeno(1,2,3-cd)pyrene were detected above a RAG in the confirmatory samples; therefore, they were retained as site COPCs. While not considered site COPCs,

analysis for mercury and the expanded list of ICP metals (which also includes antimony, arsenic, barium, beryllium, boron, cadmium, cobalt, copper, lead, manganese, molybdenum, nickel, selenium, silver, and vanadium) were requested. Although sulfate was detected in the confirmatory samples, the maximum value of 506 mg/kg was well below the river protection RAG of 25,000 mg/kg; therefore, sulfate was not included as a COPC for verification sampling.

No radiological activity was detected during confirmatory sampling; therefore, radionuclides were not included as COPCs. Field screening did not detect VOCs, and oily soil or evidence of burning was not observed during confirmatory sampling field activities. Therefore, VOC analysis and TPH were not requested and are not considered site COPCs. Suspect asbestos-containing material was not identified during field activities; therefore, asbestos analysis was not requested and asbestos is not a site COPC.

100-H-51:6 Contaminants of Potential Concern

The COPCs for verification sampling at the 100-H-51:6 subsite were determined based on the confirmatory sampling results (Appendix B). Cadmium, chromium, copper, manganese, molybdenum, nickel, zinc, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, and dibenz(a,h)anthracene were detected above a RAG in the confirmatory samples; therefore, they were retained as site COPCs. Although not considered site COPCs, the analysis for mercury and the expanded list of ICP metals (which also includes antimony, arsenic, barium, beryllium, boron, cobalt, lead, selenium, silver, and vanadium) were requested. Hexavalent chromium was detected; therefore, it was included as a site COPC.

Polychlorinated biphenyls, TPH, and radionuclides were either undetected or detected well below the RAGs; therefore, they were not included as site COPCs. Additionally, suspect asbestos-containing material was not identified during confirmatory sampling field activities; therefore, asbestos was not considered a site COPC.

The combined list of analyses for the 100-H-51:3 and 100-H-51:6 verification sampling included ICP metals, mercury, hexavalent chromium, and PAH. The analytical methods that were performed to evaluate the site COPCs are provided in Table 3.

Table 3. Laboratory Analytical Methods for the 100-H-51:3 and 100-H-51:6 Subsites.

Analytical Method	Contaminants of Potential Concern
ICP metals [a] – EPA Method 6010	Cadmium, chromium, copper, manganese, molybdenum, zinc
Mercury – EPA Method 7471	Mercury
Hexavalent chromium – EPA Method 7196	Hexavalent chromium
PAH – EPA Method 8310	Benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, fluoranthene, indeno(1,2,3-cd)pyrene

[a] 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.

EPA = U.S. Environmental Protection Agency
ICP = inductively coupled plasma
PAH = polycyclic aromatic hydrocarbons

Although PAHs were identified as site COPCs based on the confirmatory sampling results, it was subsequently determined that the elevated PAH results were related to a tar coating on the pipe rather than the pipeline processes.

Verification Sample Design

The 100-H-51:3 and 100-H-51:6 pipeline subsites were combined into one decision unit for verification sampling. A combination statistical and focused sampling design was used to evaluate the waste site excavations. Twelve statistical verification soil samples plus one duplicate were collected from the excavations. To provide sufficient sample coverage over the entire pipeline excavation, one focused sample was collected from the east end of the east/west segment of the 100-H-51:6 excavation. 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, with the exception of the EXC-11 sample location. Due to interference with the above ground pump-and-treat pipelines crossing over the 100-H-51:6 subsite, sample location EXC-11 was moved approximately 3.7 m (12 ft) north of the original location. A photograph of the pump-and-treat pipelines is provided in Figure 8. Additional information related to verification sampling can be found in the sampling logbook (WCH 2014a). The verification sample summary is provided in Table 4 and the sample locations are shown in Figure 9.

Figure 8. Pump–and-Treat Lines Crossing 100-H-51:6 Subsite.

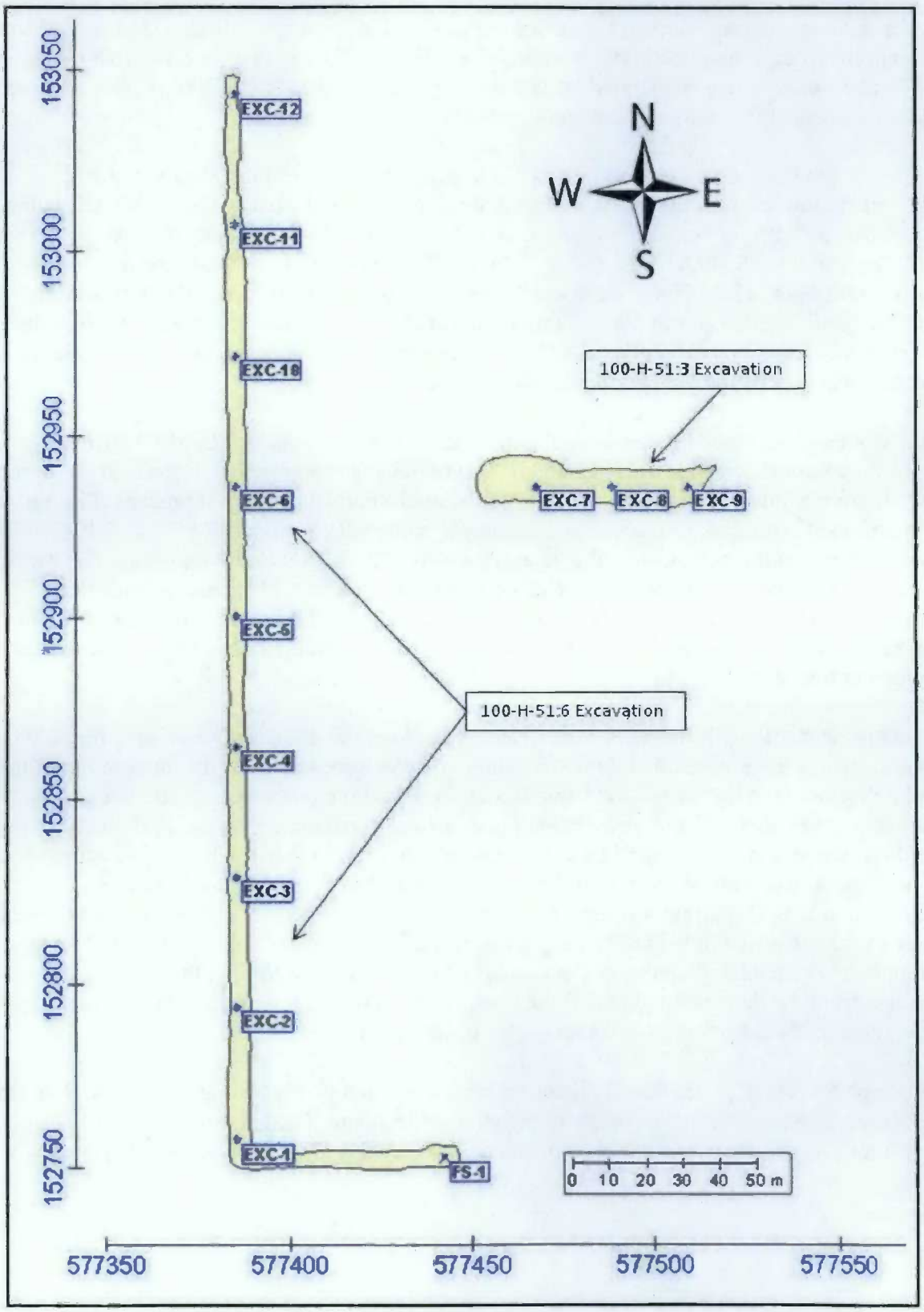
Table 4. 100-H-51:3 and 100-H-51:6 Subsites Verification Sample Summary Table.

Sample Location	HEIS Sample Number	WSP Northing (m)	WSP Easting (m)	Sample Analysis
EXC-1	J1TX47	152758.0	577385.5	ICP metals [a], mercury, hexavalent chromium, PAH
EXC-2	J1TX48	152793.6	577385.5	
EXC-3	J1TX49	152829.3	577385.5	
EXC-4	J1TX50	152865.0	577385.5	
EXC-5	J1TX51	152900.6	577385.5	
EXC-6	J1TX52	152936.3	577385.5	
EXC-7	J1TX53	152936.3	577467.8	
EXC-8	J1TX54	152936.3	577488.4	
EXC-9	J1TX55	152936.3	577509.0	
EXC-10	J1TX56	152971.9	577385.5	
EXC-11	J1TX57	153011.3	577385.3	
EXC-12	J1TX58	153043.3	577385.5	
Duplicate of FS-1	J1TX59	152753.1	577442.6	
FS-1	J1TX60	152753.1	577442.6	
Equipment blank	J1TX61	NA	NA	ICP metals [a], mercury

[a] 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
FS = focused sample
HEIS = Hanford Environmental Information System
ICP = inductively coupled plasma
NA = not applicable
PAH = polycyclic aromatic hydrocarbons
WSP = Washington State Plane

Figure 9. 100-H-51:3 and 100-H-51:6 Subsites Verification Sample Locations.



Verification Sample Results

All verification samples were collected for full protocol laboratory analysis and analyzed using EPA-approved analytical methods. Evaluation of the verification data from the 100-H-51:3 and 100-H-51:6 subsites was performed by direct comparison of the statistical or maximum sample results for each COPC against the cleanup criteria.

The primary statistical calculation to evaluate compliance with cleanup standards is the 95% upper confidence limit (UCL) on the arithmetic mean of the data. The 95% UCL values for each detected COPC are computed for the 100-H-51:3 and 100-H-51:6 decision unit as specified by the 100 Area RDR/RAWP (DOE-RL 2009b). The calculations are provided in Appendix C. When a nonradionuclide COPC was detected in fewer than 50% of the verification samples collected for the decision unit, the maximum detected value was used for comparison to the RAGs. If no detections for a given COPC were reported in the data set, then no statistical calculation or evaluation was performed for that COPC.

Comparisons of the results for each COPC from the 100-H-51:3 and 100-H-51:6 subsites against the RAGs are summarized in Tables 5 and 6. 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 tables.

Polycyclic aromatic hydrocarbons were detected in the verification samples above the RAGs; however, it was determined that the PAH sample results were related to the tar coating on the pipelines rather than the 100-H-51:3 and 100-H-51:6 pipeline processes. A site walkdown was conducted in October 2014 to observe the pipelines and surrounding area after the verification sampling results showed elevated PAHs above remedial action goals. The walkdown attendees included personnel from Washington Closure Hanford, Washington State Department of Ecology, and U.S. Department of Energy, Richland Operations Office. The consensus was that the exceedances were not related to the pipeline processes, and were likely attributed to asphaltic material and/or chunks of coal in and around the excavations. Therefore, the PAH analyses were excluded from the data evaluation and the comparison tables. The PAH results are presented in Attachment 1 of the 95% UCL calculation for information.

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 95% UCL calculations (Appendix C).

Table 5. Comparison of Contaminant Concentrations to Action Levels for the 100-H-51:3 and 100-H-51:6 Subsites Statistical Verification Samples.

COPC	Statistical or Maximum Result [b] (mg/kg)	Remedial Action Goals (mg/kg) [a]			Does the Result Exceed RAGs?	Does the Result Pass RESRAD Modeling?
		Direct Exposure	Soil Cleanup Level for Groundwater Protection	Soil Cleanup Level for River Protection		
Arsenic	9.3	20 [c]	20 [c]	20 [d]	No	--
Barium	211	5,600	200	400	Yes	Yes [d]
Beryllium	0.35 (<BG)	10.4 [e]	1.51 [c]	1.51 [c]	No	--
Boron [f]	47.3	7,200	320	-- [g]	No	--
Cadmium [h]	0.055 (<BG)	13.9 [e]	0.81 [c]	0.81 [c]	No	--
Chromium	27.8	80,000	18.5 [c]	18.5 [c]	Yes	Yes [d]
Cobalt	8.3 (<BG)	24	15.7 [c]	-- [g]	No	--
Copper	62.5	2,960	59.2	22.0 [c]	Yes	Yes [d]
Lead	10.9	353	10.2 [c]	10.2 [c]	Yes	Yes [d]
Manganese	450 (<BG)	3,760	512 [c]	512 [c]	No	--
Mercury	0.018 (<BG)	24	0.33 [c]	0.33 [c]	No	--
Molybdenum [f]	3.5	400	8	-- [g]	No	--
Nickel	39.0	1,600	19.1 [c]	27.4	Yes	Yes [d]
Selenium [h]	0.81	400	5	1	No	--
Silver	0.22 (<BG)	400	8	0.73 [c]	No	--
Vanadium	41.5 (<BG)	560	85.1 [c]	-- [g]	No	--
Zinc	41.9 (<BG)	24,000	480	67.8 [c]	No	--

[a] RAGs obtained from the 100 Area RDR/RAWP (DOE-RL 2009b).

[b] Maximum or 95% upper confidence limit, depending on data censorship, as described in the *100-H-51:3 and 100-H-51:6 Subsites Cleanup Verification 95% UCL Calculation* (Appendix C).

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

[d] Based on RESRAD modeling discussed in Appendix C of the 100 Area RDR/RAWP (DOE-RL 2009b), the residual concentrations of barium, chromium, copper, lead, and nickel are not predicted to migrate more than 2.6 m (8.5 ft) vertically within 1,000 years (based on the lowest soil-partitioning coefficient [Kd] of the contaminants [copper with a Kd of 22 mL/g]). The vadose zone beneath the 100-H-51:3 and 100-H-51:6 subsites is approximately 9 m (30 ft) thick. Therefore, the residual concentration of barium, chromium, copper, lead, and nickel are predicted to be protective of groundwater and the Columbia River.

[e] Carcinogenic cleanup level calculated based on the inhalation exposure pathway (WAC 173-340-750[3], 1996).

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

[g] No parameters (bioconcentration factors or ambient water quality criteria values) are available from the Washington State Department of Ecology Cleanup Levels and Risk Calculations database or other databases to calculate cleanup levels (WAC 173-340-730[3][a][iii], 1996 [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).

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

Table 6. Comparison of Contaminant Concentrations to Action Levels for the 100-H-51:6 Focused Verification Sample.

COPC	Maximum Result [b] (mg/kg)	Remedial Action Goals (mg/kg) [a]			Does the Result Exceed RAGs?	Does the Result Pass RESRAD Modeling?
		Direct Exposure	Soil Cleanup Level for Groundwater Protection	Soil Cleanup Level for River Protection		
Arsenic	4.3 (<BG)	20 [c]	20 [c]	20 [c]	No	--
Barium	109 (<BG)	5,600	200	400	No	--
Beryllium	0.28 (<BG)	10.4 [d]	1.51 [c]	1.51 [c]	No	--
Boron [e]	9.3	7,200	320	-- [f]	No	--
Chromium	11.4 (<BG)	80,000	18.5 [c]	18.5 [c]	No	--
Cobalt	7.2 (<BG)	24	15.7 [c]	-- [f]	No	--
Copper	14.4 (<BG)	2,960	59.2	22.0 [c]	No	--
Lead	7.6 (<BG)	353	10.2 [c]	10.2 [c]	No	--
Manganese	321 (<BG)	3,760	512 [c]	512 [c]	No	--
Mercury	0.0099 (<BG)	24	0.33 [c]	0.33 [c]	No	--
Nickel	15.0 (<BG)	1,600	19.1 [c]	27.4	No	--
Vanadium	43.0 (<BG)	560	85.1 [c]	-- [f]	No	--
Zinc	41.1 (<BG)	24,000	480	67.8 [c]	No	--

[a] RAGs obtained from the 100 Area RDR/RAWP (DOE-RL 2009b).
[b] Maximum result as described in the *100-H-51:3 and 100-H-51:6 Subsites Cleanup Verification 95% UCL Calculations* (Appendix C).
[c] Where cleanup levels are less than background, cleanup levels default to background per WAC 173-340-700(4)(d) (1996). 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).
[d] Carcinogenic cleanup level calculated based on the inhalation exposure pathway (WAC 173-340-750[3], 1996).
[e] No Hanford Site-specific or Washington State background value available.
[f] No parameters (bioconcentration factors or ambient water quality criteria values) are available from the Washington State Department of Ecology Cleanup Levels and Risk Calculations database or other databases to calculate cleanup levels (WAC 173-340-730[3][a][iii], 1996 [Method B for surface waters]).

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

DATA EVALUATION

This section demonstrates that contaminant concentrations at the 100-H-51:3 and 100-H-51:6 subsites 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 5 and 6 compare the cleanup verification sample values for the 100-H-51:3 and 100-H-51:6 subsites excavation 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 barium, chromium, copper, lead, and nickel. Given the lowest soil-partitioning coefficient (K_d) of these contaminants (copper) of 22 mL/g, none would be expected to migrate more than 2.6 m (8.5 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-51:3 and 100-H-51:6 subsites is approximately 9 m (30 ft) thick.

Antimony was detected in two samples; one result exceeded RAGs for groundwater and river protection. All other antimony results were undetected. The antimony detections are believed to be the result of heterogeneity in the sample matrix. Therefore, both samples were reanalyzed; antimony was undetected in each. The results from the reanalysis are used for the site evaluation.

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% UCL value must be less than the cleanup level, (2) no single detection shall exceed two times the cleanup criteria, and (3) the percentage of samples exceeding the cleanup criteria must be less than 10% of the data set.

The application of the three-part test for the 100-H-51:3 and 100-H-51:6 subsites is included in the *100-H-51:3 and 100-H-51:6 Subsites 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 barium, chromium, copper, lead, and nickel, which fail 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 barium, chromium, copper, lead and nickel are not predicted to migrate more than 2.6 m (8.5 ft) vertically within 1,000 years (based on the lowest soil-partitioning coefficient [K_d] of the contaminants [copper with a K_d of 22 mL/g]). The vadose zone beneath the 100-H-51:3 and 100-H-51:6 subsites is approximately 9 m (30 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 with the exception of antimony, which fails two parts of the three-part test to be protective of groundwater and the Columbia River. Antimony was elevated in two samples; one result exceeded RAGs for groundwater and river protection. The antimony detections are attributed to heterogeneity in the sample matrix. Both detected samples were reanalyzed and antimony was not detected. The original elevated antimony results are concluded not to represent sufficient contaminant mass to present a threat to groundwater.

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-51:3 and 100-H-51:6 subsites, 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 1.0×10^{-1}, which is less than 1.0. No carcinogenic constituents met the criteria for excess cancer risk evaluation; therefore, no calculations were performed. The 100-H-51:3 and 100-H-51:6 subsites meet the requirements for the direct contact hazard quotient and excess carcinogenic risk as identified in the 100 Area RDR/RAWP (DOE-RL 2009b).

