WASTE SITE RECLASSIFICATION FORM

Operable Unit: 100-IU-2 **Control No.:** 2013-093

Waste Site Code(s)/Subsite Code(s):

600-376, Segment 4 Stained Soil Area #2
600-376:1, Segment 4 Stained Soil Area #2a
600-376:2, Segment 4 Stained Soil Area #2b

Reclassification Category: Interim ☒ Final ☐

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

Approvals Needed: DOE ☒ Ecology ☐ EPA ☒

Description of current waste site condition:

The 600-376, Segment 4 Stained Soil Area #2 waste site is located in the 100-IU-2 Operable Unit of the Hanford Site and consists of two subsites which included stained soil areas and patches of bare ground. The 600-376 waste site was added to the *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington* (100 Area Remaining Sites ROD), U.S. Environmental Protection Agency, Region 10, Seattle, Washington (EPA 1999), as a candidate site for confirmatory sampling in the Fact Sheet *100 Area "Plug-In" and Candidate Waste Sites for Calendar Year 2011*, U.S. Department of Energy, Richland Operations Office, Richland, Washington (DOE-RL 2012). This waste site was subsequently recommended for remove, treat, and dispose without confirmatory sampling and is being dispositioned as a "plug-in" site in accordance with 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 (100 Area ESD) (EPA 2009). Remediation of the 600-376 site occurred between September 16, 2013, and September 23, 2013. The final excavation depth for the 600-376:1 and 600-376:2 subsite was 0.6 m (2 ft) and 1.0 m (3.3 ft), respectively. A total of approximately 101 bank cubic meters (132 bank cubic yards) of material was removed and disposed to the Environmental Restoration Disposal Facility (ERDF).

Cleanup verification sampling at the 600-376 subsites was performed on September 17 and 24, 2013, to determine if the subsites meet remedial action objectives (RAOs) and remedial action goals (RAGs) established by the 100 Area Remaining Sites ROD (EPA 1999) and the *Remedial Design Report/Remedial Action Work Plan for the 100 Areas* (100 Area RDR/RAWP), DOE/RL-97-17, Rev. 6, U.S. Department of Energy, Richland Operations Office, Richland, Washington (DOE-RL 2009b). The selected remedy involved (1) excavating the subsite to the extent required to meet specified soil cleanup levels, (2) disposing of contaminated excavation materials at ERDF at the 200 Area of the Hanford Site, (3) demonstrating through verification sampling that cleanup goals have been achieved, and (4) proposing the subsite for reclassification as Interim Closed Out.

Basis for reclassification:

Cleanup verification sampling results were evaluated in comparison to the RAGs. In accordance with this evaluation, the verification sampling results support a reclassification of the 600-376 subsites to Interim Closed Out. The current subsite conditions achieve the RAOs and RAGs established by the 100 Area Remaining Sites ROD (EPA 1999) and the 100 Area RDR/RAWP (DOE-RL 2009b). The results of verification sampling 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 analytical results and rationale presented in the attached remaining sites verification package also demonstrate that residual contaminant concentrations meet direct exposure cleanup criteria and are protective of groundwater and the Columbia River. The subsites contamination does not extend into the deep zone soils. 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 600-376, Segment 4 Stained Soil Area #2* (attached).

WASTE SITE RECLASSIFICATION FORM

Operable Unit: 100-IU-2 **Control No.:** 2013-093

Waste Site Code(s)/Subsite Code(s):

600-376, Segment 4 Stained Soil Area #2
600-376:1, Segment 4 Stained Soil Area #2a
600-376:2, Segment 4 Stained Soil Area #2b

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		1/14/14
DOE Federal Project Director (printed)	Signature	Date
N/A		
Ecology Project Manager (printed)	Signature	Date
C. Guzzetti		1/16/14
EPA Project Manager (printed)	Signature	Date

REMAINING SITES VERIFICATION PACKAGE FOR THE 600-376, SEGMENT 4 STAINED SOIL AREA #2

Attachment to Waste Site Reclassification Form 2013-093

January 2014

REMAINING SITES VERIFICATION PACKAGE FOR THE 600-376, SEGMENT 4 STAINED SOIL AREA #2

EXECUTIVE SUMMARY

The 600-376, Segment 4 Stained Soil Area #2 waste site is part of the 100-IU-2 Operable Unit. This remaining sites verification package combines the reporting of the evaluations, remediation, and subsequent cleanup verification of the two subsites that make up the 600-376 waste site. Based on observations during the field walkdowns to support remedial action, it was determined that these subsites required remediation. The 600-376 waste site was added to the *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington* (100 Area Remaining Sites ROD), (EPA 1999), as a candidate site for confirmatory sampling in the Fact Sheet *100 Area "Plug-In" and Candidate Waste Sites for Calendar Year 2011*, (DOE-RL 2012). This waste site was subsequently recommended for remove, treat, and dispose without confirmatory sampling (WCH 2013c) and is being dispositioned as a "plug-in" site in accordance with 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).

Remediation of the two 600-376 subsites occurred September 16 and 23, 2013, resulting in approximately 101 bank cubic meters (132 bank cubic yards) of soil and debris being removed and disposed at the Environmental Restoration Disposal Facility.

No overburden soil was stockpiled to be used as backfill at either of the subsites. Following remediation, verification sampling was conducted for the 600-376:1 subsite on September 17, 2013, and for the 600-376:2 subsite on September 24, 2013. These results indicated that residual contaminant concentrations met the remedial action objectives (RAOs) and remedial action goals (RAGs) for the two 600-376 subsites.

A summary of the cleanup evaluation for the soil results compared to the applicable cleanup criteria is presented in Table ES-1. The results of the verification sampling are used to make reclassification decisions for the 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 support a reclassification of the 600-376 subsites to Interim Closed Out. The current subsite conditions achieve the RAOs and the corresponding RAGs established in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE-RL 2009b) and the 100 Area Remaining Sites ROD (EPA 1999). These results show that residual soil concentrations support future land uses that can be represented (or bounded) by a rural-residential scenario. The results also demonstrate that residual contaminant concentrations support unrestricted future use of shallow zone soil (i.e., surface to 4.6 m [15 ft]), and contaminant levels remaining in the soil are protective of groundwater and the Columbia River.

Table ES-1. Summary of Remedial Action Goals for the 600-376 Subsites.

Regulatory Requirement	Remedial Action Goals	Results	Remedial Action Objectives Attained?
Direct Exposure – Radionuclides	Attain 15 mrem/yr dose rate above background over 1,000 years.	Radionuclides were not COPCs for the 600-376 subsites.	NA
Direct Exposure – Nonradionuclides	Attain individual COPC RAGs.	All individual COPC concentrations are below the direct-exposure criteria for both subsites	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 all sampling areas (2.2×10^{-3}) is <1.	
	Attain an excess cancer risk of $<1 \times 10^{-6}$ for individual carcinogens.	No carcinogenic constituents met the criteria for evaluation; therefore, no calculations of excess carcinogenic risk were performed.	
	Attain a cumulative excess cancer risk of $<1 \times 10^{-5}$ for carcinogens.	No carcinogenic constituents met the criteria for evaluation; therefore, no calculations of excess carcinogenic risk were performed.	
Groundwater/River Protection – Radionuclides	Attain single COC groundwater and river RAGs.	Radionuclides were not COPCs for the 600-376 subsites.	NA
	Attain National Primary Drinking Water Regulations: 4 mrem/yr (beta/gamma) dose standard to target receptor/organ [a].		
	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 21.2 pCi/L [c].		
Groundwater/River Protection – Nonradionuclides	Attain individual nonradionuclide groundwater and Columbia River cleanup requirements.	Residual concentrations of chromium (total) and/or lead exceed soil RAGs for the protection of groundwater and/or the Columbia River for one or both of the 600-376 subsites. However, RESRAD modeling predicts that these constituents will not migrate to groundwater and hence the Columbia River within 1,000 years. Therefore, residual concentrations of these contaminants are predicted to be protective of groundwater and the Columbia River [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 chromium (total) and/or lead are predicted to be protective of groundwater and Columbia River at the 600-376 subsites for 1,000 years. Site-specific discussions of comparisons of residual contaminant concentrations to RAGs are presented in Tables 10 and 11.

COC = contaminant of concern
COPC = contaminant of potential concern
MCL = maximum contaminant level
NA = not applicable
RAG = remedial action goal
RDR/RAWP = Remedial Design Report/Remedial Action Work Plan
RESRAD = RESidual RADioactivity (dose model)

The 600-376 subsites contamination does not extend into the deep zone soil; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone of the subsites are not required.