Nonradionuclide Groundwater Hazard Quotient and Carcinogenic Risk RAGs Attained

Assessment of the risk requirements for the 100-H-51:3 and 100-H-51:6 subsites 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 9 m (30 ft) in thickness, a K_d of 7.9 mL/g or greater is required to show no predicted migration to groundwater in 1,000 years. All individual hazard quotients for noncarcinogenic constituents are less than 1.0. The cumulative hazard quotient for the 100-H-51:3 and 100-H-51:6 subsites is 3.1×10^{-1}, which is less than 1.0. No carcinogenic constituents met the criteria for groundwater protection evaluation at the 100-H-51:3 and 100-H-51:6 subsites; 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-51:3 and 100-H-51:6 subsites 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-51:3 and 100-H-51:6 subsites have been evaluated in accordance with the Remaining Sites ROD (EPA 1999) and the 100 Area RDR/RAWP (DOE-RL 2009b). Verification sampling was performed, and the analytical results indicate that the residual concentrations of COPCs at the site meet the remedial action objectives for direct exposure, groundwater protection, and river protection.

In accordance with this evaluation, the verification sampling results support a reclassification of the 100-H-51:3 and 100-H-51:6 subsites to Interim Closed Out. Contamination above direct exposure levels was not observed in the shallow zone soils and is concluded to not exist in deep zone soils. Institutional controls to prevent uncontrolled drilling or excavation into the deep zone of the sites are not required.

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APPENDIX A

ECOLOGICAL RISK COMPARISON TABLE

Table A-1. Maximum Contaminant Concentrations that Exceed Ecological Screening Levels for the 100-H-51:3 and 100-H-51:6 Subsites [a].

Hazardous Substance		2001 WAC 173-340 Table 749-3			EPA Ecological Soil Screening Levels [b]				Maximum Result
		Plants	Soil Biota	Wildlife	Plants	Soil Biota	Avian [c]	Mammalian [c]	
	Background	Metals (mg/kg)							
Arsenic	6.5	NA	NA	7	18	NA	43	46	9.3
Barium	132	500	NA	102	NA	330	NA	2,000	211
Boron	NA	0.5	NA	NA	NA	NA	NA	NA	47.3
Chromium (total)	18.5	42	42	67	NA	NA	26	34	27.8
Copper	22.0	100	50	217	70	80	28	49	62.5
Manganese	512	1,100 [d]	NA	1,500	220	450	4,300	4,000	450 (<BG)
Molybdenum	NA	2	NA	7	NA	NA	NA	NA	3.5
Nickel	19.1	30	200	980	38	280	210	130	39.0
Selenium	0.78	1	70	0.3	0.52	4.1	1.2	0.63	0.81
Vanadium	85.1	2	NA	NA	NA	NA	7.8	280	43.0 (<BG)

NOTE: Shaded cells indicate screening values that are exceeded.

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

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

[c] Wildlife.

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

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

APPENDIX B

CONFIRMATORY SAMPLE DATA

APPENDIX B

CONFIRMATORY SAMPLE DATA

Table B-1. 100-H-51:3 Confirmatory Sampling Results. (2 Pages)

Site Code	Sample Number	Sample Date/Time	Northing	Easting	Aluminum			Antimony			Arsenic			Barium		
					mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
100-H-51:3	J1C360	10/5/2010 8:10	152936	577456	8610		4.07	0.489	U	0.49	6.62		0.82	77.8		0.41
100-H-51:3	J1C361	10/5/2010 8:15	152936	577456	7850		4.08	0.49	U	0.49	9.62		0.82	73.3		0.41
100-H-51:3	J1C362	10/5/2010 9:30	152936	577492	10300		5.15	0.618	U	0.62	5.4		1.03	85.4		0.52
100-H-51:3	J1C364	10/5/2010 12:15	152936	577527	8210		4.48	0.537	U	0.54	5.39		0.9	76.9		0.45

Site Code	Sample Number	Sample Date/Time	Northing	Easting	Beryllium			Boron			Cadmium			Calcium		
					mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
100-H-51:3	J1C360	10/5/2010 8:10	152936	577456	0.302		0.16	2.83		1.63	0.174		0.16	5760		81.5
100-H-51:3	J1C361	10/5/2010 8:15	152936	577456	0.265		0.16	2.83		1.63	0.146	B	0.16	5050		81.6
100-H-51:3	J1C362	10/5/2010 9:30	152936	577492	0.362		0.21	8.28		2.06	0.175	B	0.21	9680		103
100-H-51:3	J1C364	10/5/2010 12:15	152936	577527	0.291		0.18	9.28		1.79	0.143	B	0.18	7830		89.5

Site Code	Sample Number	Sample Date/Time	Northing	Easting	Chromium			Cobalt			Copper			Hexavalent Chromium		
					mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
100-H-51:3	J1C360	10/5/2010 8:10	152936	577456	18.9		0.16	6.03		1.63	15.5		0.82	0.51	U	0.51
100-H-51:3	J1C361	10/5/2010 8:15	152936	577456	17.2		0.16	5.5		1.63	15.2		0.82	0.51	U	0.51
100-H-51:3	J1C362	10/5/2010 9:30	152936	577492	19.8		0.21	6.88		2.06	14.4		1.03	0.52	U	0.52
100-H-51:3	J1C364	10/5/2010 12:15	152936	577527	16.2		0.18	6.2		1.79	13.5		0.9	0.53	U	0.53

Site Code	Sample Number	Sample Date/Time	Northing	Easting	Iron			Lead			Magnesium			Manganese		
					mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
100-H-51:3	J1C360	10/5/2010 8:10	152936	577456	17900		16.3	8.13		0.41	5720		61.1	272		4.07
100-H-51:3	J1C361	10/5/2010 8:15	152936	577456	16400		16.3	7.43		0.41	5070		61.2	232		4.08
100-H-51:3	J1C362	10/5/2010 9:30	152936	577492	19200		20.6	6.1		0.52	6860		77.3	308		5.15
100-H-51:3	J1C364	10/5/2010 12:15	152936	577527	17700		17.9	7.71		0.45	5550		67.1	264		4.48

Site Code	Sample Number	Sample Date/Time	Northing	Easting	Mercury			Molybdenum			Nickel			Potassium		
					mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
100-H-51:3	J1C360	10/5/2010 8:10	152936	577456	0.024	U	0.02	0.306	B	1.63	15.8		3.26	912		326
100-H-51:3	J1C361	10/5/2010 8:15	152936	577456	0.027	U	0.03	0.257	B	1.63	14.5		3.27	846		327
100-H-51:3	J1C362	10/5/2010 9:30	152936	577492	0.026	U	0.03	0.273	B	2.06	16.9		4.12	1790		412
100-H-51:3	J1C364	10/5/2010 12:15	152936	577527	0.269		0.03	0.281	B	1.79	14.3		3.58	1130		358

Site Code	Sample Number	Sample Date/Time	Northing	Easting	Selenium			Silicon			Silver			Sodium		
					mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
100-H-51:3	J1C360	10/5/2010 8:10	152936	577456	0.244	U	0.24	501		1.63	0.163	U	0.16	769		40.7
100-H-51:3	J1C361	10/5/2010 8:15	152936	577456	0.245	U	0.25	408		1.63	0.163	U	0.16	759		40.8
100-H-51:3	J1C362	10/5/2010 9:30	152936	577492	0.309	U	0.31	610		2.06	0.206	U	0.21	326		51.5
100-H-51:3	J1C364	10/5/2010 12:15	152936	577527	0.269	U	0.27	486		1.79	0.179	U	0.18	227		44.8

Site Code	Sample Number	Sample Date/Time	Northing	Easting	Vanadium			Zinc		
					mg/kg	Q	PQL	mg/kg	Q	PQL
100-H-51:3	J1C360	10/5/2010 8:10	152936	577456	37.4		2.04	82.8		8.15
100-H-51:3	J1C361	10/5/2010 8:15	152936	577456	33.7		2.04	76		8.16
100-H-51:3	J1C362	10/5/2010 9:30	152936	577492	40.5		2.58	45.9		10.3
100-H-51:3	J1C364	10/5/2010 12:15	152936	577527	39.4		2.24	50.4		8.95

Table B-1. 100-H-51:3 Confirmatory Sampling Results. (2 Pages)

Site Code	Sample Number	Sample Date/Time	Northing	Easting	Bromide			Chloride			Fluoride		
					mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
100-H-51:3	J1C360	10/5/2010 8:10	152936	577456	4.1	U	4.1	14.1		4.1	2.5		4.1
100-H-51:3	J1C361	10/5/2010 8:15	152936	577456	5	U	5	14.7		5	2.5		5
100-H-51:3	J1C362	10/5/2010 9:30	152936	577492	4.1	U	4.1	7.6		4.1	1.2	B	4.1
100-H-51:3	J1C364	10/5/2010 12:15	152936	577527	4.7	U	4.7	0.9		4.7	4.7	U	4.7

Site Code	Sample Number	Sample Date/Time	Northing	Easting	Nitrate			Nitrite			Nitrogen in Nitrite and Nitrate		
					mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
100-H-51:3	J1C360	10/5/2010 8:10	152936	577456	4.1	U	4.1	4.1	U	4.1	0.29	B	0.41
100-H-51:3	J1C361	10/5/2010 8:15	152936	577456	5	U	5	5	U	5	0.38	B	0.5
100-H-51:3	J1C362	10/5/2010 9:30	152936	577492	4.1	U	4.1	4.1	U	4.1	0.12	B	0.41
100-H-51:3	J1C364	10/5/2010 12:15	152936	577527	4.7	U	4.7	4.7	U	4.7	0.65		0.47

Site Code	Sample Number	Sample Date/Time	Northing	Easting	Phosphate			Sulfate			Percent Solids		
					mg/kg	Q	PQL	mg/kg	Q	PQL	%	Q	PQL
100-H-51:3	J1C360	10/5/2010 8:10	152936	577456	8.1	U	8.1	44.3		4.1	97.4		0.1
100-H-51:3	J1C361	10/5/2010 8:15	152936	577456	10	U	10	44.3		5	97.2		0.1
100-H-51:3	J1C362	10/5/2010 9:30	152936	577492	8.1	U	8.1	459	D	90.8	97.1		0.1
100-H-51:3	J1C364	10/5/2010 12:15	152936	577527	9.4	U	9.4	506	D	49.6	94.7		0.1

SAMPLE NUMBER		J1C360			J1C361			J1C362			J1C364		
LOCATION		100-H-51:3			100-H-51:3			100-H-51:3			100-H-51:3		
CONSTITUENT	CLASS	10/05/10 08:10 AM			10/05/10 08:15 AM			10/05/10 09:30 AM			10/05/10 12:15 PM		
		ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
Acenaphthene	PAH	29200	D	1020	897	D	6.76	3.37	U	3.37	3120	D	34.1
Acenaphthylene	PAH	361	JD	1020	108	D	6.76	45.8		3.37	301	D	34.1
Anthracene	PAH	7240	D	1020	189	D	6.76	1.18	J	3.37	577	D	34.1
Benzo(a)anthracene	PAH	13800	D	1020	489	D	6.76	0.895	J	3.37	2040	D	34.1
Benzo(a)pyrene	PAH	20800	D	1020	696	D	6.76	3.37	U	3.37	2590	D	34.1
Benzo(b)fluoranthene	PAH	17700	D	1020	593	D	6.76	3.37	U	3.37	2360	D	34.1
Benzo(ghi)perylene	PAH	1020	UD	1020	6.76	UD	6.76	3.37	U	3.37	34.1	UD	34.1
Benzo(k)fluoranthene	PAH	8940	D	1020	292	D	6.76	3.37	U	3.37	1120	D	34.1
Chrysene	PAH	11500	D	1020	399	D	6.76	3.37	U	3.37	1680	D	34.1
Dibenz[a,h]anthracene	PAH	1020	UD	1020	6.76	UD	6.76	3.37	U	3.37	34.1	UD	34.1
Fluoranthene	PAH	39600	D	1020	1290	D	6.76	3.37	U	3.37	5730	D	34.1
Fluorene	PAH	3690	D	1020	87.6	D	6.76	3.37	U	3.37	175	D	34.1
Indeno(1,2,3-cd)pyrene	PAH	1020	UD	1020	6.76	UD	6.76	3.37	U	3.37	34.1	UD	34.1
Naphthalene	PAH	4680	D	1020	148	D	6.76	3.37	U	3.37	351	D	34.1
Phenanthrene	PAH	27900	D	1020	755	D	6.76	1.69	J	3.37	2210	D	34.1
Pyrene	PAH	29300	D	1020	1830	D	6.76	3.37	U	3.37	6870	D	34.1

Table B-2. 100-H-51:6 Confirmatory Sampling Results. (5 Pages)

Site Code	Sample Number	Sample Date/Time	Sample Area	Northing	Easting	Aluminum			Antimony			Arsenic		
						mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
100-H-51:6	J1CNV8	11/15/2010 7:45	EB Tie To J1CNV9			213		4.46	0.536	U	0.54	0.893	U	0.89
100-H-51:6	J1CNV9	11/15/2010 8:30	AREA 4	153064	577385	5670		3.52	0.363	B	0.42	2.77		0.71
100-H-51:6	J1CNW0	11/15/2010 8:30	Duplicate of J1CNV9	153064	577385	5510		3.63	0.503		0.44	2.3		0.73
100-H-51:6	J1CNW1	11/15/2010 9:10	AREA 3	153064	577378	7560		5.34	0.641	U	0.64	2.85		1.07
100-H-51:6	J1CNW2	11/15/2010 9:30	AREA 5	153064	577392	6360		4.08	0.49	U	0.49	2.92		0.82
100-H-51:6	J1CNX1	11/15/2010 12:40	AREA 4	153064	577385	554		28.8	3.46	U	3.46	19.8		5.77
100-H-51:6	J1CNX5	11/15/2010 12:40	AREA 4	153064	577385									
100-H-51:6	J1JW30	6/20/2011 14:50	AREA 7	152830	577386	4840		3.7	0.444	U	0.44	2.07		0.74
100-H-51:6	J1JW31	6/20/2011 15:30	AREA 8	152998	577385	7060		4.09	0.491	U	0.49	2.34		0.82
100-H-51:6	J1JW32	6/21/2011 8:05	AREA 7	152830	577386	398		58.8	11.2		7.06	40.4		11.8
100-H-51:6	J1JW33	6/21/2011 9:40	AREA 8	152998	577385	1020		60	46.8		7.2	63.2		12

Site Code	Sample Number	Sample Date/Time	Sample Area	Northing	Easting	Barium			Beryllium			Boron		
						mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
100-H-51:6	J1CNV8	11/15/2010 7:45	EB Tie To J1CNV9			2.35		0.45	0.047	B	0.18	1.79	U	1.79
100-H-51:6	J1CNV9	11/15/2010 8:30	AREA 4	153064	577385	52.9		0.35	0.215		0.14	1.36	B	1.41
100-H-51:6	J1CNW0	11/15/2010 8:30	Duplicate of J1CNV9	153064	577385	54.9		0.36	0.221		0.15	1.42	B	1.45
100-H-51:6	J1CNW1	11/15/2010 9:10	AREA 3	153064	577378	86.6		0.53	0.294		0.21	4.19		2.14
100-H-51:6	J1CNW2	11/15/2010 9:30	AREA 5	153064	577392	232		0.41	0.32		0.16	12.2		1.63
100-H-51:6	J1CNX1	11/15/2010 12:40	AREA 4	153064	577385	52.3		2.88	1.15	U	1.15	11.5	U	11.5
100-H-51:6	J1CNX5	11/15/2010 12:40	AREA 4	153064	577385									
100-H-51:6	J1JW30	6/20/2011 14:50	AREA 7	152830	577386	68.2		0.37	0.186		0.15	2.88		1.48
100-H-51:6	J1JW31	6/20/2011 15:30	AREA 8	152998	577385	56.1		0.41	0.226		0.16	1.73		1.64
100-H-51:6	J1JW32	6/21/2011 8:05	AREA 7	152830	577386	36.3		5.88	2.35	U	2.35	23.5	U	23.5
100-H-51:6	J1JW33	6/21/2011 9:40	AREA 8	152998	577385	42.3		6	2.4	U	2.4	24	U	24

Site Code	Sample Number	Sample Date/Time	Sample Area	Northing	Easting	Cadmium			Calcium			Chromium		
						mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
100-H-51:6	J1CNV8	11/15/2010 7:45	EB Tie To J1CNV9			0.179	U	0.18	48.1	B	89.3	0.179	U	0.18
100-H-51:6	J1CNV9	11/15/2010 8:30	AREA 4	153064	577385	0.155		0.14	5430		70.5	9.79		0.14
100-H-51:6	J1CNW0	11/15/2010 8:30	Duplicate of J1CNV9	153064	577385	0.091	B	0.15	5370		72.7	8.55		0.15
100-H-51:6	J1CNW1	11/15/2010 9:10	AREA 3	153064	577378	0.135	B	0.21	3910		107	9.9		0.21
100-H-51:6	J1CNW2	11/15/2010 9:30	AREA 5	153064	577392	0.11	B	0.16	5600		81.7	7.14		0.16
100-H-51:6	J1CNX1	11/15/2010 12:40	AREA 4	153064	577385	2.04		1.15	2480		577	37.7		1.15
100-H-51:6	J1CNX5	11/15/2010 12:40	AREA 4	153064	577385									
100-H-51:6	J1JW30	6/20/2011 14:50	AREA 7	152830	577386	0.111	B	0.15	5450		74.1	5.61		0.15
100-H-51:6	J1JW31	6/20/2011 15:30	AREA 8	152998	577385	0.124	B	0.16	4970		81.8	10.5		0.16
100-H-51:6	J1JW32	6/21/2011 8:05	AREA 7	152830	577386	1.76	B	2.35	3100		1180	77		2.35
100-H-51:6	J1JW33	6/21/2011 9:40	AREA 8	152998	577385	1.59	B	2.4	5590		1200	223		2.4

Site Code	Sample Number	Sample Date/Time	Sample Area	Northing	Easting	Cobalt			Copper			Hexavalent Chromium		
						mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
100-H-51:6	J1CNV8	11/15/2010 7:45	EB Tie To J1CNV9			1.79	U	1.79	0.893	U	0.89			
100-H-51:6	J1CNV9	11/15/2010 8:30	AREA 4	153064	577385	5.33		1.41	17.2		0.71	0.51	U	0.51
100-H-51:6	J1CNW0	11/15/2010 8:30	Duplicate of J1CNV9	153064	577385	5.22		1.45	14.7		0.73	0.51	U	0.51
100-H-51:6	J1CNW1	11/15/2010 9:10	AREA 3	153064	577378	5.71		2.14	11.6		1.07	0.54	U	0.54
100-H-51:6	J1CNW2	11/15/2010 9:30	AREA 5	153064	577392	4.77		1.63	16.7		0.82	0.57	U	0.57
100-H-51:6	J1CNX1	11/15/2010 12:40	AREA 4	153064	577385	11.3	B	11.5	108		5.77			
100-H-51:6	J1CNX5	11/15/2010 12:40	AREA 4	153064	577385							0.15	U	0.15
100-H-51:6	J1JW30	6/20/2011 14:50	AREA 7	152830	577386	5.73		1.48	13		0.74	0.53	U	0.53
100-H-51:6	J1JW31	6/20/2011 15:30	AREA 8	152998	577385	5.26		1.64	12		0.82	0.52	U	0.52
100-H-51:6	J1JW32	6/21/2011 8:05	AREA 7	152830	577386	26.5		23.5	294		11.8			
100-H-51:6	J1JW33	6/21/2011 9:40	AREA 8	152998	577385	17	B	24	484		12			
100-H-51:6	J1JW34	6/21/2011 8:05	AREA 7	152830	577386							1.05		0.15
100-H-51:6	J1JW35	6/21/2011 9:40	AREA 8	152998	577385							1.52		0.15

Site Code	Sample Number	Sample Date/Time	Sample Area	Northing	Easting	Iron			Lead			Magnesium		
						mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
100-H-51:6	J1CNV8	11/15/2010 7:45	EB Tie To J1CNV9			313		17.9	0.447		0.45	29.4	B	67
100-H-51:6	J1CNV9	11/15/2010 8:30	AREA 4	153064	577385	24500		14.1	2.94		0.35	3750		52.9
100-H-51:6	J1CNW0	11/15/2010 8:30	Duplicate of J1CNV9	153064	577385	19000		14.5	2.79		0.36	3640		54.5
100-H-51:6	J1CNW1	11/15/2010 9:10	AREA 3	153064	577378	16600		21.4	4.73		0.53	3970		80.1
100-H-51:6	J1CNW2	11/15/2010 9:30	AREA 5	153064	577392	12500		16.3	3.49		0.41	3280		61.2
100-H-51:6	J1CNX1	11/15/2010 12:40	AREA 4	153064	577385	453000		462	2.88	U	2.88	465		433
100-H-51:6	J1CNX5	11/15/2010 12:40	AREA 4	153064	577385									
100-H-51:6	J1JW30	6/20/2011 14:50	AREA 7	152830	577386	18900		14.8	3.76		0.37	3380		55.6
100-H-51:6	J1JW31	6/20/2011 15:30	AREA 8	152998	577385	17600		16.4	3.64		0.41	3880		61.3
100-H-51:6	J1JW32	6/21/2011 8:05	AREA 7	152830	577386	450000		235	13.3		5.88	260	B	882
100-H-51:6	J1JW33	6/21/2011 9:40	AREA 8	152998	577385	400000		240	15.3		6	512	B	900

Table B-2. 100-H-51:6 Confirmatory Sampling Results. (5 Pages)

Site Code	Sample Number	Sample Date/Time	Sample Area	Northing	Easting	Manganese			Mercury			Molybdenum		
						mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
100-H-51:6	J1CNV8	11/15/2010 7:45	EB Tie To J1CNV9			6.16		4.46	0.025	U	0.03	1.79	U	1.79
100-H-51:6	J1CNV9	11/15/2010 8:30	AREA 4	153064	577385	261		3.52	0.025	U	0.03	0.8	B	1.41
100-H-51:6	J1CNW0	11/15/2010 8:30	Duplicate of J1CNV9	153064	577385	241		3.63	0.025	U	0.03	0.537	B	1.45
100-H-51:6	J1CNW1	11/15/2010 9:10	AREA 3	153064	577378	278		5.34	0.029	U	0.03	0.399	B	2.14
100-H-51:6	J1CNW2	11/15/2010 9:30	AREA 5	153064	577392	177		4.08	0.012	B	0.03	0.61	B	1.63
100-H-51:6	J1CNX1	11/15/2010 12:40	AREA 4	153064	577385	738		28.8	0.023	U	0.02	18.1		11.5
100-H-51:6	J1CNX5	11/15/2010 12:40	AREA 4	153064	577385									
100-H-51:6	J1JW30	6/20/2011 14:50	AREA 7	152830	577386	235		3.7	0.028	U	0.03	0.311	B	1.48
100-H-51:6	J1JW31	6/20/2011 15:30	AREA 8	152998	577385	278		4.09	0.009	B	0.03	0.296	B	1.64
100-H-51:6	J1JW32	6/21/2011 8:05	AREA 7	152830	577386	1480		58.8	0.027	U	0.03	26.1		23.5
100-H-51:6	J1JW33	6/21/2011 9:40	AREA 8	152998	577385	1740		60	0.028	U	0.03	43.5		24

Site Code	Sample Number	Sample Date/Time	Sample Area	Northing	Easting	Nickel			Potassium			Selenium		
						mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
100-H-51:6	J1CNV8	11/15/2010 7:45	EB Tie To J1CNV9			3.57	U	3.57	48.2	B	357	0.268	U	0.27
100-H-51:6	J1CNV9	11/15/2010 8:30	AREA 4	153064	577385	13.6		2.82	779		282	0.211	U	0.21
100-H-51:6	J1CNW0	11/15/2010 8:30	Duplicate of J1CNV9	153064	577385	10.6		2.91	754		291	0.218	U	0.22
100-H-51:6	J1CNW1	11/15/2010 9:10	AREA 3	153064	577378	9.79		4.27	1660		427	0.32	U	0.32
100-H-51:6	J1CNW2	11/15/2010 9:30	AREA 5	153064	577392	8.75		3.27	996		327	0.245	U	0.25
100-H-51:6	J1CNX1	11/15/2010 12:40	AREA 4	153064	577385	277		23.1	2310	U	2310	1.73	U	1.73
100-H-51:6	J1CNX5	11/15/2010 12:40	AREA 4	153064	577385									
100-H-51:6	J1JW30	6/20/2011 14:50	AREA 7	152830	577386	8.82		2.96	601		296	0.222	U	0.22
100-H-51:6	J1JW31	6/20/2011 15:30	AREA 8	152998	577385	10.4		3.27	1060		327	0.245	U	0.25
100-H-51:6	J1JW32	6/21/2011 8:05	AREA 7	152830	577386	472		47.1	4710	U	4710	3.53	U	3.53
100-H-51:6	J1JW33	6/21/2011 9:40	AREA 8	152998	577385	248		48	292	B	4800	3.6	U	3.6

Site Code	Sample Number	Sample Date/Time	Sample Area	Northing	Easting	Silicon			Silver			Sodium		
						mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
100-H-51:6	J1CNV8	11/15/2010 7:45	EB Tie To J1CNV9			154		1.79	0.179	U	0.18	13.5	B	44.6
100-H-51:6	J1CNV9	11/15/2010 8:30	AREA 4	153064	577385	389		1.41	0.141	U	0.14	168		35.2
100-H-51:6	J1CNW0	11/15/2010 8:30	Duplicate of J1CNV9	153064	577385	262		1.45	0.145	U	0.15	176		36.3
100-H-51:6	J1CNW1	11/15/2010 9:10	AREA 3	153064	577378	494		2.14	0.214	U	0.21	206		53.4
100-H-51:6	J1CNW2	11/15/2010 9:30	AREA 5	153064	577392	387		1.63	0.163	U	0.16	297		40.8
100-H-51:6	J1CNX1	11/15/2010 12:40	AREA 4	153064	577385	1920		11.5	1.15	U	1.15	71.2	B	288
100-H-51:6	J1CNX5	11/15/2010 12:40	AREA 4	153064	577385									
100-H-51:6	J1JW30	6/20/2011 14:50	AREA 7	152830	577386	183		1.48	0.148	U	0.15	270		37
100-H-51:6	J1JW31	6/20/2011 15:30	AREA 8	152998	577385	276		1.64	0.164	U	0.16	212		40.9
100-H-51:6	J1JW32	6/21/2011 8:05	AREA 7	152830	577386	398		23.5	2.35	U	2.35	588	U	588
100-H-51:6	J1JW33	6/21/2011 9:40	AREA 8	152998	577385	543		24	2.4	U	2.4	600	U	600

Site Code	Sample Number	Sample Date/Time	Sample Area	Northing	Easting	Vanadium			Zinc		
						mg/kg	Q	PQL	mg/kg	Q	PQL
100-H-51:6	J1CNV8	11/15/2010 7:45	EB Tie To J1CNV9			0.365	B	2.23	1.29	B	8.93
100-H-51:6	J1CNV9	11/15/2010 8:30	AREA 4	153064	577385	43.4		1.76	37.7		7.05
100-H-51:6	J1CNW0	11/15/2010 8:30	Duplicate of J1CNV9	153064	577385	44.4		1.82	33.8		7.27
100-H-51:6	J1CNW1	11/15/2010 9:10	AREA 3	153064	577378	37.7		2.67	35.9		10.7
100-H-51:6	J1CNW2	11/15/2010 9:30	AREA 5	153064	577392	37.1		2.04	26.5		8.17
100-H-51:6	J1CNX1	11/15/2010 12:40	AREA 4	153064	577385	12.3	B	14.4	120		57.7
100-H-51:6	J1CNX5	11/15/2010 12:40	AREA 4	153064	577385						
100-H-51:6	J1JW30	6/20/2011 14:50	AREA 7	152830	577386	49.1		1.85	33.2		7.41
100-H-51:6	J1JW31	6/20/2011 15:30	AREA 8	152998	577385	44.9		2.04	34.4		8.18
100-H-51:6	J1JW32	6/21/2011 8:05	AREA 7	152830	577386	7.78	B	29.4	121		118
100-H-51:6	J1JW33	6/21/2011 9:40	AREA 8	152998	577385	11.4	B	30	119	B	120

Table B-2. 100-H-51:6 Confirmatory Sampling Results. (5 Pages)

Site Code	Sample Number	Sample Date/Time	Sample Area	Northing	Easting	Americium-241			Bismuth-214		
						pCi/g	Q	MDA	pCi/g	Q	MDA
100-H-51:6	J1CNV9	11/15/2010 8:30	AREA 4	153064	577385	0.275	U	0.275			
100-H-51:6	J1CNW0	11/15/2010 8:30	Duplicate of J1CNV9	153064	577385	0.184	U	0.184			
100-H-51:6	J1CNW1	11/15/2010 9:10	AREA 3	153064	577378	0.175	U	0.175			
100-H-51:6	J1CNW2	11/15/2010 9:30	AREA 5	153064	577392	0.382	U	0.382			
100-H-51:6	J1CNX1	11/15/2010 12:40	AREA 4	153064	577385	0.099	U	0.099			
100-H-51:6	J1JW30	6/20/2011 14:50	AREA 7	152830	577386	0.128	U	0.128			
100-H-51:6	J1JW31	6/20/2011 15:30	AREA 8	152998	577385	0.296	U	0.296			
100-H-51:6	J1JW32	6/21/2011 8:05	AREA 7	152830	577386	0.056	U	0.056	0.082		0.027
100-H-51:6	J1JW33	6/21/2011 9:40	AREA 8	152998	577385	0.018	U	0.018	0.131		0.028

Site Code	Sample Number	Sample Date/Time	Sample Area	Northing	Easting	Cesium-137			Cobalt-60		
						pCi/g	Q	MDA	pCi/g	Q	MDA
100-H-51:6	J1CNV9	11/15/2010 8:30	AREA 4	153064	577385	0.061	U	0.061	0.072	U	0.072
100-H-51:6	J1CNW0	11/15/2010 8:30	Duplicate of J1CNV9	153064	577385	0.039	U	0.039	0.039	U	0.039
100-H-51:6	J1CNW1	11/15/2010 9:10	AREA 3	153064	577378	0.077	U	0.077	0.079	U	0.079
100-H-51:6	J1CNW2	11/15/2010 9:30	AREA 5	153064	577392	0.088	U	0.088	0.076	U	0.076
100-H-51:6	J1CNX1	11/15/2010 12:40	AREA 4	153064	577385	0.025	U	0.025	0.023	U	0.023
100-H-51:6	J1JW30	6/20/2011 14:50	AREA 7	152830	577386	0.052	U	0.052	0.045	U	0.045
100-H-51:6	J1JW31	6/20/2011 15:30	AREA 8	152998	577385	0.079	U	0.079	0.079	U	0.079
100-H-51:6	J1JW32	6/21/2011 8:05	AREA 7	152830	577386	0.012	U	0.012	0.013	U	0.013
100-H-51:6	J1JW33	6/21/2011 9:40	AREA 8	152998	577385	0.012	U	0.012	0.015	U	0.015

Site Code	Sample Number	Sample Date/Time	Sample Area	Northing	Easting	Europium-152			Europium-154		
						pCi/g	Q	MDA	pCi/g	Q	MDA
100-H-51:6	J1CNV9	11/15/2010 8:30	AREA 4	153064	577385	0.159	U	0.159	0.186	U	0.186
100-H-51:6	J1CNW0	11/15/2010 8:30	Duplicate of J1CNV9	153064	577385	0.114	U	0.114	0.138	U	0.138
100-H-51:6	J1CNW1	11/15/2010 9:10	AREA 3	153064	577378	0.202	U	0.202	0.206	U	0.206
100-H-51:6	J1CNW2	11/15/2010 9:30	AREA 5	153064	577392	0.225	U	0.225	0.316	U	0.316
100-H-51:6	J1CNX1	11/15/2010 12:40	AREA 4	153064	577385	0.063	U	0.063	0.069	U	0.069
100-H-51:6	J1JW30	6/20/2011 14:50	AREA 7	152830	577386	0.119	U	0.119	0.149	U	0.149
100-H-51:6	J1JW31	6/20/2011 15:30	AREA 8	152998	577385	0.172	U	0.172	0.246	U	0.246
100-H-51:6	J1JW32	6/21/2011 8:05	AREA 7	152830	577386	0.04	U	0.04	0.034	U	0.034
100-H-51:6	J1JW33	6/21/2011 9:40	AREA 8	152998	577385	0.045	U	0.045	0.04	U	0.04

Site Code	Sample Number	Sample Date/Time	Sample Area	Northing	Easting	Europium-155			Lead-212		
						pCi/g	Q	MDA	pCi/g	Q	MDA
100-H-51:6	J1CNV9	11/15/2010 8:30	AREA 4	153064	577385	0.141	U	0.141			
100-H-51:6	J1CNW0	11/15/2010 8:30	Duplicate of J1CNV9	153064	577385	0.13	U	0.13			
100-H-51:6	J1CNW1	11/15/2010 9:10	AREA 3	153064	577378	0.15	U	0.15			
100-H-51:6	J1CNW2	11/15/2010 9:30	AREA 5	153064	577392	0.26	U	0.26			
100-H-51:6	J1CNX1	11/15/2010 12:40	AREA 4	153064	577385	0.07	U	0.07			
100-H-51:6	J1JW30	6/20/2011 14:50	AREA 7	152830	577386	0.123	U	0.123			
100-H-51:6	J1JW31	6/20/2011 15:30	AREA 8	152998	577385	0.17	U	0.17			
100-H-51:6	J1JW32	6/21/2011 8:05	AREA 7	152830	577386	0.046	U	0.046	0.023		0.021
100-H-51:6	J1JW33	6/21/2011 9:40	AREA 8	152998	577385	0.034	U	0.034	0.067		0.023

Site Code	Sample Number	Sample Date/Time	Sample Area	Northing	Easting	Potassium-40			Radium-226		
						pCi/g	Q	MDA	pCi/g	Q	MDA
100-H-51:6	J1CNV9	11/15/2010 8:30	AREA 4	153064	577385	10.9		0.785	0.429		0.134
100-H-51:6	J1CNW0	11/15/2010 8:30	Duplicate of J1CNV9	153064	577385	10.8		0.426	0.421		0.088
100-H-51:6	J1CNW1	11/15/2010 9:10	AREA 3	153064	577378	12.3		0.675	0.567		0.134
100-H-51:6	J1CNW2	11/15/2010 9:30	AREA 5	153064	577392	11.1		0.736	0.455		0.169
100-H-51:6	J1CNX1	11/15/2010 12:40	AREA 4	153064	577385	0.388		0.249	0.147		0.049
100-H-51:6	J1JW30	6/20/2011 14:50	AREA 7	152830	577386	9.84		0.294	0.348		0.088
100-H-51:6	J1JW31	6/20/2011 15:30	AREA 8	152998	577385	12.1		0.584	0.472		0.14
100-H-51:6	J1JW32	6/21/2011 8:05	AREA 7	152830	577386	0.255	U	0.255	0.08		0.026
100-H-51:6	J1JW33	6/21/2011 9:40	AREA 8	152998	577385	0.708		0.166	0.127		0.027

Table B-2. 100-H-51:6 Confirmatory Sampling Results. (5 Pages)

Site Code	Sample Number	Sample Date/Time	Sample Area	Northing	Easting	Radium-228			Thorium-228		
						pCi/g	Q	MDA	pCi/g	Q	MDA
100-H-51:6	J1CNV9	11/15/2010 8:30	AREA 4	153064	577385	0.623		0.262	0.518		0.107
100-H-51:6	J1CNW0	11/15/2010 8:30	Duplicate of J1CNV9	153064	577385	0.632		0.169	0.621		0.09
100-H-51:6	J1CNW1	11/15/2010 9:10	AREA 3	153064	577378	0.908		0.284	0.822		0.09
100-H-51:6	J1CNW2	11/15/2010 9:30	AREA 5	153064	577392	0.913		0.347	0.677		0.11
100-H-51:6	J1CNX1	11/15/2010 12:40	AREA 4	153064	577385	0.111	U	0.111	0.044	U	0.044
100-H-51:6	J1JW30	6/20/2011 14:50	AREA 7	152830	577386	0.47		0.182	0.429		0.06
100-H-51:6	J1JW31	6/20/2011 15:30	AREA 8	152998	577385	0.704		0.32	0.575		0.093
100-H-51:6	J1JW32	6/21/2011 8:05	AREA 7	152830	577386	0.069	U	0.069	0.023		0.02
100-H-51:6	J1JW33	6/21/2011 9:40	AREA 8	152998	577385	0.088		0.05	0.064		0.022