Soil cleanup levels were established in the 100 Area Remaining Sites ROD (EPA 1999) based in part on a limited ecological risk assessment. Although not required by the 100 Area Remaining Sites ROD, a comparison against ecological risk screening levels has been made for the 600-376 subsites contaminants of concern, contaminants of potential concern, and other constituents. Those constituents exceeding the ecological screening level in *Washington Administrative Code* 173-340, "Model Toxics Control Act – Cleanup," were arsenic, boron, lead, and vanadium. The U.S. Environmental Protection Agency ecological soil screening levels were exceeded for antimony, cadmium, chromium (total), lead, manganese, vanadium, and zinc. Exceedance of screening values does not necessarily indicate the existence of risk to ecological receptors. Because the detected levels of antimony, cadmium, manganese, vanadium, and zinc are below Hanford Site background levels, 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 ecological effects as a part of the final closeout decision for the Columbia River corridor portion of the Hanford Site.

REMAINING SITES VERIFICATION PACKAGE FOR THE 600-376, SEGMENT 4 STAINED SOIL AREA #2

STATEMENT OF PROTECTIVENESS

The purpose of this remaining sites verification package is to provide verification sampling data, site evaluations, and supporting documentation to demonstrate that the 600-376, Segment 4 Stained Soil Area #2 subsites meet the remedial action objectives (RAOs) and remedial action goals (RAGs) established in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (100 Area RDR/RAWP) (DOE-RL 2009b) and the *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington* (100 Area Remaining Sites ROD) (EPA 1999).

The 600-376 waste site consists of the following two subsites:

- 600-376:1, Segment 4 Stained Soil Area #2a
- 600-376:2, Segment 4 Stained Soil Area #2b.

The results of evaluations of remedial actions at the two subsites show that residual soil concentrations support future land uses that can be represented (or bounded) by a rural-residential scenario. The results also demonstrate that residual contaminant concentrations support unrestricted future use of shallow zone soil (i.e., surface to 4.6 m [15 ft]) and that contaminant levels remaining in the soil are protective of groundwater and the Columbia River. Contamination from the 600-376 subsites does not extend into the deep zone soils; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone of the site are not required.

Soil cleanup levels were established in the 100 Area Remaining Sites ROD (EPA 1999) based in part on a limited ecological risk assessment. Although not required by the 100 Area Remaining Sites ROD, a comparison against ecological risk screening levels has been made for the 600-376 subsites contaminants of concern, contaminants of potential concern, and other constituents. Those constituents exceeding the ecological screening level in *Washington Administrative Code* (WAC) 173-340, "Model Toxics Control Act – Cleanup," were arsenic, boron, lead, and vanadium. The U.S. Environmental Protection Agency (EPA) ecological soil screening levels were exceeded for antimony, cadmium, chromium (total), lead, manganese, vanadium, and zinc. Exceedance of screening values does not necessarily indicate the existence of risk to ecological receptors. Because the detected levels of antimony, cadmium, manganese, vanadium, and zinc are below Hanford Site background levels, 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 ecological effects as a part of the final closeout decision for the Columbia River corridor portion of the Hanford Site.

GENERAL SITE INFORMATION AND BACKGROUND

The two 600-376, Segment 4 Stained Soil Area #2 subsites are part of the 100-IU-2 Operable Unit. Based on observations during the field walkdowns to support remedial action, it was determined that these subsites required remediation. The 600-376 waste site was added to the 100 Area Remaining Sites ROD (EPA 1999) as a candidate site for confirmatory sampling in the Fact Sheet *100 Area "Plug-In" and Candidate Waste Sites for Calendar Year 2011* (DOE-RL 2012). This waste site was subsequently recommended for remove, treat, and dispose without confirmatory sampling (WCH 2013c) and is being dispositioned as a "plug-in" site in accordance with 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).

The general locations of the two 600-376 subsites are shown in Figure 1.

The Washington State Plane coordinates for the two 600-376 subsites are as follows:

- 600-376:1 at N 150178.0, E 575916.6
- 600-376:2 at N 149545.3, E 576272.7.

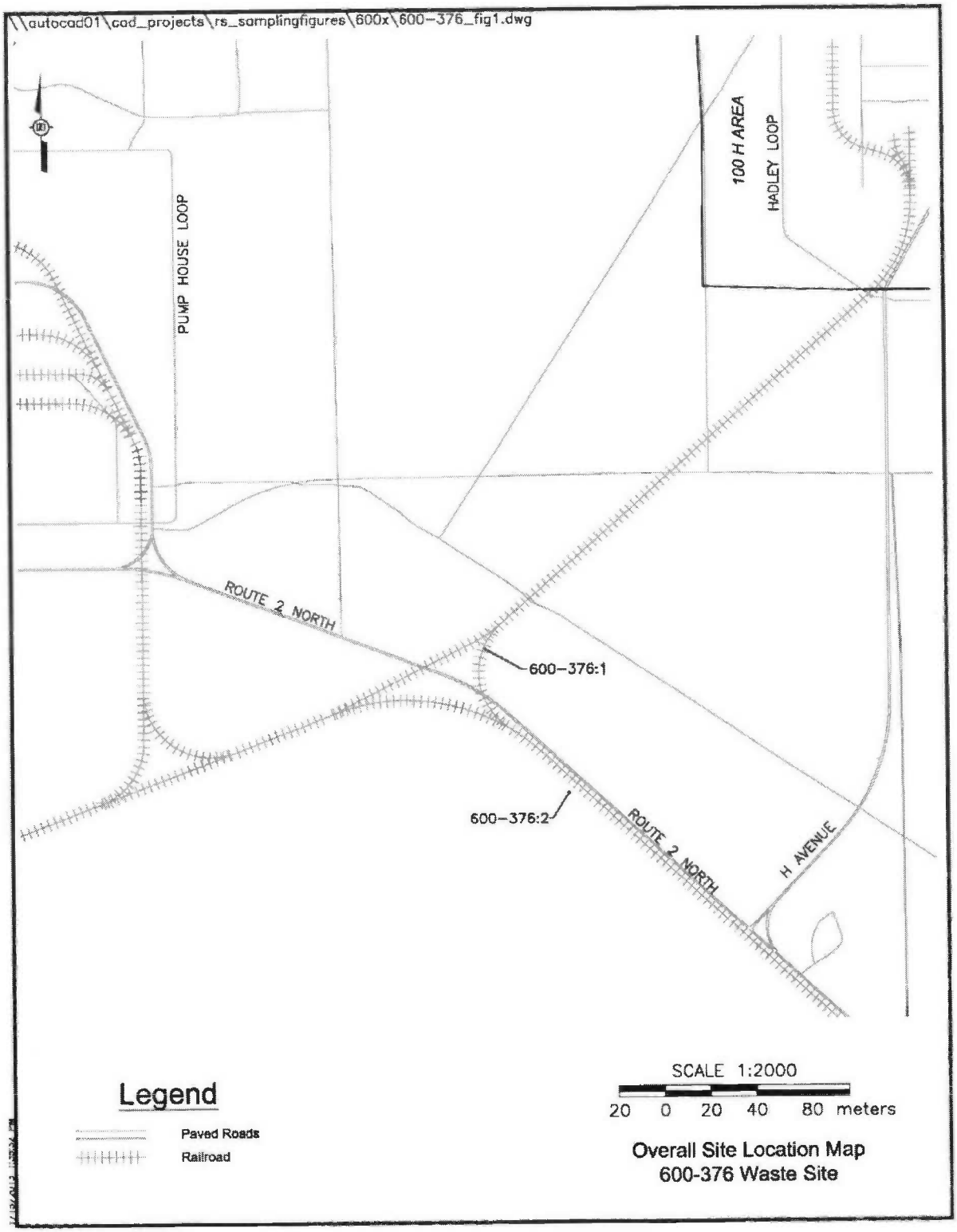
The 600-376:1 subsite consisted of two stained soil areas adjacent to the railroad tracks leading to the 100-H Area.

The 600-376:2 subsite consisted of two patches of bare ground covered with debris including black material, a glass jar (probable food container) with unknown material, and dried yellow material.

The 100-IU-2 and 100-IU-6 orphan sites evaluations that included the 600-376 subsites were performed in 2006 and 2007 (WCH 2009). Various sizes and forms of hazardous substance (*Comprehensive Environmental Response, Compensation, and Liability Act of 1980* and WAC 173-340 surface debris waste materials were found. No process history exists for these subsites; however, the types of debris and evidence of spills found in the area are believed to be the results of general Hanford townsite and White Bluffs activities.

Field walkdowns were performed for these waste sites in the spring and summer of 2011 for the purpose of locating and documenting suspect debris and waste materials. The walkdowns were limited to field observations and no sampling or waste removal was conducted.

Figure 1. The 600-376 Waste Site Location Map.



In January 2013 waste characterization samples were taken at the 600-376 subsites. Table 1 provides the sample numbers and locations.

Table 1. 600-376 Pre-Remediation Waste Characterization Soil Samples.

Location	HEIS Sample Numbers	Sample Date	Requested Analyses
600-376:1	J1RD77	1/28/2013	ICP metals, mercury, PAH, TCLP metals
600-376:2	J1RD78	1/28/2013	

Source: Field logbook EL-1666 (WCH 2013a).

HEIS = Hanford Environmental Information System
ICP = inductively coupled plasma
PAH = polycyclic aromatic hydrocarbons
TCLP = toxicity characteristic leaching procedure

Geophysical Surveys

A geophysical interpretation map for 600-376:1, completed in May 2013 prior to excavation, is presented in Figure 2. A geophysical interpretation map for 600-376:2, completed in March 2013, prior to excavation, is presented in Figure 3. The objective of the geophysical investigations was to determine if subsurface metallic objects were associated with the subsites. No surface or subsurface metal was detected within the Waste Information Data System (WIDS) boundary of either subsite. Surface and subsurface metal was detected near the 600-376:1 subsite and subsurface metal was detected near the 600-376:2 subsite.

REMEDIAL ACTION SUMMARY

Based on observations during the field walkdowns to support remedial action, it was determined that the 600-376 subsites required remediation (WCH 2013c). Remediation of the two 600-376 subsites occurred between September 16 and 23, 2013.

Remedial Action

The final excavation depth for the 600-376:1 subsite was 0.6 m (2.0 ft). The final excavation depth for the 600-376:2 subsite was 1 m (3.3 ft). A total of approximately 101 bank cubic meters (132 bank cubic yards) of material was removed and disposed to the Environmental Restoration Disposal Facility (ERDF).

Post-remediation photographs for the two 600-376 subsites are presented in Figures 4 and 5. Complete removal of stained soil from the 600-376:1 subsite and of surface debris and waste material from the 600-376:2 subsite required excavations beyond the WIDS boundaries, as shown in Figures 6 and 7.

Figure 2. Geophysical Interpretation Map for the 600-376:1 Subsite.

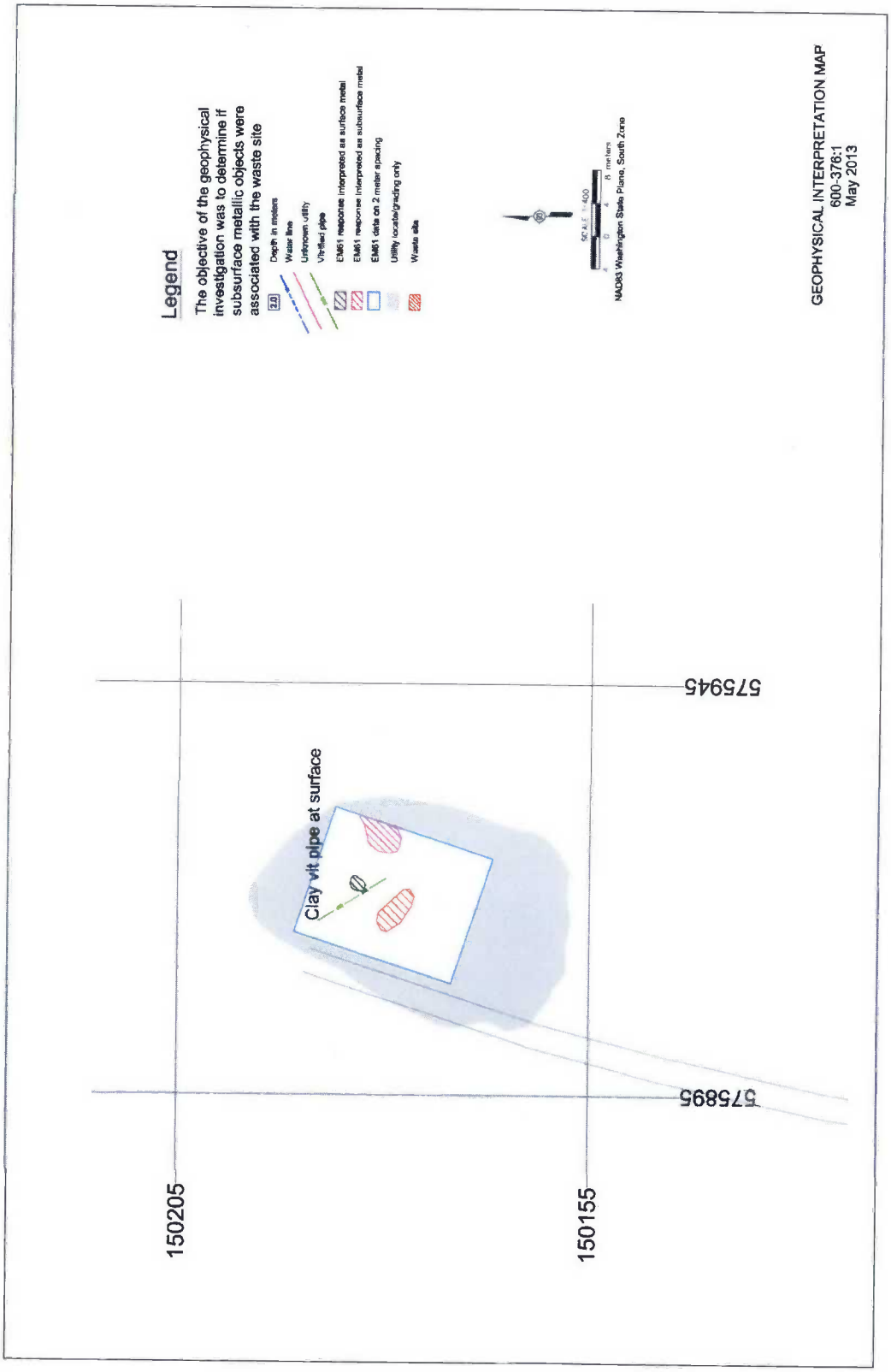


Figure 3. Geophysical Interpretation Map for the 600-376:2 Subsite.

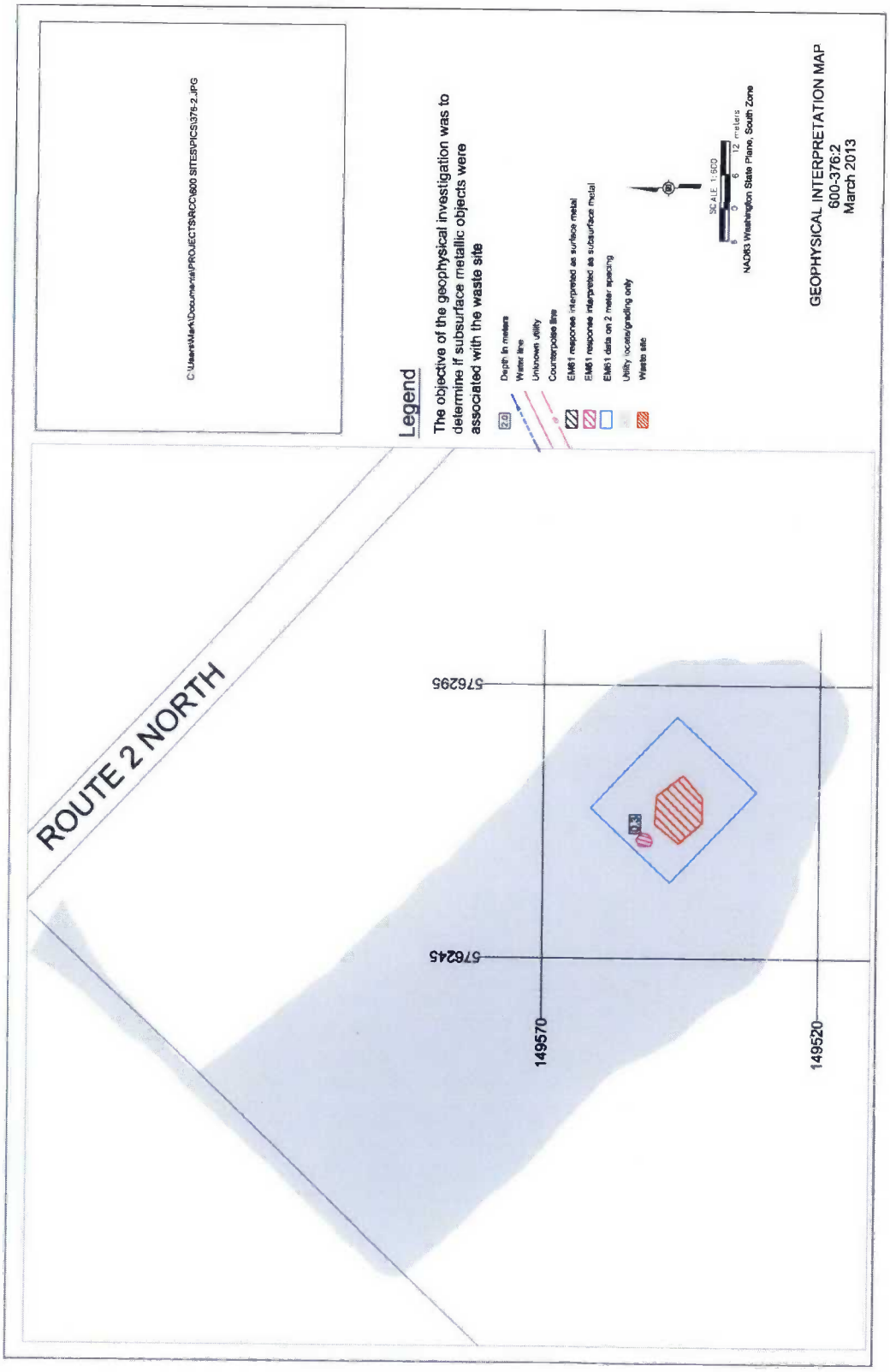


Figure 4. Post-Remediation Photograph of the 600-376:1 Subsite.