Site Code	Sample Number	Sample Date/Time	Sample Area	Northing	Easting	Thorium-232			Uranium-235		
						pCi/g	Q	MDA	pCi/g	Q	MDA
100-H-51:6	J1CNV9	11/15/2010 8:30	AREA 4	153064	577385	0.623		0.262	0.304	U	0.304
100-H-51:6	J1CNW0	11/15/2010 8:30	Duplicate of J1CNV9	153064	577385	0.632		0.169	0.231	U	0.231
100-H-51:6	J1CNW1	11/15/2010 9:10	AREA 3	153064	577378	0.908		0.284	0.385	U	0.385
100-H-51:6	J1CNW2	11/15/2010 9:30	AREA 5	153064	577392	0.913		0.347	0.461	U	0.461
100-H-51:6	J1CNX1	11/15/2010 12:40	AREA 4	153064	577385	0.111	U	0.111	0.13	U	0.13
100-H-51:6	J1JW30	6/20/2011 14:50	AREA 7	152830	577386	0.47		0.182	0.241	U	0.241
100-H-51:6	J1JW31	6/20/2011 15:30	AREA 8	152998	577385	0.704		0.32	0.332	U	0.332
100-H-51:6	J1JW32	6/21/2011 8:05	AREA 7	152830	577386	0.069	U	0.069	0.119	U	0.119
100-H-51:6	J1JW33	6/21/2011 9:40	AREA 8	152998	577385	0.088		0.05	0.093	U	0.093

Site Code	Sample Number	Sample Date/Time	Sample Area	Northing	Easting	Uranium-238			Gross alpha		
						pCi/g	Q	MDA	pCi/g	Q	MDA
100-H-51:6	J1CNV9	11/15/2010 8:30	AREA 4	153064	577385	6.44	U	6.44	7.89		3.88
100-H-51:6	J1CNW0	11/15/2010 8:30	Duplicate of J1CNV9	153064	577385	5.24	U	5.24	10.6		3.44
100-H-51:6	J1CNW1	11/15/2010 9:10	AREA 3	153064	577378	9.38	U	9.38	5.13		2.98
100-H-51:6	J1CNW2	11/15/2010 9:30	AREA 5	153064	577392	10.9	U	10.9	4.91		3.3
100-H-51:6	J1CNX1	11/15/2010 12:40	AREA 4	153064	577385	3.07	U	3.07	10.2		5.05
100-H-51:6	J1JW30	6/20/2011 14:50	AREA 7	152830	577386	5.67	U	5.67	7.71		2.97
100-H-51:6	J1JW31	6/20/2011 15:30	AREA 8	152998	577385	9.78	U	9.78	6.9		3.07
100-H-51:6	J1JW32	6/21/2011 8:05	AREA 7	152830	577386	2.17	U	2.17	2.71	U	5.31
100-H-51:6	J1JW33	6/21/2011 9:40	AREA 8	152998	577385	1.48	U	1.48	8.83		7.27

Site Code	Sample Number	Sample Date/Time	Sample Area	Northing	Easting	Gross beta		
						pCi/g	Q	MDA
100-H-51:6	J1CNV9	11/15/2010 8:30	AREA 4	153064	577385	18.3		4.95
100-H-51:6	J1CNW0	11/15/2010 8:30	Duplicate of J1CNV9	153064	577385	16.4		7.82
100-H-51:6	J1CNW1	11/15/2010 9:10	AREA 3	153064	577378	18.6		5.24
100-H-51:6	J1CNW2	11/15/2010 9:30	AREA 5	153064	577392	16.4		5.55
100-H-51:6	J1CNX1	11/15/2010 12:40	AREA 4	153064	577385	7.92		5.4
100-H-51:6	J1JW30	6/20/2011 14:50	AREA 7	152830	577386	14.6		5.12
100-H-51:6	J1JW31	6/20/2011 15:30	AREA 8	152998	577385	16.2		5.1
100-H-51:6	J1JW32	6/21/2011 8:05	AREA 7	152830	577386	-0.4	U	5.47
100-H-51:6	J1JW33	6/21/2011 9:40	AREA 8	152998	577385	6.28		5.15

Table B-2. 100-H-51:6 Confirmatory Sampling Results. (5 Pages)

Site Code	Sample Number	Sample Date/Time	Sample Area	Northing	Easting	TPH - Diesel			TPH - motor oil (high boiling)			Percent Solids		
						ug/kg	Q	PQL	ug/kg	Q	PQL	%	Q	PQL
100-H-51:6	J1CNV8	11/15/2010 7:45	EB Tie To J1CNV9									100		0.1
100-H-51:6	J1CNV9	11/15/2010 8:30	AREA 4	153064	577385	3300	U	3300	23900		9910	98.5		0.1
100-H-51:6	J1CNW0	11/15/2010 8:30	Duplicate of J1CNV9	153064	577385	3340	U	3340	36800		10000	98.3		0.1
100-H-51:6	J1CNW1	11/15/2010 9:10	AREA 3	153064	577378	3570	U	3570	29000		10700	91.8		0.1
100-H-51:6	J1CNW2	11/15/2010 9:30	AREA 5	153064	577392	28200		3650	62000		11000	87.5		0.1
100-H-51:6	J1CNX1	11/15/2010 12:40	AREA 4	153064	577385	6290	U	6290	9400	J	18900			
100-H-51:6	J1CNX5	11/15/2010 12:40	AREA 4	153064	577385									
100-H-51:6	J1JW30	6/20/2011 14:50	AREA 7	152830	577386							93.8		0.1
100-H-51:6	J1JW31	6/20/2011 15:30	AREA 8	152998	577385							97.1		0.1
100-H-51:6	J1JW32	6/21/2011 8:05	AREA 7	152830	577386									
100-H-51:6	J1JW33	6/21/2011 9:40	AREA 8	152998	577385									

Sample Number		J1CNV8			J1CNV9			J1CNW0			J1CNW1			J1CNW2		
Location		100-H-51:6			100-H-51:6			Duplicate of			100-H-51:6			100-H-51:6		
Constituent	Class	11/15/10 07:45 AM			11/15/10 08:30 AM			11/15/10 08:30 AM			11/15/10 09:10 AM			11/15/10 09:30 AM		
		ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
Acenaphthene	PAH	3.32	U	3.32	643	D	13.4	463	D	13.2	24.9		3.57	147		3.8
Acenaphthylene	PAH	3.32	U	3.32	35.9	D	13.4	188	D	13.2	3.57	U	3.57	3.8	U	3.8
Anthracene	PAH	3.32	U	3.32	33.3	D	13.4	29	D	13.2	3.57	U	3.57	3.5	J	3.8
Benzo(a)anthracene	PAH	3.32	U	3.32	384	D	13.4	334	D	13.2	0.929	J	3.57	3.8	U	3.8
Benzo(a)pyrene	PAH	3.32	U	3.32	508	D	13.4	454	D	13.2	3.57	U	3.57	3.8	U	3.8
Benzo(b)fluoranthene	PAH	3.32	U	3.32	617	D	13.4	509	D	13.2	3.57	U	3.57	3.8	U	3.8
Benzo(ghi)perylene	PAH	3.32	U	3.32	916	D	13.4	48.8	D	13.2	3.57	U	3.57	2.86	J	3.8
Benzo(k)fluoranthene	PAH	3.32	U	3.32	285	D	13.4	287	D	13.2	3.57	U	3.57	3.8	U	3.8
Chrysene	PAH	3.32	U	3.32	384	D	13.4	467	D	13.2	1.93	J	3.57	153		3.8
Dibenz[a,h]anthracene	PAH	3.32	U	3.32	13.4	UD	13.4	39.1	D	13.2	3.57	U	3.57	3.48	J	3.8
Fluoranthene	PAH	3.32	U	3.32	1510	D	13.4	1260	D	13.2	6.04		3.57	106		3.8
Fluorene	PAH	3.32	U	3.32	32.4	D	13.4	22.3	D	13.2	2.43	J	3.57	50.6		3.8
Indeno(1,2,3-cd)pyrene	PAH	3.32	U	3.32	13.4	UD	13.4	86.1	D	13.2	15.4		3.57	133		3.8
Naphthalene	PAH	3.32	U	3.32	13.4	UD	13.4	13.2	UD	13.2	3.57	U	3.57	24.2		3.8
Phenanthrene	PAH	3.32	U	3.32	543	D	13.4	540	D	13.2	5.02		3.57	95.7		3.8
Pyrene	PAH	3.32	U	3.32	1710	D	13.4	1000	D	13.2	1.61	J	3.57	18.1		3.8
Aroclor-1016	PCB															
Aroclor-1221	PCB															
Aroclor-1232	PCB															
Aroclor-1242	PCB															
Aroclor-1248	PCB															
Aroclor-1254	PCB															
Aroclor-1260	PCB															

Sample Number		J1CNX1			J1JW30			J1JW31			J1JW32			J1JW33		
Location		100-H-51:6			100-H-51:6			100-H-51:6			100-H-51:6			100-H-51:6		
Constituent	Class	11/15/10 12:40 PM			06/20/11 02:50 PM			06/20/11 03:30 PM			06/21/11 08:05 AM			06/21/11 09:40 AM		
		ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
Acenaphthene	PAH	186		9.47	2240	D	71	2.06	J	3.38	805	D	16.4	4.58		3.29
Acenaphthylene	PAH	6.73	J	9.47	275	D	71	19.9		3.38	102	D	16.4	3.29	U	3.29
Anthracene	PAH	14.1		9.47	47.1	JD	71	3.38	U	3.38	85.9	D	16.4	3.29	U	3.29
Benzo(a)anthracene	PAH	170		9.47	829	D	71	8.73		3.38	983	D	16.4	25.7		3.29
Benzo(a)pyrene	PAH	234		9.47	2080	D	71	14.5		3.38	1450	D	16.4	41.1		3.29
Benzo(b)fluoranthene	PAH	255		9.47	2030	D	71	13.6		3.38	1280	D	16.4	40.9		3.29
Benzo(ghi)perylene	PAH	194		9.47	1620	D	71	10.7		3.38	1070	D	16.4	39.1		3.29
Benzo(k)fluoranthene	PAH	120		9.47	1090	D	71	6.99		3.38	495	D	16.4	19.5		3.29
Chrysene	PAH	128		9.47	1300	D	71	9.01		3.38	719	D	16.4	14.6		3.29
Dibenz[a,h]anthracene	PAH	37.3		9.47	286	D	71	2.21	J	3.38	140	D	16.4	6.27		3.29
Fluoranthene	PAH	504		9.47	6620	D	71	30		3.38	2350	D	16.4	51.9		3.29
Fluorene	PAH	13		9.47	200	D	71	3.38	U	3.38	26.8	D	16.4	3.29	U	3.29
Indeno(1,2,3-cd)pyrene	PAH	151		9.47	1350	D	71	10.5		3.38	600	D	16.4	29.8		3.29
Naphthalene	PAH	9.47	U	9.47	71	UD	71	3.38	U	3.38	70.1	D	16.4	3.29	U	3.29
Phenanthrene	PAH	206		9.47	4140	D	71	13.9		3.38	549	D	16.4	15.8		3.29
Pyrene	PAH	689		9.47	3830	D	71	26		3.38	2160	D	16.4	35.2		3.29
Aroclor-1016	PCB	39	U	39												
Aroclor-1221	PCB	39	U	39												
Aroclor-1232	PCB	39	U	39												
Aroclor-1242	PCB	39	U	39												
Aroclor-1248	PCB	39	U	39												
Aroclor-1254	PCB	39	U	39												
Aroclor-1260	PCB	39	U	39												

APPENDIX C

CALCULATIONS

APPENDIX C

CALCULATION BRIEFS

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

100-H-51:3 and 100-H-51:6 Subsites Cleanup Verification 95% UCL Calculations, 0100H-CA-V0206, Rev. 1, Washington Closure Hanford, Richland, Washington.

100-H-51:3 and 100-H-51:6 Subsites Direct Contact Hazard Quotient and Carcinogenic Risk Calculations, 0100H-CA-V0207, Rev. 1, Washington Closure Hanford, Richland, Washington.

100-H-51:3 and 100-H-51:6 Subsites Hazard Quotient and Carcinogenic Risk Calculations for Protection of Groundwater, 0100H-CA-V0208, 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-V0206

Subject: 100-H-51:3 and 100-H-51:6 Subsites Cleanup Verification 95% UCL 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 = 11 Attm. 1 = 6 Total = 18	R. J. Nielson	I. B. Berezovskiy	J. D. Skoglie	S. G. Wilkinson	10-30-14
1	Cover = 1 Sheets = 11 Attm. 1 = 6 Total = 18	R. J. Nielson	I. B. Berezovskiy	NA	S. G. Wilkinson	2/23/15

SUMMARY OF REVISION

1	Changes were made to sheets 4 and 8 of the calculation sheets to remove antimony as the results were all undetected, and changes were made to sheet 1 of the attachment to gray out the antimony result that was not used in the calculation and to remove the gray shading from the result that is used.

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

Washington Closure Hanford **CALCULATION SHEET**

Originator	R. J. Nielson RN	**Date**	02/03/15	**Calc. No.**	0100H-CA-V0206	**Rev. No.**	1
Project	100-H Area Closure Operations	**Job No.**	14655	**Checked**	I. B. Berezovskiy	**Date**	02/03/15
Subject	100-H-51:3 and 100-H-51:6 Subsites Cleanup Verification 95% UCL Calculations					**Sheet No.**	1 of 11

Summary

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

Table of Contents:
Sheets 1 to 5 - Calculation Sheet Summary
Sheets 6 to 8 - Statistical/Maximum Sheets Verification Data Results
Sheets 9 to 10 - Ecology Software (MTCAStat) Results
Sheet 11 - Calculation Sheet Duplicate Analysis
Attachment 1 - 100-H-51:3 and 100-H-51:6 subsites Verification Sampling Results (6 pages)

Given/References:
1) Sample Results (Attachment 1).
2) 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.
3) 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.
4) Ecology, 1992, *Statistical Guidance for Ecology Site Managers*, Publication #92-54, Washington Department of Ecology, Olympia, Washington.
5) 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.
6) Ecology, 2011, Cleanup Levels and Risk Calculations (CLARC) Database, Washington State Department of Ecology, Olympia, Washington, <https://fortress.wa.gov/ecy/clarc/CLARCHome.aspx>.
7) EPA, 1989, *Risk Assessment Guidance for Superfund:* Volume 1, *Human Health Evaluation Manual, Part A; Interim Final*, EPA/540/1-89/002, U.S. Environmental Protection Agency, Washington, D. C.
8) WAC 173-340, 1996, "Model Toxic Control Act - Cleanup," *Washington Administrative Code.*

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

Calculation Description:
The subject calculations were performed on statistical data from soil verification samples (Attachment 1) from the 100-H-51:3 and 100-H-51:5 subsites. The data were entered into an EXCEL 2010 spreadsheet and calculations performed by using the built-in spreadsheet functions and/or creating formulae within the cells. The statistical evaluation of data for use in accordance with the RDR/RAWP (DOE-RL 2009b) is documented by this calculation. Duplicate RPD results are used in evaluation of data quality within the RSVP for this site.

Methodology:
The 100-H-51:3 and 100-H-51:6 subsites underwent statistical sampling that consists of one decision unit within the excavation for verification sampling (EXC). One focused sample was also included. 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.

The detections of polycyclic aromatic hydrocarbons (PAHs) in 100-H-51:3 and 100-H-51:6 verification data were determined to be the result of cross-contamination from pipe mastic/coating and not from the waste site processes. Therefore, the PAH results are excluded from the calculation. The results are presented in the attachment for information only.

Elevated antimony detected in samples J1TX49 and J1TX57 is the result of heterogeneity in the sample matrix. Both samples were reanalyzed and antimony was undetected. The reanalysis data are presented in the attachment as J1TX49-A and J1TX57-A and are for information only.

Washington Closure Hanford **CALCULATION SHEET**

Originator R. J. Nielson RN	**Date** 02/03/15	**Calc. No.** 0100H-CA-V0206		**Rev. No.**	1
Project 100-H Area Closure Operations	**Job No.** 14655	**Checked** I. B. Berezovskiy		**Date**	02/03/15
Subject 100-H-51:3 and 100-H-51:6 Subsites Cleanup Verification 95% UCL Calculations				**Sheet No.**	2 of 11

Summary (continued)

Methodology, continued:

For nonradioactive analytes with ≤50% of the data below detection limits, the statistical value calculated to evaluate the effectiveness of cleanup is the 95% UCL. For nonradioactive analytes with >50% of the data below detection limits, as determined by direct inspection of the sample results (Attachment 1), the maximum detected value for the data set 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 (2011) under WAC 173-340-740(3) for calcium, magnesium, potassium, silicon, and sodium. The EPA's *Risk Assessment Guidance* for Superfund (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 COCs/COPCs and are also not included in these calculations.

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 the duplicate value for a given analyte are above detection limits and are greater than 5 times the target detection limit (TDL). The TDLs are pre-determined values for analytical methods and constituents with cleanup levels as listed in Table 2-1 of the SAP (DOE-RL 2009a). Table 2-1 includes nominal TDLs for identified methods based organic analyses. The nominal TDLs are also used in support of the RPD calculation for the methods based analytes. TDLs not included in Table 2-1 are based on the laboratory and/or methods 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) split and 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 sample, but was quantified at less than 5 times the TDL in one or both samples, an additional parameter is evaluated. In this case, if the difference between the primary and duplicate results exceeds a control limit of 2 times the TDL, further assessment regarding the usability of the data is performed. Additional discussion as necessary is provided in the data quality assessment section of the applicable RSVP.