Figure 5. Post-Remediation Photograph of the 600-376:2 Subsite.

Figure 6. The 600-376:1 Pre-Excavation WIDS Boundary, Post-Excavation Global Positioning Survey Walk-Around Boundary, and Indicated Coordinates of Composite Sample (September 2013).

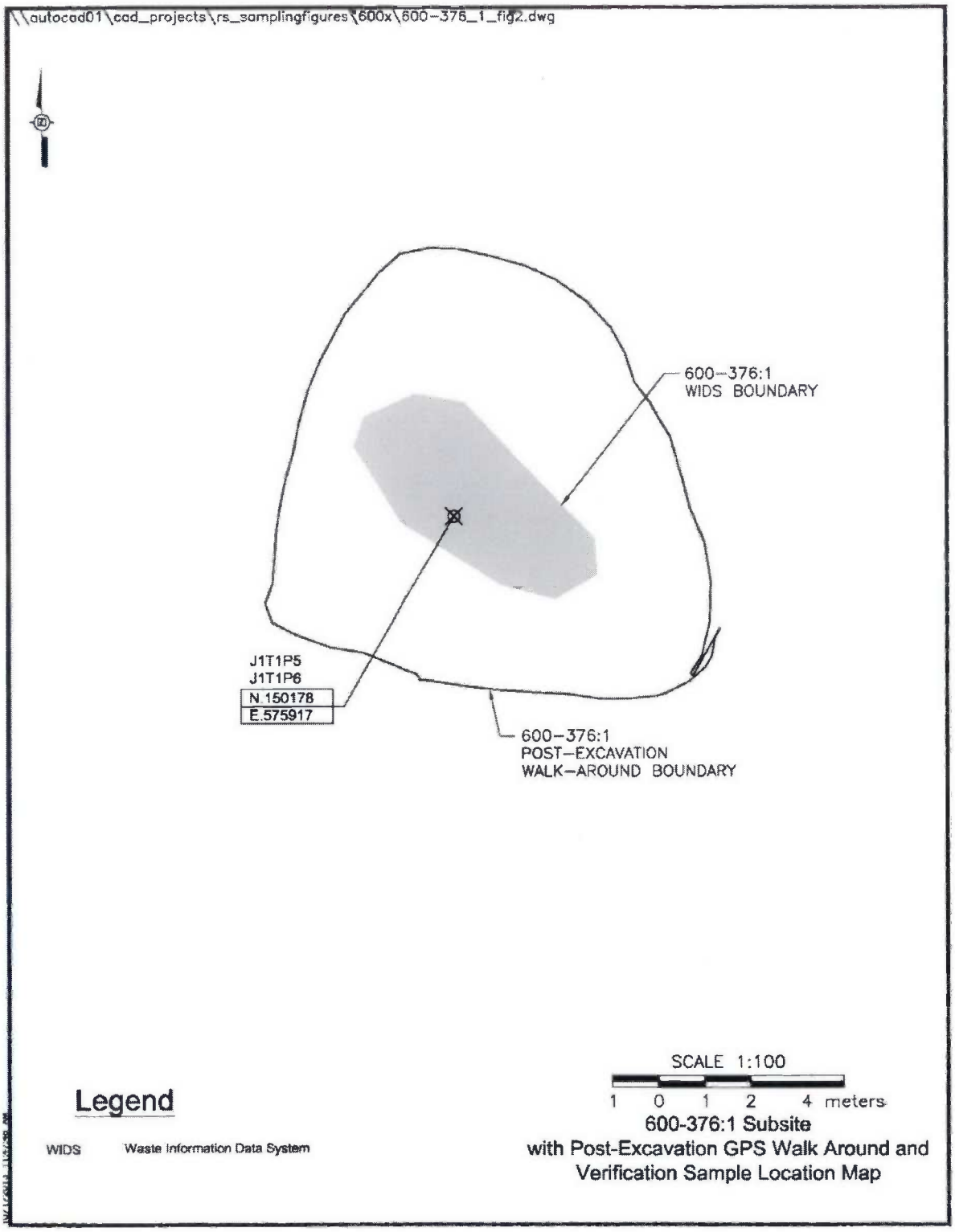
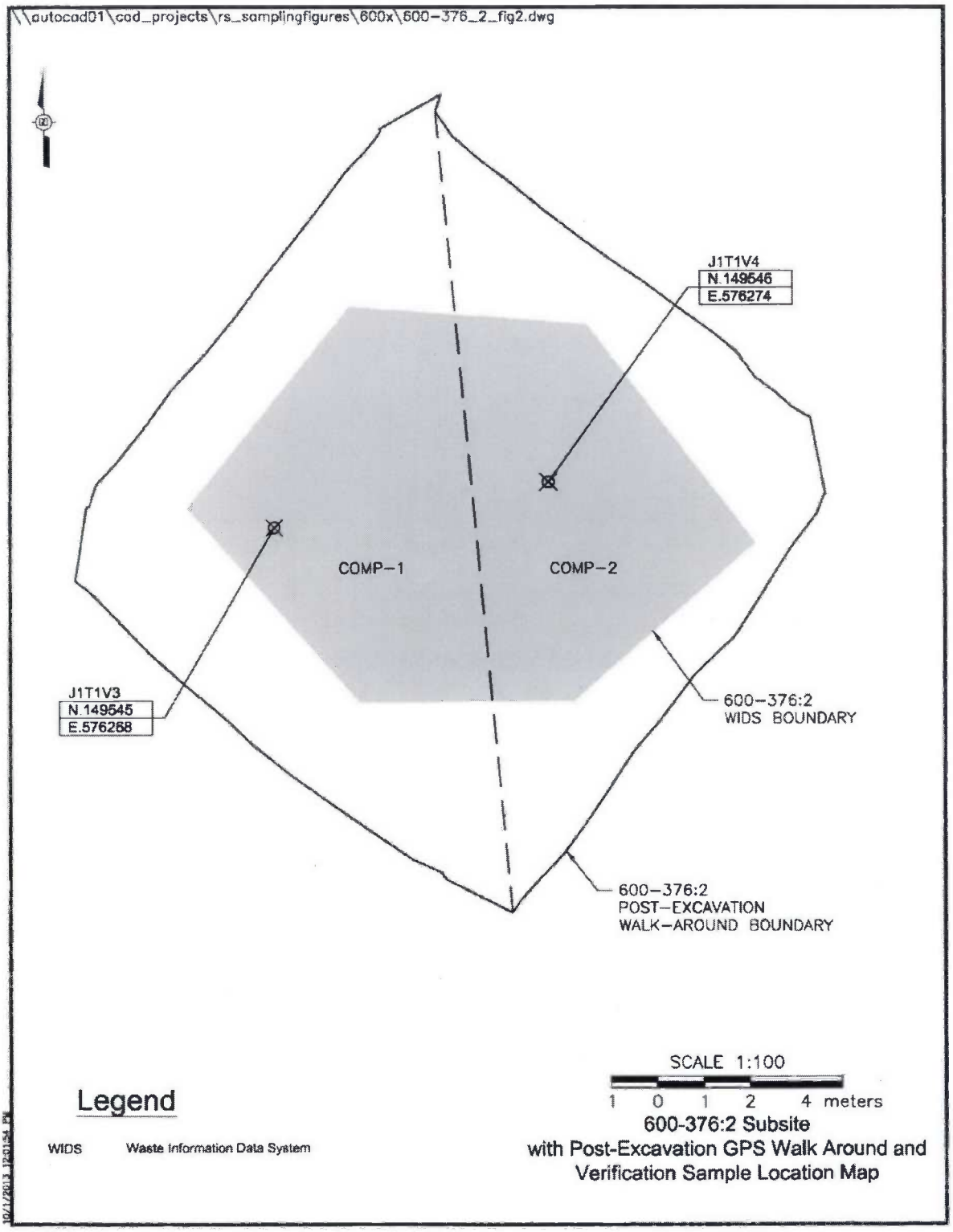


Figure 7. The 600-376:2 Pre-Excavation WIDS Boundary, Post-Excavation Global Positioning Survey Walk-Around Boundary, and Indicated Coordinates of Composite Samples (September 2013).