Washington Closure Hanford **CALCULATION SHEET**

Originator R. J. Nielson RN **Date** 02/03/15 **Calc. No.** 0100H-CA-V0206 **Rev. No.** 1
Project 100-H Area Closure Operations **Job No.** 14655 **Checked** I. B. Berezovskiy **Date** 02/03/15
Subject 100-H-51:3 and 100-H-51:6 Subsites Cleanup Verification 95% UCL Calculations **Sheet No.** 3 of 11

Summary (continued)

QUALIFIER LIST

B = estimated result. Result is less than the RL but greater than the MDL
C = the analyte was detected in both the sample and the associated QC blank, and the sample concentration was ≤ 5X the blank
J = estimate
M = sample duplicate precision not met
N = recovery is outside the control limits
U = undetected
X (metals) = serial dilution in the analytical batch indicates that physical and chemical interferences are present
X (organics) = >40% difference between the primary and confirmation detector results. The lower of the two results is reported

ACRONYM LIST

-- = not applicable
DE = direct exposure
EXC = excavation
GW = groundwater
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)
RPD = relative percent difference
RSVP = remaining sites verification package
SAP = sampling and analysis plan
TDL = target detection limit
UCL = upper confidence limit
WAC = Washington Administrative Code

Washington Closure Hanford

CALCULATION SHEET

Originator	R. J. Nielson RN	**Date**	02/03/15	**Calc. No.**	0100H-CA-V0206	**Rev. No.**	1
Project	100-H Area Closure Operations	**Job No.**	14655	**Checked**	I. B. Berezovskiy	**Date**	02/03/15
Subject	100-H-51:3 and 100-H-51:6 Subsites Cleanup Verification 95% UCL Calculations					**Sheet No.**	4 of 11

Results:
The results presented in the tables that follow include the summary of the results of the 95% UCL calculations and/or maximum for the excavation decision unit (EXC), 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	EXC		Focused	Units
	95% UCL Result	Maximum Result	Maximum Result	
Arsenic	9.3	--	4.3	mg/kg
Barium	211	--	109	mg/kg
Beryllium	0.35	--	0.28	mg/kg
Boron	47.3	--	9.3	mg/kg
Cadmium	--	0.055	--	mg/kg
Chromium	27.8	--	11.4	mg/kg
Cobalt	8.3	--	7.2	mg/kg
Copper	62.5	--	14.4	mg/kg
Lead	10.9	--	7.6	mg/kg
Manganese	450	--	321	mg/kg
Mercury	0.018	--	0.0099	mg/kg
Molybdenum	3.5	--	--	mg/kg
Nickel	39.0	--	15.0	mg/kg
Selenium	--	0.81	--	mg/kg
Silver	--	0.22	--	mg/kg
Vanadium	41.5	--	43.0	mg/kg
Zinc	41.9	--	41.1	mg/kg

WAC 173-340-740(7)(e) Evaluation:

WAC 173-340 3-Part Test for most stringent RAG:	EXC	
95% UCL or maximum> Cleanup Limit?	YES	YES
> 10% above Cleanup Limit?	YES	NO
Any sample > 2x Cleanup Limit?	YES	YES

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

Washington Closure Hanford **CALCULATION SHEET**

Originator R. J. Nielson	**Date** 02/03/15	**Calc. No.** 0100H-CA-V0206	**Rev. No.** 1
Project 100-H Area Closure Operations	**Job No.** 14655	**Checked** I. B. Berezovskiy	**Date** 02/03/15
Subject 100-H-51:3 and 100-H-51:6 Subsites Cleanup Verification 95% UCL Calculations			**Sheet No.** 5 of 11

Results:
The results presented in the tables that follow include the summary of the results of the 95% UCL calculations and/or maximum for the excavation decision unit (EXC), 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.

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

Analyte	Duplicate Analysis FS-1
Aluminum	4.7%
Barium	1.9%
Calcium	3.7%
Chromium	6.3%
Copper	4.3%
Iron	2.7%
Magnesium	2.2%
Silicon	13.7%
Sodium	17.6%
Vanadium	2.8%
Zinc	0.7%

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

CALCULATION SHEET

Washington Closure Hanford

Originator R. J. Nielson RN
Project 100-H Area Closure Operations
Subject 100-H-51:3 and 100-H-51:6 Subsites Cleanup Verification 95% UCL Calculations

Date 02/03/15
Job No. 14655

Calc. No. 0100H-CA-V0206
Checked I. B. Berezovskiy

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Date 02/03/15
Sheet No. 6 of 11

100-H-51:3 and 100-H-51:6 Subsites Statistical Calculations

Verification Data - Decision Unit - EXC

1	Sample	Sample	Sample	Arsenic			Barium			Beryllium			Boron			Chromium			Cobalt			Copper			Lead			Manganese		
2	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	mg/kg	Q	PQL
3	EXC-1	J1TX47	8/4/14	4.4		0.62	69.4	X	0.071	0.18	B	0.031	2.1		0.92	8.4		0.054	7.0	X	0.094	12.5	X	0.20	5.6		0.25	287	X	0.094
4	EXC-2	J1TX48	8/4/14	10.8		0.57	94.6	X	0.066	0.28		0.028	4.0		0.84	11.6		0.050	7.3	X	0.086	13.4	X	0.19	7.7		0.23	329	X	0.086
5	EXC-3	J1TX49	8/4/14	14.6		0.63	525	X	0.073	0.54		0.032	47.2		0.94	26.0		0.056	10.7	X	0.096	94.3	X	0.21	21.1		0.26	489	X	0.096
6	EXC-4	J1TX50	8/4/14	3.6		0.59	93.8	X	0.068	0.25		0.030	5.0		0.88	11.1		0.052	6.9	X	0.090	13.8	X	0.19	5.3		0.24	308	X	0.090
7	EXC-5	J1TX51	8/4/14	2.4		0.60	43.7	X	0.069	0.097	B	0.030	0.89	U	0.89	9.5		0.052	5.3	X	0.090	11.8	X	0.20	2.8		0.24	240	X	0.090
8	EXC-6	J1TX52	8/4/14	4.2		0.61	90.2	X	0.071	0.19		0.031	5.2		0.91	14.1		0.054	6.8	X	0.093	25.7	X	0.20	4.4		0.25	304	X	0.093
9	EXC-7	J1TX53	8/4/14	3.7		0.66	60.5	X	0.076	0.13	B	0.033	1.3	B	0.98	9.6		0.058	6.3	X	0.10	13.6	X	0.22	9.3		0.27	243	X	0.10
10	EXC-8	J1TX54	8/4/14	5.3		0.64	104	X	0.074	0.29		0.032	9.5		0.95	18.2		0.056	6.6	X	0.097	15.6	X	0.21	7.7		0.26	288	X	0.097
11	EXC-9	J1TX55	8/4/14	4.2		0.56	93.9	X	0.064	0.22		0.028	4.8		0.83	13.2		0.049	6.3	X	0.084	16.4	X	0.18	11.1		0.23	261	X	0.084
12	EXC-10	J1TX56	8/4/14	5.3		0.58	343	X	0.067	0.49		0.029	40.2		0.86	13.9		0.051	8.3	X	0.088	23.0	X	0.19	6.5		0.24	449	X	0.088
13	EXC-11	J1TX57	8/4/14	19.6		0.56	123	X	0.064	0.13	B	0.028	8.3		0.83	77.8		0.049	11.5	X	0.084	190	X	0.18	2.8		0.23	890	X	0.084
14	EXC-12	J1TX58	8/4/14	2.9		0.66	81.9	X	0.075	0.18	B	0.033	2.8		0.97	10.2		0.058	6.2	X	0.099	16.3	X	0.22	4.2		0.27	262	X	0.099

15 **Statistical Computation Input Data**

16	Sample	Sample	Sample	Arsenic	Barium	Beryllium	Boron	Chromium	Cobalt	Copper	Lead	Manganese
17	Area	Number	Date	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
18	EXC-1	J1TX47	8/4/14	4.4	69.4	0.18	2.1	8.4	7.0	12.5	5.6	287
19	EXC-2	J1TX48	8/4/14	10.8	94.6	0.28	4.0	11.6	7.3	13.4	7.7	329
20	EXC-3	J1TX49	8/4/14	14.6	525	0.54	47.2	26.0	10.7	94.3	21.1	489
21	EXC-4	J1TX50	8/4/14	3.6	93.8	0.25	5.0	11.1	6.9	13.8	5.3	308
22	EXC-5	J1TX51	8/4/14	2.4	43.7	0.097	0.45	9.5	5.3	11.8	2.8	240
23	EXC-6	J1TX52	8/4/14	4.2	90.2	0.19	5.2	14.1	6.8	25.7	4.4	304
24	EXC-7	J1TX53	8/4/14	3.7	60.5	0.13	1.3	9.6	6.3	13.6	9.3	243
25	EXC-8	J1TX54	8/4/14	5.3	104	0.29	9.5	18.2	6.6	15.6	7.7	288
26	EXC-9	J1TX55	8/4/14	4.2	93.9	0.22	4.8	13.2	6.3	16.4	11.1	261
27	EXC-10	J1TX56	8/4/14	5.3	343	0.49	40.2	13.9	8.3	23.0	6.5	449
28	EXC-11	J1TX57	8/4/14	19.6	123	0.13	8.3	77.8	11.5	190	2.8	890
29	EXC-12	J1TX58	8/4/14	2.9	81.9	0.18	2.8	10.2	6.2	16.3	4.2	262

30 **Statistical Computations**

31		Arsenic	Barium	Beryllium	Boron	Chromium	Cobalt	Copper	Lead	Manganese
32	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), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.	Large data set (n ≥ 10), 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.
33	N	12	12	12	12	12	12	12	12	12
34	% < Detection limit	0%	0%	0%	8%	0%	0%	0%	0%	0%
35	Mean	6.8	144	0.25	10.9	18.6	7.4	37.2	7.4	363
36	Standard deviation	5.4	143	0.14	15.6	19.2	1.9	53.3	5.0	183
37	95% UCL on mean	9.3	211	0.35	47.3	27.8	8.3	62.5	10.9	450
38	Maximum value	19.6	525	0.54	47.2	77.8	11.5	190	21.1	890
39	**Most Stringent Cleanup Limit for nonradionuclide and RAG type (mg/kg)**	20 DE, GW & River Protection	200 GW Protection	1.51 GW & River Protection	320 GW Protection	18.5 GW & River Protection	15.7 GW Protection	22.0 River Protection	10.2 GW & River Protection	512 GW & River Protection
40	**WAC 173-340 3-PART TEST**									
41	95% UCL > Cleanup Limit?	NO	YES	NA	NO	YES	NA	YES	YES	NO
42	> 10% above Cleanup Limit?	NO	YES	NA	NO	YES	NA	YES	YES	NO
43	Any sample > 2X Cleanup Limit?	NO	YES	NA	NO	YES	NA	YES	YES	NO
44	**WAC 173-340 Compliance?**	The data set meets the 3-part test criteria when compared to the most stringent RAG.	A detailed assessment will be performed. The data set meets the 3-part test criteria when compared to the direct exposure RAG.	Because all values are below background (1.51 mg/kg) the WAC 173-340 3-part test is not required.	The data set meets the 3-part test criteria when compared to the most stringent RAG.	A detailed assessment will be performed. The data set meets the 3-part test criteria when compared to the direct exposure RAG.	Because all values are below background (15.7 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.	A detailed assessment will be performed. The data set meets the 3-part test criteria when compared to the direct exposure RAG.	The data set meets the 3-part test criteria when compared to the most stringent RAG.

45 **Acronyms and qualifiers are defined on sheet 3.**

CALCULATION SHEET

Washington Closure Hanford

Originator R. J. Nielson RN
Project 100-H Area Closure Operations
Subject 100-H-51:3 and 100-H-51:6 Subsites Cleanup Verification 95% UCL Calculations

Date 02/03/15
Job No. 14655

Calc. No. 0100H-CA-V0206
Checked I. B. Berezovskiy

Rev. No. 1
Date 02/03/15
Sheet No. 7 of 11

100-H-51:3 and 100-H-51:6 Subsites Statistical Calculations
Verification Data - Decision Unit - EXC

1	Sample	Sample	Sample	Mercury			Molybdenum			Nickel			Vanadium			Zinc		
2	Area	Number	Date	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
3	EXC-1	J1TX47	8/4/14	0.0057	U	0.0057	0.48	B	0.24	8.8	X	0.12	42.2	X	0.088	38.1	X	0.37
4	EXC-2	J1TX48	8/4/14	0.0057	B	0.0051	0.41	B	0.22	11.6	X	0.11	39.9	X	0.081	39.6	X	0.34
5	EXC-3	J1TX49	8/4/14	0.021		0.0057	4.9		0.25	88.8	X	0.12	42.2	X	0.090	34.3	X	0.38
6	EXC-4	J1TX50	8/4/14	0.0087	B	0.0052	0.23	U	0.23	10.4	X	0.11	39.4	X	0.084	38.1	X	0.36
7	EXC-5	J1TX51	8/4/14	0.0069	B	0.0054	0.23	U	0.23	9.1	X	0.11	40.6	X	0.085	30.5	X	0.36
8	EXC-6	J1TX52	8/4/14	0.0094	B	0.0049	1.0	B	0.24	20.2	X	0.11	38.9	X	0.087	35.4	X	0.37
9	EXC-7	J1TX53	8/4/14	0.0058	B	0.0055	0.26	U	0.26	9.4	X	0.12	43.5	X	0.094	40.4	X	0.40
10	EXC-8	J1TX54	8/4/14	0.014	B	0.0055	0.25	U	0.25	16.1	X	0.12	37.0	X	0.092	51.0	X	0.39
11	EXC-9	J1TX55	8/4/14	0.025		0.0054	0.22	U	0.22	12.8	X	0.10	39.4	X	0.079	44.2	X	0.34
12	EXC-10	J1TX56	8/4/14	0.019		0.0054	0.74	B	0.23	20.5	X	0.11	40.8	X	0.082	46.9	X	0.35
13	EXC-11	J1TX57	8/4/14	0.0075	B	0.0055	12.7		0.22	84.5	X	0.10	25.2	X	0.079	18.0	X	0.34
14	EXC-12	J1TX58	8/4/14	0.0064	B	0.0055	0.26	B	0.26	11.2	X	0.12	41.5	X	0.093	34.0	X	0.40

15 **Statistical Computation Input Data**

16	Sample	Sample	Sample	Mercury	Molybdenum	Nickel	Vanadium	Zinc
17	Area	Number	Date	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
18	EXC-1	J1TX47	8/4/14	0.0029	0.48	8.8	42.2	38.1
19	EXC-2	J1TX48	8/4/14	0.0057	0.41	11.6	39.9	39.6
20	EXC-3	J1TX49	8/4/14	0.021	4.9	88.8	42.2	34.3
21	EXC-4	J1TX50	8/4/14	0.0087	0.12	10.4	39.4	38.1
22	EXC-5	J1TX51	8/4/14	0.0069	0.12	9.1	40.6	30.5
23	EXC-6	J1TX52	8/4/14	0.0094	1.0	20.2	38.9	35.4
24	EXC-7	J1TX53	8/4/14	0.0058	0.13	9.4	43.5	40.4
25	EXC-8	J1TX54	8/4/14	0.014	0.13	16.1	37.0	51.0
26	EXC-9	J1TX55	8/4/14	0.025	0.11	12.8	39.4	44.2
27	EXC-10	J1TX56	8/4/14	0.019	0.74	20.5	40.8	46.9
28	EXC-11	J1TX57	8/4/14	0.0075	12.7	84.5	25.2	18.0
29	EXC-12	J1TX58	8/4/14	0.0064	0.26	11.2	41.5	34.0

30 **Statistical Computations**

31		Mercury	Molybdenum	Nickel	Vanadium	Zinc
32	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), 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 normal distribution.
33	N	12	12	12	12	12
34	% < Detection limit	8%	42%	0%	0%	0%
35	Mean	0.011	1.8	25.3	39.2	37.5
36	Standard deviation	0.007	3.7	29.0	4.7	8.4
37	95% UCL on mean	0.018	3.5	39.0	41.5	41.9
38	Maximum value	0.025	12.7	88.8	43.5	51.0
39	**Most Stringent Cleanup Limit for nonradionuclide and RAG type (mg/kg)**	0.33 GW & River Protection	8 GW Protection	19.1 GW Protection	85.1 GW Protection	67.8 River Protection
40	**WAC 173-340 3-PART TEST**					
41	95% UCL > Cleanup Limit?	NA	NO	YES	NA	NA
42	> 10% above Cleanup Limit?	NA	NO	YES	NA	NA
43	Any sample > 2X Cleanup Limit?	NA	NO	YES	NA	NA
44	**WAC 173-340 Compliance?**	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.	A detailed assessment will be performed. The data set meets the 3-part test criteria when compared to the direct exposure 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.

45 **Acronyms and qualifiers are defined on sheet 3.**

MAXIMUM VALUE 3-PART TEST CALCULATION SHEET

Washington Closure Hanford

Originator R. J. Nielson RN
Project 100-H Area Closure Operations
Subject 100-H-51:3 and 100-H-51:6 Subsites Cleanup Verification 95% UCL Calculations

Date 02/03/15
Job No. 14655

Calc. No. 0100H-CA-V0206
Checked I. B. Berezovskiy

Rev. No. 1
Date 02/03/15
Sheet No. 8 of 11

100-H-51:3 and 100-H-51:6 Subsites Maximum Calculations

Verification Data - Decision Unit - EXC

Sample Area	Sample Number	Sample Date	Cadmium			Selenium			Silver		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-1	J1TX47	8/4/14	0.038	U	0.038	0.81	U	0.81	0.15	U	0.15
EXC-2	J1TX48	8/4/14	0.035	U	0.035	0.74	U	0.74	0.14	U	0.14
EXC-3	J1TX49	8/4/14	0.039	U	0.039	0.83	U	0.83	0.15	U	0.15
EXC-4	J1TX50	8/4/14	0.037	U	0.037	0.77	U	0.77	0.14	U	0.14
EXC-5	J1TX51	8/4/14	0.037	U	0.037	0.78	U	0.78	0.14	U	0.14
EXC-6	J1TX52	8/4/14	0.038	U	0.038	0.80	U	0.80	0.15	U	0.15
EXC-7	J1TX53	8/4/14	0.041	U	0.041	0.86	U	0.86	0.16	U	0.16
EXC-8	J1TX54	8/4/14	0.040	U	0.040	0.84	U	0.84	0.16	U	0.16
EXC-9	J1TX55	8/4/14	0.055	B	0.035	0.72	U	0.72	0.13	U	0.13
EXC-10	J1TX56	8/4/14	0.048	B	0.036	0.75	U	0.75	0.14	U	0.14
EXC-11	J1TX57	8/4/14	0.035	U	0.035	0.81	B	0.72	0.22		0.13
EXC-12	J1TX58	8/4/14	0.041	U	0.041	0.85	U	0.85	0.16	U	0.16

Statistical Computations

	Cadmium	Selenium	Silver
% < Detection limit	83%	92%	92%
Maximum value	0.055	0.81	0.22
Most Stringent Cleanup Limit for nonradionuclide and RAG type (mg/kg)	0.81 GW & River Protection	1.0 River Protection	0.73 River Protection
3-PART TEST			
Maximum > Cleanup Limit?	NA	NO	NA
> 10% above Cleanup Limit?	NA	NO	NA
Any sample > 2X Cleanup Limit?	NA	NO	NA
3-Part Test Compliance?	Because all values are below background (0.81 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 (0.73 mg/kg) the WAC 173-340 3-part test is not required.

Acronyms and qualifiers are defined on sheet 3.