A post-excavation global positioning survey walk-around for the 600-376 subsites was performed following excavation as shown in Figures 6 and 7. All excavated material was direct loaded for disposal to ERDF, and no soil staging pile area or overburden areas were utilized.

VERIFICATION SAMPLING ACTIVITIES

Verification sampling was conducted at the 600-376 subsites as listed in Table 2. 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 100 Area Remaining Sites ROD (EPA 1999).

Table 2. Verification Sampling Dates.

Subsite Code	Verification Sampling Dates
600-376:1	September 17, 2013
600-376:2	September 24, 2013

The verification sample results are provided in Appendix A and indicate that the waste removal actions achieved compliance with the RAOs and RAGs for the 600-376 subsites. The following subsections provide additional discussion of the information used to develop the verification sampling design. The maximum results of verification sampling are also summarized to support interim closure of the site. A more detailed discussion of the verification sampling can be found in the *Work Instruction for Verification Sampling of the Combined 600 Area Waste Sites, 600-368, 600-369, 600-370, 600-371, 600-372, 600-373, 600-374, 600-375, 600-376, 600-377, 600-379* (WCH 2013d).

Contaminants of Potential Concern

The contaminants of potential concern (COPCs) for the 600-376 subsites were based on site descriptions, the results of waste characterization sampling, and professional judgment. The technical basis for the COPC determination is detailed in Table 3. Analytes that were detected near or above RAGs during waste characterization sampling (WCH 2013d) were included as COPCs for verification sampling. Polycyclic aromatic hydrocarbons were not detected and were not included as COPCs for verification sampling.

The COPCs for verification sampling and the laboratory analytical methods are identified in Table 4.

Table 3. 600-376 Waste Site Verification Sampling Contaminants of Potential Concern.

Waste Site	WIDS Name	Subsite	Operable Unit	Analytes from Waste Characterization Sampling	Suggested COPCs in RTD Report	COPCs for Verification Sampling
600-376	Segment 4 Stained Soil Area #2	600-376:1	100-IU-2	ICP metals, mercury, TCLP metals, PAH	ICP metals, mercury	ICP metals, mercury [a]
		600-376:2				

Source: Verification work instruction (WCH 2013d), field logbook EL-1666-01 (WCH 2013b), and RTD report (WCH 2013c).

[a] Analysis was performed for mercury, though it was not specified in the verification work instruction.

COPC = contaminant of potential concern
ICP = inductively coupled plasma
PAH = polycyclic aromatic hydrocarbons
RTD = remove, treat, dispose
TCLP = toxicity characteristic leaching procedure
WIDS = Waste Information Data System

Table 4. 600-376 Waste Site Laboratory Analytical Methods.

Analytical Method	Contaminant of Potential Concern
ICP metals [a] – EPA Method 6010	Metals [a]
Mercury – EPA Method 7471	Mercury [b]

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

[b] Analysis was performed for mercury, though it was not specified in the verification work instruction.

EPA = U.S. Environmental Protection Agency ICP = inductively coupled plasma

Verification Sample Design

This section describes the basis for selection of an appropriate sample design and determination of the number of verification samples that were collected. All sampling was performed in accordance with the *100 Area Remedial Action Sampling and Analysis Plan* (100 Area SAP) (DOE-RL 2009a). Composite sampling occurred based on the size of each subsite area in accordance with Table 5. The dimensions and numbers of samples per subsite were determined based on previously approved subsite designs in the 100-IU-2 Operable Unit per the verification work instruction (WCH 2013d).

Table 5. Verification Sampling Design Based on Subsite Surface Area (WCH 2013d).

Surface Area	Sample Design
<100 m^2	One composite sample
100 – 500 m^2	Two composite samples (halves)
500 – 1,000 m^2	Four composite samples (quadrants)
>1,000 m^2	Statistical design using Visual Sample Plan [a]

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

Table 6 includes information from the verification sampling instructions (WCH 2013d) that estimated the dimensions of each subsite and correlated the number of composite samples to be collected to the estimated subsite size based on the information in Table 5. Each composite sample consisted of the collection of 25 aliquots of soil distributed across the surface of each excavated area.

Table 6. 600-376 Subsite Dimension and Sample Design Information.

Subsite	WSP Coordinate Northing (m)	WSP Coordinate Easting (m)	Estimated Remediation Dimensions [a] L x W x D (m)	Estimated Surface Area [a] (m^2)	Initial Sample Design [a]	Actual Surface Area [b] (m^2)	Actual Sample Design [c]
600-376:1	150179.0	575916.6	6 x 3 x 1	18	One composite	76.0	One composite
600-376:2	149545.3	576272.7	9 x 12 x 1	108	Two composites	163.8	Two composites

[a] These are the estimated dimensions, surface area, and initial sample design from the verification work instruction (WCH 2013d).
[b] The actual waste site surface areas were determined after remediation activities.
[c] Duplicate samples are not in listed count. See field logbook EL-1666-01 (WCH 2013b).

The Hanford Environmental Information System (HEIS) numbers for each sample are provided in Table 7. Figures 6 and 7 show the waste site excavation footprints and the approximate center of the sampling locations for collection of the composite samples. All sampling was performed in accordance with ENV-1, *Environmental Monitoring & Management*, to fulfill the requirements of the 100 Area SAP (DOE-RL 2009a). Additional information related to verification sampling can be found in the field sampling logbook (WCH 2013b).

Table 7. Verification Sample Summary for the 600-376:1 and 600-376:2 Composite Samples.

Sample Location	HEIS Number	Sample Date	Washington State Plane Coordinate Locations (m)	Sample Analysis
600-376:1, Comp-1	J1T1P5	9/17/2013	N 150178 E 575917	ICP metals [a], mercury
Duplicate of J1T1P5	J1T1P6	9/17/2013		
600-376:2, Comp-1	J1T1V3	9/24/2013	N 149545 E 576268	
600-376:2, Comp-2	J1T1V4	9/24/2013	N 149546 E 576274	
Equipment blank (600-376:1)	J1T1P7	9/17/2013	NA	

Source: Field logbook EL-1666-01 (WCH 2013b).
[a] Analysis for the expanded list of ICP metals included antimony, arsenic, barium, beryllium, boron, cadmium, chromium (total), cobalt, copper, lead, manganese, molybdenum, nickel, selenium, silver, vanadium, and zinc in the analytical results package.
HEIS = Hanford Environmental Information System
ICP = inductively coupled plasma
NA = not applicable

Verification Sample Results

Verification samples were analyzed using EPA-approved analytical methods. The maximum detected value for each analyte was compared to the RAGs for each subsite as specified by the 100 Area RDR/RAWP (DOE-RL 2009b). If no detections for a given COPC were reported in the data set, then no maximum evaluation or calculations were performed for that COPC.

Comparisons of the results for each COPC from the 600-376 subsite excavation areas against site RAGs are summarized in Tables 8 and 9. Contaminants that were not detected by laboratory analysis are excluded from these tables.

Table 8. Comparison of Maximum Verification Sample Contaminant Concentrations to Remedial Action Goals for the 600-376:1 Subsite Verification Sampling Data.

COPC	Maximum Result (mg/kg)	Remedial Action Goals [a]			Does the Maximum Result Exceed RAGs?	Do the Results Pass RESRAD Modeling?
		Direct Exposure	Soil Cleanup Level for Groundwater Protection	Soil Cleanup Level for River Protection		
Antimony [b]	3.14 (<BG)	32	5 [c]	5 [c]	No	--
Arsenic	10.2	20 [c]	20 [c]	20 [c]	No	--
Barium	83.6 (<BG)	5,600	200	400	No	--
Beryllium	0.756 (<BG)	10.4 [d]	1.51 [c]	1.51 [c]	No	--
Boron [e]	1.72	7,200	320	-- [f]	No	--
Cadmium [b]	0.357 (<BG)	13.9 [d]	0.81 [c]	0.81 [c]	No	--
Chromium (total)	12.7 (<BG)	80,000	18.5 [c]	18.5 [c]	No	--
Cobalt	9.00 (<BG)	24	15.7 [c]	-- [f]	No	--
Copper	14.5 (<BG)	2,960	59.2	22.0 [c]	No	--
Lead	31.1	353	10.2 [c]	10.2 [c]	Yes	Yes [g]
Manganese	368 (<BG)	3,760	512 [c]	512 [c]	No	--
Mercury	0.0182 (<BG)	24	0.33 [c]	0.33 [c]	No	--
Molybdenum [e]	0.614	400	8	-- [f]	No	--
Nickel	11.7 (<BG)	1,600	19.1 [c]	27.4	No	--
Vanadium	66.1 (<BG)	560	85.1 [c]	-- [f]	No	--
Zinc	50.8 (<BG)	24,000	480	67.8 [c]	No	--

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

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

[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 per WAC 173-340-750(3), 1996 (Method B for air quality) and an airborne particulate mass loading rate of 0.0001 g/m^3 (*Hanford Guidance for Radiological Cleanup* [WDOH 1997]).