CALCULATION SHEET

Washington Closure Hanford

Originator R. J. Nielson **Date** 02/03/15 **Calc. No.** 0100H-CA-V0206 **Rev. No.** 1

Project 100-H Area Closure Operations **Job No.** 14655 **Checked** I. B. Berezovskiy **Date** 02/03/15

Subject 100-H-51:3 and 100-H-51:6 Subsites Cleanup Verification 95% UCL Calculations **Sheet No.** 9 of 11

Ecology Software (MTCAStat) Results, 100-H-51:3 & 100-H-51:6 Subsites - Decision Unit EXC

Arsenic 95% UCL Calculation

DATA	ID
4.4	J1TX47
10.8	J1TX48
14.6	J1TX49
3.6	J1TX50
2.4	J1TX51
4.2	J1TX52
3.7	J1TX53
5.3	J1TX54
4.2	J1TX55
5.3	J1TX56
19.6	J1TX57
2.9	J1TX58

Number of samples		Uncensored values	
Uncensored	12	Mean	6.8
Censored		Lognormal mean	6.7
Detection limit or PQL		Std. devn.	5.4
Method detection limit		Median	4.3
TOTAL	12	Min.	2.4
		Max.	19.6

Lognormal distribution? r-squared is: 0.885
Normal distribution? r-squared is: 0.734
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 9.3

Barium 95% UCL Calculation

DATA	ID
69.4	J1TX47
94.6	J1TX48
525	J1TX49
93.8	J1TX50
43.7	J1TX51
90.2	J1TX52
60.5	J1TX53
104	J1TX54
93.9	J1TX55
343	J1TX56
123	J1TX57
81.9	J1TX58

Number of samples		Uncensored values	
Uncensored	12	Mean	144
Censored		Lognormal mean	138
Detection limit or PQL		Std. devn.	143
Method detection limit		Median	93.9
TOTAL	12	Min.	43.7
		Max.	525

Lognormal distribution? r-squared is: 0.820
Normal distribution? r-squared is: 0.607
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 211

Beryllium 95% UCL Calculation

DATA	ID
0.18	J1TX47
0.28	J1TX48
0.54	J1TX49
0.25	J1TX50
0.097	J1TX51
0.19	J1TX52
0.13	J1TX53
0.29	J1TX54
0.22	J1TX55
0.49	J1TX56
0.13	J1TX57
0.18	J1TX58

Number of samples		Uncensored values	
Uncensored	12	Mean	0.25
Censored		Lognormal mean	0.25
Detection limit or PQL		Std. devn.	0.14
Method detection limit		Median	0.21
TOTAL	12	Min.	0.097
		Max.	0.54

Lognormal distribution? r-squared is: 0.964
Normal distribution? r-squared is: 0.851
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 0.35

Boron 95% UCL Calculation

DATA	ID
2.1	J1TX47
4.0	J1TX48
47.2	J1TX49
5.0	J1TX50
0.45	J1TX51
5.2	J1TX52
1.3	J1TX53
9.5	J1TX54
4.8	J1TX55
40.2	J1TX56
8.3	J1TX57
2.8	J1TX58

Number of samples		Uncensored values	
Uncensored	12	Mean	10.9
Censored		Lognormal mean	11.8
Detection limit or PQL		Std. devn.	15.6
Method detection limit		Median	4.9
TOTAL	12	Min.	0.45
		Max.	47.2

Lognormal distribution? r-squared is: 0.952
Normal distribution? r-squared is: 0.628
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 47.3

Chromium 95% UCL Calculation

DATA	ID
8.4	J1TX47
11.6	J1TX48
26.0	J1TX49
11.1	J1TX50
9.5	J1TX51
14.1	J1TX52
9.6	J1TX53
18.2	J1TX54
13.2	J1TX55
13.9	J1TX56
77.8	J1TX57
10.2	J1TX58

Number of samples		Uncensored values	
Uncensored	12	Mean	18.6
Censored		Lognormal mean	17.6
Detection limit or PQL		Std. devn.	19.2
Method detection limit		Median	12.4
TOTAL	12	Min.	8.4
		Max.	77.8

Lognormal distribution? r-squared is: 0.751
Normal distribution? r-squared is: 0.500
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 27.8

Cobalt 95% UCL Calculation

DATA	ID
7.0	J1TX47
7.3	J1TX48
10.7	J1TX49
6.9	J1TX50
5.3	J1TX51
6.8	J1TX52
6.3	J1TX53
6.6	J1TX54
6.3	J1TX55
8.3	J1TX56
11.5	J1TX57
6.2	J1TX58

Number of samples		Uncensored values	
Uncensored	12	Mean	7.4
Censored		Lognormal mean	7.4
Detection limit or PQL		Std. devn.	1.9
Method detection limit		Median	6.9
TOTAL	12	Min.	5.3
		Max.	11.5

Lognormal distribution? r-squared is: 0.867
Normal distribution? r-squared is: 0.804
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 8.3

Copper 95% UCL Calculation

DATA	ID
12.5	J1TX47
13.4	J1TX48
94.3	J1TX49
13.8	J1TX50
11.8	J1TX51
25.7	J1TX52
13.6	J1TX53
15.6	J1TX54
16.4	J1TX55
23.0	J1TX56
190	J1TX57
16.3	J1TX58

Number of samples		Uncensored values	
Uncensored	12	Mean	37.2
Censored		Lognormal mean	33.0
Detection limit or PQL		Std. devn.	53.3
Method detection limit		Median	16.0
TOTAL	12	Min.	11.8
		Max.	190

Lognormal distribution? r-squared is: 0.699
Normal distribution? r-squared is: 0.515
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 62.5

Lead 95% UCL Calculation

DATA	ID
5.6	J1TX47
7.7	J1TX48
21.1	J1TX49
5.3	J1TX50
2.8	J1TX51
4.4	J1TX52
9.3	J1TX53
7.7	J1TX54
11.1	J1TX55
6.5	J1TX56
2.8	J1TX57
4.2	J1TX58

Number of samples		Uncensored values	
Uncensored	12	Mean	7.4
Censored		Lognormal mean	7.4
Detection limit or PQL		Std. devn.	5.0
Method detection limit		Median	6.1
TOTAL	12	Min.	2.8
		Max.	21.1

Lognormal distribution? r-squared is: 0.961
Normal distribution? r-squared is: 0.773
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 10.9

Manganese 95% UCL Calculation

DATA	ID
287	J1TX47
329	J1TX48
489	J1TX49
308	J1TX50
240	J1TX51
304	J1TX52
243	J1TX53
288	J1TX54
261	J1TX55
449	J1TX56
890	J1TX57
262	J1TX58

Number of samples		Uncensored values	
Uncensored	12	Mean	363
Censored		Lognormal mean	360
Detection limit or PQL		Std. devn.	183
Method detection limit		Median	296
TOTAL	12	Min.	240
		Max.	890

Lognormal distribution? r-squared is: 0.784
Normal distribution? r-squared is: 0.640
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 450

Acronyms and qualifiers are defined on sheet 3.

CALCULATION SHEET

Washington Closure Hanford

Originator R. J. Nielson **Date** 02/03/15 **Calc. No.** 0100H-CA-V0206 **Rev. No.** 1

Project 100-H Area Closure Operations **Job No.** 14655 **Checked** I. B. Berezovskiy **Date** 02/03/15

Subject 100-H-51:3 and 100-H-51:6 Subsites Cleanup Verification 95% UCL Calculations **Sheet No.** 10 of 11

Ecology Software (MTCAStat) Results, 100-H-51:3 & 100-H-51:6 Subsites - Decision Unit EXC

Mercury 95% UCL Calculation

DATA	ID
0.0029	J1TX47
0.0057	J1TX48
0.021	J1TX49
0.0087	J1TX50
0.0069	J1TX51
0.0094	J1TX52
0.0058	J1TX53
0.014	J1TX54
0.025	J1TX55
0.019	J1TX56
0.0075	J1TX57
0.0064	J1TX58

Number of samples		Uncensored values	
Uncensored	12	Mean	0.011
Censored		Lognormal mean	0.011
Detection limit or PQL		Std. devn.	0.0071
Method detection limit		Median	0.0081
TOTAL	12	Min.	0.0029
		Max.	0.025

Lognormal distribution? r-squared is: 0.952
Normal distribution? r-squared is: 0.871
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 0.018

Molybdenum 95% UCL Calculation

DATA	ID
0.48	J1TX47
0.41	J1TX48
4.9	J1TX49
0.12	J1TX50
0.12	J1TX51
1.0	J1TX52
0.13	J1TX53
0.13	J1TX54
0.11	J1TX55
0.74	J1TX56
12.7	J1TX57
0.26	J1TX58

Number of samples		Uncensored values	
Uncensored	12	Mean	1.8
Censored		Lognormal mean	1.5
Detection limit or PQL		Std. devn.	3.7
Method detection limit		Median	0.34
TOTAL	12	Min.	0.11
		Max.	12.7

Lognormal distribution? r-squared is: 0.853
Normal distribution? r-squared is: 0.494
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 3.5

Nickel 95% UCL Calculation

DATA	ID
8.8	J1TX47
11.6	J1TX48
88.8	J1TX49
10.4	J1TX50
9.1	J1TX51
20.2	J1TX52
9.4	J1TX53
16.1	J1TX54
12.8	J1TX55
20.5	J1TX56
84.5	J1TX57
11.2	J1TX58

Number of samples		Uncensored values	
Uncensored	12	Mean	25.3
Censored		Lognormal mean	23.8
Detection limit or PQL		Std. devn.	29.0
Method detection limit		Median	12.2
TOTAL	12	Min.	8.8
		Max.	88.8

Lognormal distribution? r-squared is: 0.763
Normal distribution? r-squared is: 0.583
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 39.0

Vanadium 95% UCL Calculation

DATA	ID
42.2	J1TX47
39.9	J1TX48
42.2	J1TX49
39.4	J1TX50
40.6	J1TX51
38.9	J1TX52
43.5	J1TX53
37.0	J1TX54
39.4	J1TX55
40.8	J1TX56
25.2	J1TX57
41.5	J1TX58

Number of samples		Uncensored values	
Uncensored	12	Mean	39.2
Censored		Lognormal mean	39.3
Detection limit or PQL		Std. devn.	4.7
Method detection limit		Median	40.3
TOTAL	12	Min.	25.2
		Max.	43.5

Lognormal distribution? r-squared is: 0.587
Normal distribution? r-squared is: 0.653
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 41.5

Zinc 95% UCL Calculation

DATA	ID
38.1	J1TX47
39.6	J1TX48
34.3	J1TX49
38.1	J1TX50
30.5	J1TX51
35.4	J1TX52
40.4	J1TX53
51.0	J1TX54
44.2	J1TX55
46.9	J1TX56
18.0	J1TX57
34.0	J1TX58

Number of samples		Uncensored values	
Uncensored	12	Mean	37.5
Censored		Lognormal mean	37.8
Detection limit or PQL		Std. devn.	8.4
Method detection limit		Median	38.1
TOTAL	12	Min.	18.0
		Max.	51.0

Lognormal distribution? r-squared is: 0.826
Normal distribution? r-squared is: 0.929
Recommendations:
Use normal distribution.

UCL (based on t-statistic) is 41.9

Acronyms and qualifiers are defined on sheet 3.

CALCULATION SHEET

Washington Closure Hanford

Originator R. J. Nielson **Date** 02/03/15 **Calc. No.** 0100H-CA-V0206 **Rev. No.** 1

Project 100-H Area Closure Operations **Job No.** 14655 **Checked** I. B. Berezovskiy **Date** 02/03/15

Subject 100-H-51:3 and 100-H-51:6 Subsites Cleanup Verification 95% UCL Calculations **Sheet No.** 11 of 11

Duplicate Analysis - 100-H-51:3 & 100-H-51:6 Subsites EXC

Sampling Area	Sample Number	Sample Date	Aluminum			Arsenic			Barium			Beryllium			Boron			Calcium			Chromium			Cobalt			Copper			Iron		
			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	mg/kg	Q	PQL
FS-1	J1TX60	8/4/14	9010	X	1.5	4.1		0.64	109	X	0.073	0.27		0.032	9.3		0.95	5280	X	13.6	10.7		0.056	7.2	X	0.097	13.8	X	0.21	18300	X	3.7
Duplicate of J1TX60	J1TX59	8/4/14	9440	X	1.5	4.3		0.65	107	X	0.075	0.28		0.032	9.0		0.96	5480	X	13.9	11.4		0.057	7.2	X	0.098	14.4	X	0.21	18800	X	3.7

Analysis:

TDL			5			10			2			0.2			2			100			1			2			1			5		
Duplicate Analysis	Both > PQL?		Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)		
	Both >5xTDL?		Yes (calc RPD)			No-Stop (acceptable)			Yes (calc RPD)			No-Stop (acceptable)			No-Stop (acceptable)			Yes (calc RPD)			Yes (calc RPD)			No-Stop (acceptable)			Yes (calc RPD)			Yes (calc RPD)		
	RPD		4.7%						1.9%									3.7%			6.3%						4.3%			2.7%		
	Difference > 2 TDL?		Not applicable			No - acceptable			Not applicable			No - acceptable			No - acceptable			Not applicable			Not applicable			No - acceptable			Not applicable			Not applicable		

Duplicate Analysis - 100-H-51:3 & 100-H-51:6 Subsites EXC

Sampling Area	Sample Number	Sample Date	Lead			Magnesium			Manganese			Mercury			Nickel			Potassium			Silicon			Sodium			Vanadium			Zinc		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
FS-1	J1TX60	8/4/14	7.6		0.26	4560	X	3.6	321	X	0.097	0.0096	B	0.0064	15.0	X	0.12	1780		39.6	241	N	5.5	337		57.0	41.8	X	0.091	40.8	X	0.38
Duplicate of J1TX60	J1TX59	8/4/14	7.6		0.27	4660	X	3.6	321	X	0.098	0.0099	B	0.0057	10.7	X	0.12	1690		40.3	210	N	5.6	402		58.0	43.0	X	0.092	41.1	X	0.39

Analysis:

TDL			5			75			5			0.2			4			400			2			50			2.5			1		
Duplicate Analysis	Both > PQL?		Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)		
	Both >5xTDL?		No-Stop (acceptable)			Yes (calc RPD)			Yes (calc RPD)			No-Stop (acceptable)			No-Stop (acceptable)			No-Stop (acceptable)			Yes (calc RPD)			Yes (calc RPD)			Yes (calc RPD)			Yes (calc RPD)		
	RPD					2.2%			0.0%												13.7%			17.6%			2.8%			0.7%		
	Difference > 2 TDL?		No - acceptable			Not applicable			Not applicable			No - acceptable			No - acceptable			No - acceptable			Not applicable			Not applicable			Not applicable			Not applicable		

Duplicate Analysis - 100-H-51:3 & 100-H-51:6 Subsites EXC

Sampling Area	Sample Number	Sample Date	Benzo(a)anthracene			Benzo(a)pyrene			Benzo(b)fluoranthene			Benzo(ghi)perylene			Benzo(k)fluoranthene			Chrysene			Fluoranthene			Indeno(1,2,3-cd)pyrene			Pyrene		
			ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
FS-1	J1TX60	8/4/14	7.3	JX	3.2	14	J	6.5	6.6	JX	4.3	48		7.3	10	J	4	19	J	4.9	16	JX	13	36		12	14	JX	12
Duplicate of J1TX60	J1TX59	8/4/14	5.0	JX	3.2	24	J	6.4	8.1	JX	4.2	64		7.2	10	J	3.9	17	J	4.8	15	JX	13	31	X	12	12	JX	12

Analysis:

TDL			15			15			15			15			15			15			15			15			15			15		
Duplicate Analysis	Both > PQL?		Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)			Yes (continue)			No-Stop (acceptable)		
	Both >5xTDL?		No-Stop (acceptable)			No-Stop (acceptable)			No-Stop (acceptable)			No-Stop (acceptable)			No-Stop (acceptable)			No-Stop (acceptable)			No-Stop (acceptable)			No-Stop (acceptable)			No-Stop (acceptable)					
	RPD																															
	Difference > 2 TDL?		No - acceptable			No - acceptable			No - acceptable			No - acceptable			No - acceptable			No - acceptable			No - acceptable			No - acceptable			No - acceptable			No - acceptable		

Attachment 1. 100-H-51:3 and 100-H-51:6 Subsites Verification Sample Results (Metals).

Sample Location	HEIS Number	Sample Date	Aluminum			Antimony			Arsenic			Barium			Beryllium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-1	J1TX47	8/4/14	7920	X	1.5	0.36	UJ	0.36	4.4		0.62	69.4	X	0.071	0.18	B	0.031
EXC-2	J1TX48	8/4/14	9730	X	1.3	0.33	UJ	0.33	10.8		0.57	94.6	X	0.066	0.28		0.028
EXC-3	J1TX49	8/4/14	11200	X	1.5	4.3	J	0.36	14.6		0.63	525	X	0.073	0.54		0.032
EXC-3	J1TX49-A	8/4/14	13700	X	1.6	0.38	U	0.38	9.3	N	0.66	709	NX	0.077	0.37	N	0.033
EXC-4	J1TX50	8/4/14	8840	X	1.4	0.34	UJ	0.34	3.6		0.59	93.8	X	0.068	0.25		0.030
EXC-5	J1TX51	8/4/14	5670	X	1.4	0.34	UJ	0.34	2.4		0.60	43.7	X	0.069	0.097	B	0.030
EXC-6	J1TX52	8/4/14	7310	X	1.4	0.35	UJ	0.35	4.2		0.61	90.2	X	0.071	0.19		0.031
EXC-7	J1TX53	8/4/14	6030	X	1.6	0.38	UJ	0.38	3.7		0.66	60.5	X	0.076	0.13	B	0.033
EXC-8	J1TX54	8/4/14	9580	X	1.5	0.37	UJ	0.37	5.3		0.64	104	X	0.074	0.29		0.032
EXC-9	J1TX55	8/4/14	7780	X	1.3	0.32	UJ	0.32	4.2		0.56	93.9	X	0.064	0.22		0.028
EXC-10	J1TX56	8/4/14	12500	X	1.4	0.33	UJ	0.33	5.3		0.58	343	X	0.067	0.49		0.029
EXC-11	J1TX57	8/4/14	4320	X	1.3	19.1	J	0.32	19.6		0.56	123	X	0.064	0.13	B	0.028
EXC-11	J1TX57-A	8/4/14	7000	X	1.4	0.34	U	0.34	2.6		0.59	170	X	0.068	0.03	U	0.03
EXC-12	J1TX58	8/4/14	6920	X	1.5	0.38	UJ	0.38	2.9		0.66	81.9	X	0.075	0.18	B	0.033
FS-1	J1TX60	8/4/14	9010	X	1.5	0.37	UJ	0.37	4.1		0.64	109	X	0.073	0.27		0.032
Duplicate of J1TX60	J1TX59	8/4/14	9440	X	1.5	0.37	UJ	0.37	4.3		0.65	107	X	0.075	0.28		0.032
Equipment Blank	J1TX61	8/4/14	96.7	X	1.3	0.33	UJ	0.33	0.57	U	0.57	1.1	X	0.066	0.029	U	0.029

Grey cells indicate not applicable or data will not be used.