[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 Cleanup Levels and Risk Calculations Database (Ecology 2013) or other databases to calculate cleanup levels (WAC 173-340-730[3][a][iii], 1996 [Method B for surface waters]).

[g] Based on RESRAD modeling discussed in Appendix C of the 100 Area RDR/RAWP (DOE-RL 2009b), residual concentrations are not expected to migrate more than 2 m (6.6 ft) vertically in 1,000 years (based on the K_d of lead with a K_d of 30 mL/g). The vadose zone underlying the soil below the floor of the excavation is approximately 10 m (33 ft) thick based on an elevation at ground surface of 129 m (423 ft), a groundwater elevation of approximately 118 m (387 ft) above mean sea level (*Hanford Site Groundwater Monitoring Report for 2012* [DOE-RL 2013]), and an excavation depth of 0.6 m (2 ft) below ground surface. Therefore, residual concentrations of these contaminants are predicted to be protective of groundwater and the Columbia River.

-- = not applicable
BG = background
COPC = contaminant of potential concern
K_d = distribution coefficient
RAG = remedial action goal
RDR/RAWP = Remedial Design Report/Remedial Action Work Plan
RESRAD = RESidual RADioactivity (dose model)
WAC = *Washington Administrative Code*

Table 9. Comparison of Maximum Verification Sample Contaminant Concentrations to Remedial Action Goals for the 600-376:2 Subsite Verification Sampling Data.

COPC	Maximum Result (mg/kg)	Remedial Action Goals [a]			Does the Maximum Result Exceed RAGs?	Do the Results Pass RESRAD Modeling?
		Direct Exposure	Soil Cleanup Level for Groundwater Protection	Soil Cleanup Level for River Protection		
Arsenic	3.74 (<BG)	20 [b]	20 [b]	20 [b]	No	--
Barium	87.8 (<BG)	5,600	200	400	No	--
Beryllium	0.768 (<BG)	10.4 [c]	1.51 [b]	1.51 [b]	No	--
Boron [d]	1.93	7,200	320	-- [e]	No	--
Cadmium [f]	0.441 (<BG)	13.9 [c]	0.81 [b]	0.81 [b]	No	--
Chromium (total)	28.8	80,000	18.5 [b]	18.5 [b]	Yes	Yes [g]
Cobalt	9.30 (<BG)	24	15.7 [b]	-- [e]	No	--
Copper	18.7 (<BG)	2,960	59.2	22.0 [b]	No	--
Lead	78.6	353	10.2 [b]	10.2 [b]	Yes	Yes [g]
Manganese	357 (<BG)	3,760	512 [b]	512 [b]	No	--
Molybdenum [d]	0.624	400	8	-- [e]	No	--
Nickel	12.9 (<BG)	1,600	19.1 [b]	27.4	No	--
Vanadium	62.0 (<BG)	560	85.1 [b]	-- [e]	No	--
Zinc	50.2 (<BG)	24,000	480	67.8 [b]	No	--

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

[b] 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).

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

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

[e] No parameters (bioconcentration factors or ambient water quality criteria values) are available from the Cleanup Levels and Risk Calculations Database (Ecology 2013) or other databases to calculate cleanup levels (WAC 173-340-730[3][a][iii], 1996 [Method B for surface waters]).

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

[g] Based on RESRAD modeling discussed in Appendix C of the 100 Area RDR/RAWP (DOE-RL 2009b), residual concentrations are not expected to migrate more than 2 m (6.6 ft) vertically in 1,000 years (based on the lowest K_d of the chromium (total) and lead contaminants that exceeded the RAGs [lead with a K_d of 30 mL/g). The vadose zone underlying the soil below the floor of the excavation is approximately 9 m (30 ft) thick based on an elevation at ground surface of 128 m (420 ft), a groundwater elevation of approximately 118 m (387 ft) above mean sea level (*Hanford Site Groundwater Monitoring Report for 2012* [DOE-RL 2013]), and an excavation depth of 1 m (3 ft) below ground surface. Therefore, residual concentrations of these contaminants are predicted to be protective of groundwater and the Columbia River.

-- = not applicable
BG = background
COPC = contaminant of potential concern
K_d = distribution coefficient
RAG = remedial action goal
RDR/RAWP = Remedial Design Report/Remedial Action Work Plan
RESRAD = RESidual RADioactivity (dose model)
WAC = *Washington Administrative Code*

Calculated cleanup levels are not presented in the Cleanup Levels and Risk Calculations Database (Ecology 2013) 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 COPCs and are also not included in these tables. The complete laboratory results for all constituents are stored in a Washington Closure Hanford (WCH) project-specific database prior to archival in the HEIS and are presented in an attachment to the relative percent difference calculation in Appendix A.

VERIFICATION SAMPLE DATA EVALUATION

This section demonstrates that contaminant concentrations at the 600-376 subsites achieve the applicable RAGs developed to support unrestricted land use at the 100 Area as established in the 100 Area Remaining Sites ROD (EPA 1999) and the 100 Area RDR/RAWP (DOE-RL 2009b).

Nonradionuclide Soil RAGs for Direct Exposure and Groundwater and River Protection Attained

Tables 8 and 9 compare the cleanup verification maximum composite sample results to the applicable soil RAGs for direct exposure, protection of groundwater, and protection of the Columbia River.

All maximum composite sample results listed in Tables 8 and 9 from verification sampling at the 600-376 subsites are less than the applicable RAGs with the exception of the results for lead and chromium (total), which were quantified at concentrations exceeding soil RAGs for protection of groundwater and/or the Columbia River. Data were not collected on the vertical extent of these contaminants, but based on RESidual RADioactivity input parameters and soil-partitioning coefficients from Appendix B of the 100 Area RDR/RAWP (DOE-RL 2009b) for a residential exposure scenario, residual concentrations of these contaminants are not expected to migrate vertically more than 2 m (6.6 ft) in 1,000 years (based on the lowest distribution coefficient of the contaminant that exceeded the RAGs, i.e., lead, with a distribution coefficient of 30 mL/g). The shallowest vadose zone underlying the soil below the 600-376 subsites is below the floor of the 600-376:1 excavation and is approximately 9 m (30 ft) thick based on an elevation at ground surface of 128 m (420 ft), a groundwater elevation of approximately 118 m (387 ft) above mean sea level (*Hanford Site Groundwater Monitoring for 2012* [DOE-RL 2013]), and an excavation depth of 1 m (3 ft) below ground surface. Therefore, residual concentrations of these constituents are predicted to be protective of groundwater and the Columbia River.

Nonradionuclide Direct Contact Hazard Quotient and Carcinogenic Risk RAGs Attained

Assessment of the risk requirements for the 600-376 subsites was performed by calculating the hazard quotient and examining the excess carcinogenic risk values for direct contact (Appendix A).
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 600-376 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 levels.

All individual hazard quotients for noncarcinogenic constituents were less than 1.0. The cumulative hazard quotient for those noncarcinogenic constituents above background or detection levels is 2.2×10^{-3}. No carcinogenic constituents met the criteria for evaluation in direct exposure at the 600-376 waste site; therefore, no calculations of excess carcinogenic risk were performed. The requirement of $<1 \times 10^{-6}$ is met. These 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). Calculation of the 600-376 subsites direct contact hazard quotient and carcinogenic risk is presented in Appendix A.

DATA QUALITY ASSESSMENT

A data quality assessment (DQA) was performed to compare the verification sampling approach (WCH 2013d), the field logbook (WCH 2013b), and resulting analytical data with the sampling and data quality requirements specified by the project objectives and performance specifications.

The DQA for the 600-376 subsites established that the data are of the right type, quality, and quantity to support site cleanup verification decisions within specified error tolerances. The evaluation verified that the sample design was sufficient for the purpose of clean site verification. The complete laboratory results for all constituents are stored in a WCH project-specific database prior to archival in HEIS and are presented in Attachment 1 of the calculations (Appendix A). The detailed DQA is presented in Appendix B.

SUMMARY FOR INTERIM CLOSURE

The 600-376 subsites have been evaluated in accordance with the 100 Area Remaining Sites ROD (EPA 1999) and the 100 Area RDR/RAWP (DOE-RL 2009b). Remedial action was performed September 11 and 16, 2013, removing contaminated soil and debris from the sites. Verification sampling was performed September 17 and 23, 2013, and the analytical results indicate that the residual concentrations of COPCs meet the RAGs and associated RAOs for direct exposure, groundwater protection, and river protection.