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

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

B = estimated result. Result is less than the RL but greater than the MDL

C = the analyte was detected in both the sample and the associated QC blank, and the sample

EXC = excavation

HEIS = Hanford Environmental Information System

J = estimate

M = sample duplicate precision not met

N = recovery is outside control limits

PAH = polycyclic aromatic hydrocarbons

PQL = practical quantitative limit

Q = qualifier

U = undetected

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

X (organics) = >40% difference between the primary and confirmation detector results. The lower of the two results is reported.

Attachment	1	Sheet No.	1 of 6
Originator	R. J. Nielson RN	Date	2/3/15
Checked	I. B. Berezovskiy IB	Date	2/3/15
Calc. No.	0100H-CA-V0206	Rev. No.	1

Attachment 1. 100-H-51:3 and 100-H-51:6 Subsites Verification Sample Results (Metals).

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-1	J1TX47	8/4/14	2.1		0.92	0.038	U	0.038	4320	X	13.2	8.4		0.054	7.0	X	0.094
EXC-2	J1TX48	8/4/14	4.0		0.84	0.035	U	0.035	3780	X	12.2	11.6		0.050	7.3	X	0.086
EXC-3	J1TX49	8/4/14	47.2		0.94	0.039	U	0.039	13300	X	13.5	26.0		0.056	10.7	X	0.096
EXC-3	J1TX49-A	8/4/14	86.9	NX	0.99	0.13	B	0.041	17900	NX	14.2	12.5		0.058	7.4	NX	0.1
EXC-4	J1TX50	8/4/14	5.0		0.88	0.037	U	0.037	5070	X	12.6	11.1		0.052	6.9	X	0.090
EXC-5	J1TX51	8/4/14	0.89	U	0.89	0.037	U	0.037	6230	X	12.7	9.5		0.052	5.3	X	0.090
EXC-6	J1TX52	8/4/14	5.2		0.91	0.038	U	0.038	6130	X	13.1	14.1		0.054	6.8	X	0.093
EXC-7	J1TX53	8/4/14	1.3	B	0.98	0.041	U	0.041	5790	X	14.1	9.6		0.058	6.3	X	0.10
EXC-8	J1TX54	8/4/14	9.5		0.95	0.040	U	0.040	7700	X	13.7	18.2		0.056	6.6	X	0.097
EXC-9	J1TX55	8/4/14	4.8		0.83	0.055	B	0.035	7960	X	11.9	13.2		0.049	6.3	X	0.084
EXC-10	J1TX56	8/4/14	40.2		0.86	0.048	B	0.036	8780	X	12.4	13.9		0.051	8.3	X	0.088
EXC-11	J1TX57	8/4/14	8.3		0.83	0.035	U	0.035	5100	X	11.9	77.8		0.049	11.5	X	0.084
EXC-11	J1TX57-A	8/4/14	11.6	X	0.88	0.14	B	0.037	7760	X	12.6	8.9		0.052	5.8	X	0.09
EXC-12	J1TX58	8/4/14	2.8		0.97	0.041	U	0.041	5580	X	14.0	10.2		0.058	6.2	X	0.099
FS-1	J1TX60	8/4/14	9.3		0.95	0.040	U	0.040	5280	X	13.6	10.7		0.056	7.2	X	0.097
Duplicate of J1TX60	J1TX59	8/4/14	9.0		0.96	0.040	U	0.040	5480	X	13.9	11.4		0.057	7.2	X	0.098
Equipment Blank	J1TX61	8/4/14	0.85	U	0.85	0.036	U	0.036	20.3	BX	12.3	0.13	BCUJ	0.05	0.087	UX	0.087

Sample Location	HEIS Number	Sample Date	Copper			Hexavalent Chromium			Iron			Lead			Magnesium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-1	J1TX47	8/4/14	12.5	X	0.20	0.155	U	0.155	18300	X	3.6	5.6		0.25	3690	X	3.5
EXC-2	J1TX48	8/4/14	13.4	X	0.19	0.155	U	0.155	19700	X	3.3	7.7		0.23	4570	X	3.2
EXC-3	J1TX49	8/4/14	94.3	X	0.21	0.155	U	0.155	72600	X	3.6	21.1		0.26	4350	X	3.5
EXC-3	J1TX49-A	8/4/14	36	MNX	0.22				22600	X	3.8	22.6	NX	0.27	5840	NX	3.7
EXC-4	J1TX50	8/4/14	13.8	X	0.19	0.155	U	0.155	18100	X	3.4	5.3		0.24	4530	X	3.3
EXC-5	J1TX51	8/4/14	11.8	X	0.20	0.155	U	0.155	15500	X	3.4	2.8		0.24	4020	X	3.3
EXC-6	J1TX52	8/4/14	25.7	X	0.20	0.155	U	0.155	26000	X	3.5	4.4		0.25	4320	X	3.4
EXC-7	J1TX53	8/4/14	13.6	X	0.22	0.155	U	0.155	16600	X	3.8	9.3		0.27	4020	X	3.7
EXC-8	J1TX54	8/4/14	15.6	X	0.21	0.155	U	0.155	16900	X	3.7	7.7		0.26	6040	X	3.6
EXC-9	J1TX55	8/4/14	16.4	X	0.18	0.155	U	0.155	16100	X	3.2	11.1		0.23	4980	X	3.1
EXC-10	J1TX56	8/4/14	23.0	X	0.19	0.155	U	0.155	26800	X	3.3	6.5		0.24	5270	X	3.2
EXC-11	J1TX57	8/4/14	190	X	0.18	0.155	U	0.155	162000	X	3.2	2.8		0.23	2320	X	3.1
EXC-11	J1TX57-A	8/4/14	16.2	X	0.19				17400	X	3.4	3.7	X	0.24	4420	X	3.3
EXC-12	J1TX58	8/4/14	16.3	X	0.22	0.155	U	0.155	17000	X	3.8	4.2		0.27	4220	X	3.7
FS-1	J1TX60	8/4/14	13.8	X	0.21	0.155	U	0.155	18300	X	3.7	7.6		0.26	4560	X	3.6
Duplicate of J1TX60	J1TX59	8/4/14	14.4	X	0.21	0.155	U	0.155	18800	X	3.7	7.6		0.27	4660	X	3.6
Equipment Blank	J1TX61	8/4/14	0.2	BX	0.19				584	MJ	3.7	0.41	B	0.23	12	BX	3.2

Attachment	1	Sheet No.	2 of 6
Originator	R. J. Nielson	Date	2/3/15
Checked	I. B. Berezovskiy	Date	2/3/15
Calc. No.	0100H-CA-V0206	Rev. No.	1

Attachment 1. 100-H-51:3 and 100-H-51:6 Subsites Verification Sample Results (Metals).

Sample Location	HEIS Number	Sample Date	Manganese			Mercury			Molybdenum			Nickel			Potassium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-1	J1TX47	8/4/14	287	X	0.094	0.0057	U	0.0057	0.48	B	0.24	8.8	X	0.12	1430		38.5
EXC-2	J1TX48	8/4/14	329	X	0.086	0.0057	B	0.0051	0.41	B	0.22	11.6	X	0.11	2080		35.3
EXC-3	J1TX49	8/4/14	489	X	0.096	0.021		0.0057	4.9		0.25	88.8	X	0.12	1210		39.3
EXC-3	J1TX49-A	8/4/14	294	X	0.1				1.2	BN	0.26	23.1	MNX	0.12	1360	N	41.3
EXC-4	J1TX50	8/4/14	308	X	0.090	0.0087	B	0.0052	0.23	U	0.23	10.4	X	0.11	1700		36.7
EXC-5	J1TX51	8/4/14	240	X	0.090	0.0069	B	0.0054	0.23	U	0.23	9.1	X	0.11	728		37.0
EXC-6	J1TX52	8/4/14	304	X	0.093	0.0094	B	0.0049	1.0	B	0.24	20.2	X	0.11	1240		38.1
EXC-7	J1TX53	8/4/14	243	X	0.10	0.0058	B	0.0055	0.26	U	0.26	9.4	X	0.12	857		41.1
EXC-8	J1TX54	8/4/14	288	X	0.097	0.014	B	0.0055	0.25	U	0.25	16.1	X	0.12	1330		39.9
EXC-9	J1TX55	8/4/14	261	X	0.084	0.025		0.0054	0.22	U	0.22	12.8	X	0.10	1170		34.5
EXC-10	J1TX56	8/4/14	449	X	0.088	0.019		0.0054	0.74	B	0.23	20.5	X	0.11	2040		36.0
EXC-11	J1TX57	8/4/14	890	X	0.084	0.0075	B	0.0055	12.7		0.22	84.5	X	0.10	435		34.5
EXC-11	J1TX57-A	8/4/14	249	X	0.09				0.31	B	0.23	10.7	X	0.11	839		36.7
EXC-12	J1TX58	8/4/14	262	X	0.099	0.0064	B	0.0055	0.26	B	0.26	11.2	X	0.12	970		40.7
FS-1	J1TX60	8/4/14	321	X	0.097	0.0096	B	0.0064	0.25	U	0.25	15.0	X	0.12	1780		39.6
Duplicate of J1TX60	J1TX59	8/4/14	321	X	0.098	0.0099	B	0.0057	0.26	U	0.26	10.7	X	0.12	1690		40.3
Equipment Blank	J1TX61	8/4/14	3.4	X	0.087	0.0057	U	0.0057	0.23	U	0.23	0.12	BXCUJ	0.11	35.7	U	35.7

Sample Location	HEIS Number	Sample Date	Selenium			Silicon			Silver			Sodium			Vanadium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-1	J1TX47	8/4/14	0.81	U	0.81	189	NJ	5.3	0.15	U	0.15	227		55.4	42.2	X	0.088
EXC-2	J1TX48	8/4/14	0.74	U	0.74	248	NJ	4.9	0.14	U	0.14	223		50.9	39.9	X	0.081
EXC-3	J1TX49	8/4/14	0.83	U	0.83	337	NJ	5.4	0.15	U	0.15	640		56.6	42.2	X	0.090
EXC-3	J1TX49-A	8/4/14	0.87	UN	0.87	345	NX	5.7	0.16	UN	0.16	1450	MN	59.4	47.4	NX	0.095
EXC-4	J1TX50	8/4/14	0.77	U	0.77	218	NJ	5.1	0.14	U	0.14	238		52.9	39.4	X	0.084
EXC-5	J1TX51	8/4/14	0.78	U	0.78	145	NJ	5.1	0.14	U	0.14	197		53.3	40.6	X	0.085
EXC-6	J1TX52	8/4/14	0.80	U	0.80	211	NJ	5.3	0.15	U	0.15	206		54.8	38.9	X	0.087
EXC-7	J1TX53	8/4/14	0.86	U	0.86	109	NJ	5.7	0.16	U	0.16	230		59.2	43.5	X	0.094
EXC-8	J1TX54	8/4/14	0.84	U	0.84	239	NJ	5.5	0.16	U	0.16	335		57.4	37.0	X	0.092
EXC-9	J1TX55	8/4/14	0.72	U	0.72	183	NJ	4.8	0.13	U	0.13	236		49.7	39.4	X	0.079
EXC-10	J1TX56	8/4/14	0.75	U	0.75	375	NJ	5.0	0.14	U	0.14	383		51.7	40.8	X	0.082
EXC-11	J1TX57	8/4/14	0.81	B	0.72	162	NJ	4.8	0.22		0.13	238		49.7	25.2	X	0.079
EXC-11	J1TX57-A	8/4/14	0.77	U	0.77	299	X	5.1	0.14	U	0.14	329		52.8	44.3	X	0.084
EXC-12	J1TX58	8/4/14	0.85	U	0.85	183	NJ	5.6	0.16	U	0.16	216		58.6	41.5	X	0.093
FS-1	J1TX60	8/4/14	0.83	U	0.83	241	NJ	5.5	0.15	U	0.15	337		57.0	41.8	X	0.091
Duplicate of J1TX60	J1TX59	8/4/14	0.85	U	0.85	210	NJ	5.6	0.16	U	0.16	402		58.0	43.0	X	0.092
Equipment Blank	J1TX61	8/4/14	0.75	U	0.75	72.5	NJ	4.9	0.14	U	0.14	51.3	U	51.3	0.18	BX	0.082

Attachment	1	Sheet No.	3 of 6
Originator	R. J. Nielson	Date	2/3/15
Checked	I. B. Berezovskiy	Date	2/3/15
Calc. No.	0100H-CA-V0206	Rev. No.	1

Attachment 1. 100-H-51:3 and 100-H-51:6 Subsites Verification Sample Results. (Metals & Physical)

Sample Location	HEIS Number	Sample Date	Zinc			Percent Moisture (wet sample)		
			mg/kg	Q	PQL	%	Q	PQL
EXC-1	J1TX47	8/4/14	38.1	X	0.37	0.39		0.10
EXC-2	J1TX48	8/4/14	39.6	X	0.34	0.85		0.10
EXC-3	J1TX49	8/4/14	34.3	X	0.38	0.73		0.10
EXC-3	J1TX49-A	8/4/14	39	NX	0.4			
EXC-4	J1TX50	8/4/14	38.1	X	0.36	0.39		0.10
EXC-5	J1TX51	8/4/14	30.5	X	0.36	0.26		0.10
EXC-6	J1TX52	8/4/14	35.4	X	0.37	0.32		0.10
EXC-7	J1TX53	8/4/14	40.4	X	0.40	0.26		0.10
EXC-8	J1TX54	8/4/14	51.0	X	0.39	0.26		0.10
EXC-9	J1TX55	8/4/14	44.2	X	0.34	0.26		0.10
EXC-10	J1TX56	8/4/14	46.9	X	0.35	0.85		0.10
EXC-11	J1TX57	8/4/14	18.0	X	0.34	0.26		0.10
EXC-11	J1TX57-A	8/4/14	34.5	X	0.36			
EXC-12	J1TX58	8/4/14	34.0	X	0.40	0.32		0.10
FS-1	J1TX60	8/4/14	40.8	X	0.38	2.3		0.10
Duplicate of J1TX60	J1TX59	8/4/14	41.1	X	0.39	2.3		0.10
Equipment Blank	J1TX61	8/4/14	0.68	BX	0.35	0.10	U	0.10

Attachment	1	Sheet No.	4 of 6
Originator	R. J. Nielson	Date	2/3/15
Checked	I. B. Berezovskiy	Date	2/3/15
Calc. No.	0100H-CA-V0206	Rev. No.	1

Attachment 1. 100-H-51:3 and 100-H-51:6 Subsites Verification Sample Results (Organics).

CONSTITUENT	CLASS	J1TX47			J1TX48			J1TX49			J1TX50			J1TX51		
		EXC-1			EXC-2			EXC-3			EXC-4			EXC-5		
		8/4/14			8/4/14			8/4/14			8/4/14			8/4/14		
		ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
Acenaphthene	PAH	9.7	U	9.7	10	U	10	300	XJ	9.6	9.7	U	9.7	73	JX	9.8
Acenaphthylene	PAH	8.8	U	8.8	9.0	U	9.0	8.6	U	8.6	8.7	U	8.7	8.8	U	8.8
Anthracene	PAH	3.0	U	3.0	3.1	U	3.1	92	XJ	2.9	2.9	U	2.9	3.0	U	3.0
Benzo(a)anthracene	PAH	3.1	U	3.1	5.9	JX	3.2	470	XJ	3.1	3.1	U	3.1	190		3.1
Benzo(a)pyrene	PAH	6.2	UNJ	6.2	6.4	UJ	6.4	730	J	6.1	6.2	UJ	6.2	190	J	6.3
Benzo(b)fluoranthene	PAH	5.4	JNX	4.1	4.2	U	4.2	810	J	4.0	4.1	U	4.1	190		4.1
Benzo(ghi)perylene	PAH	7.0	UN	7.0	18	JX	7.2	6.9	U	6.9	6.9	U	6.9	170	X	7.1
Benzo(k)fluoranthene	PAH	3.8	U	3.8	4.0	U	4.0	450	J	3.8	3.8	U	3.8	95		3.9
Chrysene	PAH	4.7	U	4.7	15	J	4.9	1000	J	4.6	4.7	U	4.7	250		4.7
Dibenz[a,h]anthracene	PAH	11	UN	11	11	U	11	120	XJ	11	11	U	11	37	X	11
Fluoranthene	PAH	13	U	13	26	J	13	2400	J	12	13	U	13	550		13
Fluorene	PAH	5.1	U	5.1	5.3	U	5.3	210	XJ	5.1	5.1	U	5.1	50		5.2
Indeno(1,2,3-cd)pyrene	PAH	12	UN	12	12	U	12	12	U	12	12	U	12	180		12
Naphthalene	PAH	12	U	12	12	U	12	12	U	12	12	U	12	12	U	12
Phenanthrene	PAH	12	U	12	12	U	12	12	U	12	12	U	12	400		12
Pyrene	PAH	12	U	12	24	J	12	2300	J	12	12	U	12	550		12

CONSTITUENT	CLASS	J1TX52			J1TX53			J1TX54			J1TX55			J1TX56		
		EXC-6			EXC-7			EXC-8			EXC-9			EXC-10		
		8/4/14			8/4/14			8/4/14			8/4/14			8/4/14		
		ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
Acenaphthene	PAH	46	JX	9.7	10	U	10	9.5	U	9.5	9.8	U	9.8	10	U	10
Acenaphthylene	PAH	8.7	U	8.7	9.0	U	9.0	8.6	U	8.6	8.8	U	8.8	9.0	U	9.0
Anthracene	PAH	10	JX	3.0	3.0	U	3.0	2.9	U	2.9	3.0	U	3.0	3.1	U	3.1
Benzo(a)anthracene	PAH	110		3.1	17		3.2	94		3.0	370		3.1	420		3.2
Benzo(a)pyrene	PAH	140	J	6.2	6.4	UJ	6.4	81	J	6.1	310	J	6.3	340	J	6.4
Benzo(b)fluoranthene	PAH	450		4.1	13	JX	4.2	73	X	4.0	330		4.1	340		4.2
Benzo(ghi)perylene	PAH	96	X	7.0	25	J	7.2	74		6.9	200	X	7.0	250		7.2
Benzo(k)fluoranthene	PAH	73		3.8	6.3	JX	3.9	30		3.8	120		3.8	130		3.9
Chrysene	PAH	210		4.7	14	J	4.8	77		4.6	300		4.7	460		4.8
Dibenz[a,h]anthracene	PAH	28	J	11	11	U	11	18	JX	11	73	X	11	89	X	11
Fluoranthene	PAH	390		13	43		13	190		12	690		13	820		13
Fluorene	PAH	32		5.1	5.3	U	5.3	31		5	100		5.2	57	X	5.3
Indeno(1,2,3-cd)pyrene	PAH	99		12	23	J	12	69		11	280		12	240		12
Naphthalene	PAH	12	U	12	12	U	12	11	U	11	12	U	12	12	U	12
Phenanthrene	PAH	12	U	12	31	J	12	160		11	460		12	410		12
Pyrene	PAH	370		12	43		12	180		11	750		12	810		12

Attachment	1	Sheet No.	5 of 6
Originator	R. J. Nielson	Date	2/3/15
Checked	I. B. Berezovskiy	Date	2/3/15
Calc. No.	0100H-CA-V0206	Rev. No.	1

Attachment 1. 100-H-51:3 and 100-H-51:6 Subsites Verification Sample Results (Organics).