In accordance with this evaluation, the verification sampling results support a reclassification of the 600-376 subsites to Interim Closed Out. The 600-376 subsites' contamination does not extend into the deep zone soils; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone of the subsites are not required.

REFERENCES

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WCH, 2013a, *100-K and IU-2/6 Miscellaneous Restoration and Failed Remaining Sites Sampling*, Logbook EL-1666, p. 18, Washington Closure Hanford, Richland, Washington.

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APPENDIX A

CALCULATIONS

APPENDIX A

CALCULATIONS

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

600-376 Waste Site Relative Percent Difference (RPD) and Direct Contact Hazard Quotient and Carcinogenic Risk Calculation, 0600X-CA-V0151, Rev. 0, Washington Closure Hanford, Richland, Washington.

DISCLAIMER FOR CALCULATIONS

The calculations 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.

Acrobat 8.0

CALCULATION COVER SHEET

Project Title: 100-IU-2/6 Field Remediation **Job No. 14655**

Area: 600 Area

Discipline: Environmental Calculation No: 0600X-CA-V0151

Subject: 600-376 Waste Site Relative Percent Difference (RPD) and Direct Contact Hazard Quotient and Carcinogenic Risk Calculation

Computer Program: Excel Program No: Excel 2003

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

Committed Calculation ☒ Preliminary ☐ Superseded ☐ Voided ☐

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover = 1 Summary = 5 Attachment 1 =1 Total = 7	I. B. Berezovskiy IB Berezovskiy	N. K. Schiffern N.K. Schiffern	J. D. Skoglie J. D. Skoglie	D. F. Obenauer D. F. Obenauer	1/7/14

SUMMARY OF REVISION

WCH-DE-018 (05/08/2007)

DE01-437.03

Washington Closure Hanford, Inc. CALCULATION SHEET

Originator:	I. B. Berezovskiy	Date:	10/23/2013	Calc. No.:	0600X-CA-V0151	Rev.:	0
Project:	100-IU-2/6 Field Remediation	Job No:	14655	Checked:	N. K. Schiffern	Date:	10/23/2013
Subject:	600-376 Waste Site RPD and Direct Contact Hazard Quotient and Carcinogenic Risk Calculations					Sheet No.	1 of 5

PURPOSE:

Using sample data from Attachment 1 provide documentation to support the calculation of the direct contact hazard quotient (HQ) and excess carcinogenic risk for the 600-376 waste site. 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.

Also, calculate the relative percent difference (RPD) for primary-duplicate sample pair from 600-376 waste site verification sampling, as necessary.

GIVEN/REFERENCES:

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

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

3) EPA, 1994, *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*, EPA 540/R-94/013, U.S. Environmental Protection Agency, Washington, D.C.

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

5) WCH, 2013, *Remaining Sites Verification Package for the 600-376, Segment 4 Stained Soil Area #2 Waste Site,* Attachment to Waste Site Reclassification Form 2013-093, Washington Closure Hanford, Inc., Richland, Washington.

SOLUTION:

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

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

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

Washington Closure Hanford, Inc. CALCULATION SHEET

Originator:	I. B. Berezovskiy	Date:	10/23/2013	Calc. No.:	0600X-CA-V0151	Rev.:	0
Project:	100-IU-2/6 Field Remediation	Job No:	14655	Checked:	N. K. Schiffern	Date:	10/23/2013
Subject:	600-376 Waste Site RPD and Direct Contact Hazard Quotient and Carcinogenic Risk Calculations					Sheet No. 2 of 5	

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

5) Use data from Attachment 1 to perform the RPD calculations for primary-duplicate sample pairs, as required.

METHODOLOGY:

The 600-376 waste site underwent composite sampling. Three samples and one duplicate were collected from the 600-376 waste site. The direct contact hazard quotient and carcinogenic risk calculations for the 600-376 waste site were conservatively calculated using the greatest of the maximum soil sample results from Attachment 1. Of the contaminants of potential concern (COPCs) for this site, boron and molybdenum require HQ and risk calculations because they were detected and a Washington State or Hanford Site background value is not available. Chromium requires HQ and risk calculations because it was detected above background levels. Arsenic was detected above background; however, arsenic cleanup level is not toxicity based, and therefore HQ and risk calculations for arsenic are not performed. In addition, 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. All other site nonradionuclide COPCs were not detected or were quantified below background levels. An example of the HQ and risk calculations is presented below:

1) For example, the maximum value for boron is 1.93 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 2.7×10^{-4}. Comparing this value, and all other individual values, to the requirement of <1.0, this criterion is met.

2) After the HQ calculation is completed for the appropriate analytes, the cumulative HQ can be obtained by summing the individual values. To avoid errors due to intermediate rounding, the individual HQ values prior to rounding are used for this calculation. The sum of the HQ values is 2.2×10^{-3}. Comparing this value to the requirement of <1.0, this criterion is met.

3) To calculate the excess cancer risk, the maximum value is divided by the carcinogenic RAG value, then multiplied by 1.0×10^{-6}. No carcinogenic constituents met the criteria for evaluation in direct exposure at the 600-376 waste site; therefore, no calculations of excess carcinogenic risk were performed. The requirement of $<1 \times 10^{-6}$ is met.

4) The cumulative excess cancer risk can be obtained by summing the individual values. The sum of the excess cancer risk values is zero. Comparing this value to the requirement of $<1 \times 10^{-5}$, this criterion is met.

5) The RPD is calculated when both the primary value and the duplicate value for a given analyte are above detection limits and are greater than 5 times the target detection limit (TDL). The TDL is a laboratory detection limit pre-determined for each analytical method and is listed for certain analytes in Table II-1 of the SAP (DOE-RL 2009a). Other analytes will have their own pre-determined constituents and will have their own TDLs based on the laboratory and method used. Where direct evaluation of the attached sample data showed that a given analyte was not detected in the primary

Washington Closure Hanford, Inc. CALCULATION SHEET

Originator:	I. B. Berezovskiy	Date:	10/23/2013	Calc. No.:	0600X-CA-V0151	Rev.:	0
Project:	100-IU-2/6 Field Remediation	Job No:	14655	Checked:	N. K. Schiffern	Date:	10/23/2013
Subject:	600-376 Waste Site RPD and Direct Contact Hazard Quotient and Carcinogenic Risk Calculations					Sheet No.	3 of 5

and/or duplicate sample, further evaluation of the RPD value was not performed. The RPD calculations use the following formula:

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

where, M = main sample value D = duplicate sample value

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

For quality assurance/quality control (QA/QC) duplicate RPD calculations, a value less than 30% indicates the data compare favorably. For regulatory splits, a threshold of 35% is used (EPA 1994). If the RPD is greater than 30% (or 35% for regulatory split data), further investigation regarding the usability of the data is performed. No split samples were collected for the verification sampling of the subject site. Additional discussion is provided in the data quality assessment section of the applicable RSVP (WCH 2013), as necessary.

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 hazard quotient and excess cancer risk calculations for the 600-376 waste site.

5) The evaluation of the QA/QC duplicate RPD calculations are performed within the data quality assessment section of the RSVP.

Table 2 shows the results of the RPD calculations for the 600-376 waste site.

Washington Closure Hanford, Inc. CALCULATION SHEET

Originator:	I. B. Berezovskiy	Date:	10/23/2013	Calc. No.:	0600X-CA-V0151	Rev.:	0
Project:	100-IU-2/6 Field Remediation	Job No:	14655	Checked:	N. K. Schiffern	Date:	10/23/2013
Subject:	600-376 Waste Site RPD and Direct Contact Hazard Quotient and Carcinogenic Risk Calculations					Sheet No.	4 of 5

Table 1. Direct Contact HQ and Excess Cancer Risk Results for the 600-376 Waste Site.

Contaminants of Potential Concern	Maximum Value[a] (mg/kg)	Noncarcinogen RAG[b] (mg/kg)	Hazard Quotient	Carcinogen RAG[b] (mg/kg)	Carcinogen Risk
Metals					
Arsenic[c]	10.2	20	--	--	--
Boron	1.93	7,200	2.7E-04	--	--
Chromium, total	28.8	80,000	3.6E-04	--	--
Lead[d]	78.6	353	--	--	--
Molybdenum	0.624	400	1.6E-03	--	--
Totals					
Cumulative Hazard Quotient:			**2.2E-03**		
Cumulative Excess Cancer Risk:					**0.0E+00**

Notes:

[a] = From Attachment 1.

[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

Table 2. Relative Percent Difference Calculations for the 600-376 Waste Site (2 Pages).