CONSTITUENT	CLASS	J1TX57			J1TX58			J1TX60			J1TX59		
		EXC-11			EXC-12			FS-1			Duplicate of J1TX60		
		8/4/14			8/4/14			8/4/14			8/4/14		
		ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
Acenaphthene	PAH	13	JX	9.7	88	JX	9.6	10	U	10	10	U	10
Acenaphthylene	PAH	8.7	U	8.7	8.6	U	8.6	9.1	U	9.1	9.0	U	9.0
Anthracene	PAH	3.0	U	3.0	2.9	U	2.9	3.1	U	3.1	3.0	U	3.0
Benzo(a)anthracene	PAH	22	X	3.1	280		3.0	7.3	JX	3.2	5.0	JX	3.2
Benzo(a)pyrene	PAH	42	J	6.2	270	J	6.1	14	J	6.5	24	J	6.4
Benzo(b)fluoranthene	PAH	51		4.1	300		4.0	6.6	JX	4.3	8.1	JX	4.2
Benzo(ghi)perylene	PAH	13	JX	7.0	200		6.9	48		7.3	64		7.2
Benzo(k)fluoranthene	PAH	18	X	3.8	150		3.8	10	J	4.0	10	J	3.9
Chrysene	PAH	49		4.7	370		4.6	19	J	4.9	17	J	4.8
Dibenz[a,h]anthracene	PAH	11	U	11	44	X	11	11	U	11	11	U	11
Fluoranthene	PAH	120		13	720		12	16	JX	13	15	JX	13
Fluorene	PAH	7.5	J	5.1	64		5.0	5.4	U	5.4	5.3	U	5.3
Indeno(1,2,3-cd)pyrene	PAH	21	JX	12	200		11	36		12	31	X	12
Naphthalene	PAH	12	U	12	11	U	11	12	U	12	12	U	12
Phenanthrene	PAH	75		12	11	U	11	12	U	12	12	U	12
Pyrene	PAH	110		12	700		11	14	JX	12	12	JX	12

Attachment	1	Sheet No.	6 of 6
Originator	R. J. Nielson	Date	2/3/15
Checked	I. B. Berezovskiy	Date	2/3/15
Calc. No.	0100H-CA-V0206	Rev. No.	1

Acrobat 8.0

CALCULATION COVER SHEET

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

Area: 100-H

Discipline: Environmental *Calculation No: 0100H-CA-V0207

Subject: 100-H-51:3 and 100-H-51:6 Subsites Direct Contact Hazard Quotient and Carcinogenic Risk 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 Summary = 3 Total = 4	R. J. Nielson	I. B. Berezovskiy	J. D. Skoglie	S. G. Wilkinson	10/30/14
1	Cover = 1 Summary = 3 Total = 4	R. J. Nielson	I. B. Berezovskiy	NA	S. G. Wilkinson	2/23/15

SUMMARY OF REVISION

1	Changes were made to remove antimony from the direct contact calculation as all results were undetected.

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

Washington Closure Hanford CALCULATION SHEET

Originator:	R. J. Nielson	Date:	02/03/15	Calc. No.:	0100H-CA-V0207	Rev.:	1
Project:	100-H Area Closure Operations	Job No:	14655	Checked:	I. B. Berezovskiy	Date:	02/03/15
Subject:	100-H-51:3 & 100-H-51:6 Subsites Direct Contact Hazard Quotient and Carcinogenic Risk Calculations					Sheet No.	1 of 3

PURPOSE:

Provide documentation to support the calculation of the direct contact hazard quotient (HQ) and excess carcinogenic risk for the 100-H-51:3 and 100-H-51:6 subsites. 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.

GIVEN/REFERENCES:

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

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

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

4) WCH, 2014, *100-H-51:3 and 100-H-51:6 Subsites Cleanup Verification 95% UCL Calculations*, 0100H-CA-V0206, Rev. 0, Washington Closure Hanford, Richland, Washington.

SOLUTION:

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

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

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

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

Washington Closure Hanford CALCULATION SHEET

Originator:	R. J. Nielson RJN	Date:	02/03/15	Calc. No.:	0100H-CA-V0207	Rev.:	1
Project:	100-H Area Closure Operations	Job No:	14655	Checked:	I. B. Berezovskiy	Date:	02/03/15
Subject:	100-H-51:3 & 100-H-51:6 Subsites Direct Contact Hazard Quotient and Carcinogenic Risk Calculations					Sheet No. 2 of 3	

METHODOLOGY:

The 100-H-51:3 and 100-H-51:6 subsites are comprised of one decision unit for verification sampling, consisting of the excavations. Also included is one focused sample. The direct contact hazard quotient and carcinogenic risk calculations for the 100-H-51:3 and 100-H-51:6 subsites were conservatively calculated for both subsites using the greater of the statistical or maximum value for each analyte in the excavation decision unit from WCH (2014). 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. Barium, chromium, copper, nickel, and selenium are included because they were quantitated at a concentration above the Washington State or Hanford Site background. 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 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 47.3 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 6.6×10^{-3}. 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 1.0×10^{-1}. 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}. Although polycyclic aromatic hydrocarbons (PAH) were detected; the results were determined to be attributable to cross-contamination in the sample from pipe mastic and are not related to the 100-H-51:3 and 100-H-51:6 processes; therefore, PAH analytes are excluded from the calculation. There are no other constituents detected with carcinogenic RAGs; therefore, the criterion for excess cancer risk is met. Consequently, the criterion for cumulative excess cancer risk for carcinogens is also met.

RESULTS:

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

Table 1 shows the results of the calculations.

Washington Closure Hanford CALCULATION SHEET

Originator:	R. J. Nielson	Date:	02/03/15	Calc. No.:	0100H-CA-V0207	Rev.:	1
Project:	100-H Area Closure Operations	Job No:	14655	Checked:	I. B. Berezovskiy	Date:	02/03/15
Subject:	100-H-51:3 & 100-H-51:6 Subsites Direct Contact Hazard Quotient and Carcinogenic Risk Calculations					Sheet No.	3 of 3

Table 1. Direct Contact Hazard Quotient and Excess Cancer Risk Results for the 100-H-51:3 and 100-H-51:6 Subsites.

Contaminants of Potential Concern	Statistical or Maximum Value[a] (mg/kg)	Noncarcinogen RAG[b] (mg/kg)	Hazard Quotient	Carcinogen RAG[b] (mg/kg)	Carcinogen Risk
Metals					
Arsenic[c]	9.3	20	--	--	--
Barium	211	5,600	3.8E-02	--	--
Boron	47.3	7,200	6.6E-03	--	--
Chromium, total	27.8	80,000	3.5E-04	--	--
Copper	62.5	2,960	2.1E-02	--	--
Lead[d]	10.9	353	--	--	--
Molybdenum	3.5	400	8.8E-03	--	--
Nickel	39.0	1,600	2.4E-02	--	--
Selenium	0.81	400	2.0E-03	--	--
Totals					
Cumulative Hazard Quotient:			**1.0E-01**		
Cumulative Excess Cancer Risk:					**0.0E+00**

Notes:

[a] = From WCH (2014).

[b] = Value obtained from the 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 2009a).

[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

CONCLUSION:

The calculations in Table 1 demonstrate that the 100-H-51:3 and 100-H-51:6 subsites meet the requirements for the direct contact hazard quotient and carcinogenic (excess cancer) risk, respectively, as identified in the RDR/RAWP (DOE-RL 2009b) and SAP (DOE-RL 2009a). The direct contact hazard quotient and carcinogenic (excess cancer) risk calculations are for use in the RSVP for this subsite.

Acrobat 8.0

CALCULATION COVER SHEET

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

Area: 100-H

Discipline: Environmental *Calculation No: 0100H-CA-V0208

Subject: 100-H-51:3 and 100-H-51:6 Subsites 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	R. J. Nielson	I. B. Berezovskiy	M. D. Skoglie	S. G. Wilkinson	10/30/14

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:	R. J. Nielson RJN	Date:	10/20/2014	Calc. No.:	0100H-CA-V0208	Rev.:	0
Project:	100-H Area Closure Operations	Job No:	14655	Checked:	I. B. Berezovskiy	Date:	10/20/2014
Subject:	100-H-51:3 and 100-H-51:6 Subsites Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater					Sheet No. 1 of 3	

PURPOSE:

Provide documentation to support the calculation of the hazard quotient (HQ) and excess carcinogenic risk associated with soil contaminant levels compared to soil cleanup levels for protection of groundwater for the 100-H-51:3 and 100-H-51:6 subsites. 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, 2014, *100-H-51:3 and 100-H-51:6 Subsites Cleanup Verification 95% UCL Calculations*, 0100H-CA-V0206, Rev. 0, Washington Closure Hanford, 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 CALCULATION SHEET

Originator:	R. J. Nielson	Date:	10/28/2014	Calc. No.:	0100H-CA-V0208	Rev.:	0
Project:	100-H Area Closure Operations	Job No:	14655	Checked:	I. B. Berezovskiy	Date:	10/28/2014
Subject:	100-H-51:3 and 100-H-51:6 Subsites Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater					Sheet No. 2 of 3	

METHODOLOGY:

The 100-H-51:3 and 100-H-51:6 subsites are comprised of one decision unit for the purpose of verification sampling, consisting of the excavation. Also included is one focused sample. Hazard quotient and carcinogenic risk calculations for potential impact to groundwater at the 100-H-51:3 and 100-H-51:6 subsites were conservatively calculated for the entire subsite using the greater of the statistical or maximum value for each analyte in the decision unit from the 95% UCL calculation (WCH 2014). Antimony is excluded from the calculation because the detected antimony in two samples is the result of heterogeneity in the sample matrix. Both samples were reanalyzed and antimony was undetected. The original elevated antimony results are concluded not to represent sufficient contaminant mass to present a threat to groundwater. Of the contaminants of potential concern (COPCs) for this site, arsenic, boron, and selenium are included because no Washington State or Hanford background value has been established or the detected value is greater than the background value, and the distribution coefficients are less than that necessary to show no migration to groundwater in 1,000 years using the generic site RESRAD model (BHI 2005). Based on this model and a vadose zone of approximately 9 m (29.5 ft) thickness, a K_d of 7.9 or greater is required to show no predicted migration to groundwater in 1,000 years. All other site nonradionuclide COPCs were not detected, quantified below background levels, or have a K_d greater than or equal to 7.9. An example of the HQ and risk calculations for soil constituents with a potential impact to groundwater is presented below:

1) The hazard quotient is defined as the ratio of the dose of a substance obtained over a specified time (mg/kg/day) to a reference dose for the same substance derived over the same specified time (mg/kg/day). The hazard quotient can also be calculated as the ratio of the concentration in soil (maximum or statistical value) (mg/kg) to the soil RAG (mg/kg) for protection of groundwater, where the RAG is the groundwater cleanup level (mg/L) (calculated with, and related to the hazard quotient through, WAC 173-340-720(3)(a)(ii)(A), 1996) x 100 x 1 mg/1000 mg (conversion factor). This is based on the "100 times rule" of WAC 173-340-740(3)(a)(ii)(A) (1996). For example, the statistical value for selenium of 0.81 mg/kg, divided by the noncarcinogenic RAG value of 5 mg/kg is 1.6×10^{-1}. Comparing this value to the requirement of <1.0, this criterion is met.

2) After the HQ calculation is completed for the appropriate analytes, the cumulative HQ can be obtained by summing the individual values. (To avoid errors due to intermediate rounding, the individual HQ values prior to rounding are used for this calculation.) The cumulative HQ for the 100-H-51:3 and 100-H-51:6 subsites is 3.1×10^{-1}. 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}. The 100-H-51:3 and 100-H-51:6 subsites do not have any constituents with carcinogenic RAGs; therefore, the criterion for excess risk is met. Consequently, the criterion for cumulative excess cancer risk for carcinogens 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 ground water 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 CALCULATION SHEET

Originator:	R. J. Nielson	Date:	10/20/2014	Calc. No.:	0100H-CA-V0208	Rev.:	0
Project:	100-H Area Closure Operations	Job No:	14655	Checked:	I. B. Berezovskiy	Date:	10/20/2014
Subject:	100-H-51:3 and 100-H-51:6 Subsites Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater					Sheet No. 3 of 3	

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-51:3 and 100-H-51:6 Subsites.

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	9.3	20[c]	--	--	--
Boron	47.3	320	1.5E-01	--	--
Selenium	0.81	5	1.6E-01	--	--
Totals					
Cumulative Hazard Quotient:			**3.1E-01**		
Cumulative Excess Cancer Risk:					**0.0E+00**

Notes:

[a] = From WCH (2014).

[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 2009). The arsenic standard is not toxicity based, therefore, will not have a hazard quotient calculated.

-- = not applicable

RAG = remedial action goal

CONCLUSION:

This calculation demonstrates that the 100-H-51:3 and 100-H-51:6 subsites meet the requirements for the hazard quotient 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. All samples were collected and analyzed per the sample design, with minimal alterations, as warranted by field conditions. The proximity of pump-and-treat piping necessitated a field change to the location of sample EXC-11, which was moved approximately 3.7 m (12.1 ft) north of the location specified in the sample design (WCH 2014b). This change will have no impact on the evaluation of the 100-H-51:3 and 100-H-51:6 subsites.

To ensure quality data, the 100 Area SAP (DOE/RL 2009) data assurance requirements and the *Data Validation Procedures for Chemical Analysis* (BHI 2000) is 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 data from samples collected at the 100-H-51:3 and 100-H-51:6 subsites were provided by the laboratories in one sample delivery group (SDG): SDG JP0845. SDG JP0845 was submitted for third-party validation. No major deficiencies were noted. Minor deficiencies are discussed for the 100-H-51:3 and 100-H-51:6 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 JP0845

This SDG comprises 12 statistical soil samples (J1TX47 through J1TX49, J1TX50 through J1TX58) from the excavated areas, a focused sample (J1TX59), a duplicate (J1TX60), and an equipment blank (J1TX61), for a total of 15 samples. All samples were analyzed for inductively coupled plasma (ICP) metals, mercury, hexavalent chromium, and polycyclic aromatic hydrocarbons (PAH) with the exception of the equipment blank (J1TX61), which was analyzed for ICP metals and mercury. Additionally, two samples (J1TX49 and J1TX57) were reanalyzed

for ICP metals to evaluate some spurious antimony results, which are discussed below. SDG JP0845 was submitted for third-party validation. Minor deficiencies are as follows.

In the ICP metals analysis, matrix spike recoveries for antimony (43%) and silicon (15%) are outside quality control (QC) limits. Third-party validation qualified all antimony and silicon results in SDG JP0845 as estimated with "J" flags. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, analytical results for antimony in samples J1TX49 and J1TX57 were higher than normally expected. The project requested that the laboratory reanalyze these two samples for ICP metals. The resulting data, recorded as samples J1TX49-A and J1TX57-A, were non-detected for antimony. This wide range in the antimony results suggests a high degree of heterogeneity in the sample matrix. Additionally, the laboratory qualified most of the analytes in the original sample data with "X" flags, indicating physical or chemical interference may also be impacting the reported values. The original antimony data is retained for evaluation purposes; however, these antimony results should be considered estimated. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, low levels of chromium and nickel were detected in the method blank. The field sample results for chromium and nickel were sufficient that there is no impact on those results. However, the equipment blank (J1TX61) results were of similar magnitude. Third-party validation qualified the chromium and nickel for sample J1TX61 as nondetected and estimated with "UJ" flags. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, the laboratory control sample results for silicon (9%) is outside QC limits. Third-party validation qualified all silicon results in SDG JP0845 as estimated with "J" flags. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, the relative percent difference (RPD) calculated for iron (132%) in sample J1TX61 is outside QC limits. Third-party validation qualified the iron result for sample J1TX61 as estimated with a "J" flag. Estimated data are usable for decision-making purposes.

In the PAH analysis, the matrix spike recovery for benzo(a)pyrene (550%) is outside the QC limits. These results suggests a possible high bias in the field sample results for benzo(a)pyrene. Third-party validation qualified all detected benzo(a)pyrene results in SDG JP0845 as estimated with "J" flags. Estimated and/or high biased data are usable for decision-making purposes.

In the PAH analysis, a surrogate recovery associated with sample J1TX49 is outside the QC limits. Third-party validation qualified all detected PAH results in sample J1TX49 as estimated with "J" flags. Estimated data are usable for decision-making purposes.

In the PAH analysis, the RPD calculated for benzo(a)pyrene (138%) is outside QC limits. Third-party validation qualified all benzo(a)pyrene results in SDG JP0845 as estimated with "J" flags. Estimated data are usable for decision-making purposes.

FIELD QUALITY ASSURANCE/QUALITY CONTROL

Relative percent difference 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	J1TX60	J1TX59

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 RPDs calculated for the field duplicate pair (J1TX60/J1TX59) were above the 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, including undetected analytes. 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 analytes in the 100-D-51:3 and 100-D-51:6 data set required this check.

A visual inspection of all of the data is also performed. No additional major or minor deficiencies are noted. The data are 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 the data set are within expectations for the matrix types and analyses performed. The DQA review of the 100-H-51:3 and 100-H-51:6 subsite verification sampling data found that the analytical results are accurate within the standard errors associated with the analytical methods, sampling, and

sample handling. The DQA review for 100-H-51:3 and 100-H-51:6 subsites 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 Washington Closure Hanford project-specific database prior to being submitted for inclusion in the Hanford Environmental Information System database. The verification sample analytical data are also summarized in Appendix 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-1627-08, pp. 40-44, Washington Closure Hanford, Richland, Washington.

WCH, 2014b, *Work Instruction for Verification Sampling of the 100-H-51:3, 184-H Brine Discharge Line and 100-H-51:6, Carbon Steel Pipe Waste Sites,* 0100H-WI-G0064, Rev. 0, Washington Closure Hanford, Richland, Washington.