600-376 Waste Site Duplicate Analysis

Sampling Area	HEIS Number	Sample Date	Aluminum			Arsenic			Barium			Beryllium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
600-376:1, Comp-1	J1T1P5	9/17/13	7110		7.23	8.46		0.531	73.2		0.106	0.695		0.106
600-376:1, Dplicate of J1T1P5	J1T1P6	9/17/13	7860		7.05	10.2		0.518	83.6		0.104	0.756		0.104

Analysis:

TDL		5	10	2	0.2
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	Yes (calc RPD)	No-Stop (acceptable)	Yes (calc RPD)	No-Stop (acceptable)
	RPD	10.0%		13.3%	
	Difference > 2 TDL?	Not applicable	No - acceptable	Not applicable	No - acceptable

600-376 Waste Site Duplicate Analysis

Sampling Area	HEIS Number	Sample Date	Boron			Cadmium			Calcium			Chromium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
600-376:1, Comp-1	J1T1P5	9/17/13	1.70	B	1.06	0.350	B	0.106	3160		8.50	11.8		0.159
600-376:1, Dplicate of J1T1P5	J1T1P6	9/17/13	1.72	B	1.04	0.357	B	0.104	3550		8.29	12.7		0.155

Analysis:

TDL		2	0.2	100	1
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	No-Stop (acceptable)	No-Stop (acceptable)	Yes (calc RPD)	Yes (calc RPD)
	RPD			11.6%	7.3%
	Difference > 2 TDL?	No - acceptable	No - acceptable	Not applicable	Not applicable

Washington Closure Hanford, Inc. CALCULATION SHEET

Originator:	I. B. Berezovskiy	Date:	10/23/2013	Calc. No.:	0600X-CA-V0151	Rev.:	0
Project:	100-IU-2/6 Field Remediation	Job No:	14655	Checked:	N. K. Schiffern	Date:	10/23/2013
Subject:	600-376 Waste Site RPD and Direct Contact Hazard Quotient and Carcinogenic Risk Calculations					Sheet No. 5 of 5	

Table 2. Relative Percent Difference Calculations for the 600-376 Waste Site (2 Pages).

600-376 Waste Site Duplicate Analysis

Sampling Area	HEIS Number	Sample Date	Cobalt			Copper			Iron			Lead		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
600-376:1, Comp-1	J1T1P5	9/17/13	7.63	D	0.797	13.2		0.319	19900		8.50	22.5	*DN	1.75
600-376:1, Dplicate of J1T1P5	J1T1P6	9/17/13	9.00	D	0.777	14.5		0.311	22200		8.29	31.1	*DN	1.71

Analysis:

TDL		2	1	5	5
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	No-Stop (acceptable)	Yes (calc RPD)	Yes (calc RPD)	No-Stop (acceptable)
	RPD		9.4%	10.9%	
	Difference > 2 TDL?	No - acceptable	Not applicable	Not applicable	No - acceptable

600-376 Waste Site Duplicate Analysis

Sampling Area	HEIS Number	Sample Date	Magnesium			Manganese			Molybdenum			Mercury		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
600-376:1, Comp-1	J1T1P5	9/17/13	4000		9.03	309		0.213	0.560	B	0.213	0.0125	B	0.004
600-376:1, Dplicate of J1T1P5	J1T1P6	9/17/13	4380		8.81	368		0.207	0.614	B	0.207	0.0182		0.004

Analysis:

TDL		75	5	2	0.2
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	Yes (calc RPD)	Yes (calc RPD)	No-Stop (acceptable)	No-Stop (acceptable)
	RPD	9.1%	17.4%		
	Difference > 2 TDL?	Not applicable	Not applicable	No - acceptable	No - acceptable

600-376 Waste Site Duplicate Analysis

Sampling Area	HEIS Number	Sample Date	Nickel			Potassium			Silicon			Sodium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
600-376:1, Comp-1	J1T1P5	9/17/13	10.2	M	0.159	1690	N	6.80	720	*N	1.59	119		7.44
600-376:1, Dplicate of J1T1P5	J1T1P6	9/17/13	11.7	M	0.155	1800	N	6.63	847	*N	1.55	136		7.25

Analysis:

TDL		4	400	2	50
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	No-Stop (acceptable)	No-Stop (acceptable)	Yes (calc RPD)	No-Stop (acceptable)
	RPD			16.2%	
	Difference > 2 TDL?	No - acceptable	No - acceptable	Not applicable	No - acceptable

600-376 Waste Site Duplicate Analysis

Sampling Area	HEIS Number	Sample Date	Vanadium			Zinc		
			mg/kg	Q	PQL	mg/kg	Q	PQL
600-376:1, Comp-1	J1T1P5	9/17/13	57.3	D	0.531	49.0	D	2.13
600-376:1, Dplicate of J1T1P5	J1T1P6	9/17/13	66.1	D	0.518	50.8	D	2.07

Analysis:

TDL		2.5	1.0
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)
	Both >5xTDL?	Yes (calc RPD)	Yes (calc RPD)
	RPD	14.3%	3.6%
	Difference > 2 TDL?	Not applicable	Not applicable

CONCLUSION:

The calculations in Tables 1 and 2 demonstrate that the 600-376 waste site meets the requirements for the hazard quotients and carcinogenic (excess cancer) risk and RPDs, respectively, as identified in the RDR/RAWP (DOE-RL 2009b) and SAP (DOE-RL 2009a). The hazard quotients and carcinogenic (excess cancer) risk and RPD calculations are for use in the RSVP for this site.

Attachment 1. 600-376 Waste Site 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
600-376:1, Comp-1	J1T1P5	9/17/13	7110		7.23	1.75	DU	1.75	8.46		0.531	73.2		0.106	0.695		0.106
600-376:1, Dplicate of J1T1P5	J1T1P6	9/17/13	7860		7.05	3.14	BD	1.71	10.2		0.518	83.6		0.104	0.756		0.104
600-376:2, Comp-1	J1T1V3	9/24/13	7850		6.85	1.66	DUJ	1.66	3.72		0.504	87.8	NJ	0.101	0.768		0.101
600-376:2, Comp-2	J1T1V4	9/24/13	7220		6.77	2.13	BCD UJ	1.64	3.74		0.498	82.5	NJ	0.0995	0.710		0.0995
Equipment Blank	J1T1P7	9/17/13	145		5.88	0.285	U	0.285	0.589	B	0.433	2.02		0.0865	0.119	B	0.0865

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
600-376:1, Comp-1	J1T1P5	9/17/13	1.70	B	1.06	0.350	B	0.106	3160		8.50	11.8		0.159	7.63	D	0.797
600-376:1, Dplicate of J1T1P5	J1T1P6	9/17/13	1.72	B	1.04	0.357	B	0.104	3550		8.29	12.7		0.155	9.00	D	0.777
600-376:2, Comp-1	J1T1V3	9/24/13	1.93	B	1.01	0.441	B	0.101	6730	*	8.06	12.0		0.151	8.93	D	0.756
600-376:2, Comp-2	J1T1V4	9/24/13	1.50	B	0.995	0.391	B	0.0995	4750	*	7.96	28.8		0.149	9.30	D	0.746
Equipment Blank	J1T1P7	9/17/13	0.865	U	0.865	0.0865	U	0.0865	34.7		6.92	0.163	B	0.130	0.282	B	0.130

Sample Location	HEIS Number	Sample Date	Copper			Iron			Lead			Magnesium			Manganese		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
600-376:1, Comp-1	J1T1P5	9/17/13	13.2		0.319	19900		8.50	22.5	*DN	1.75	4000		9.03	309		0.213
600-376:1, Dplicate of J1T1P5	J1T1P6	9/17/13	14.5		0.311	22200		8.29	31.1	*DN	1.71	4380		8.81	368		0.207
600-376:2, Comp-1	J1T1V3	9/24/13	18.7		0.302	22600		8.06	4.60		0.333	5100		8.57	357		0.202
600-376:2, Comp-2	J1T1V4	9/24/13	17.5		0.299	22500		7.96	78.6		0.328	4830		8.46	351		0.199
Equipment Blank	J1T1P7	9/17/13	0.285	B	0.260	886		6.92	0.536	*BN	0.285	29.8		7.35	7.13		0.173

Sample Location	HEIS Number	Sample Date	Mercury			Molybdenum			Nickel			Potassium			Selenium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
600-376:1, Comp-1	J1T1P5	9/17/13	0.0125	B	0.00427	0.560	B	0.213	10.2	M	0.159	1690	N	6.80	0.322	DU	0.322
600-376:1, Dplicate of J1T1P5	J1T1P6	9/17/13	0.0182		0.00393	0.614	B	0.207	11.7	M	0.155	1800	N	6.63	0.322	DU	0.322
600-376:2, Comp-1	J1T1V3	9/24/13	0.00428	U	0.00428	0.618	B	0.202	12.5		0.151	1580	NJ	6.45	0.353	DU	0.353
600-376:2, Comp-2	J1T1V4	9/24/13	0.00421	U	0.00421	0.624	B	0.199	12.9		0.149	1580	NJ	6.37	0.328	DU	0.328
Equipment Blank	J1T1P7	9/17/13	0.00384	U	0.00384	0.173	U	0.173	0.462	CM	0.130	47.1	N	5.54	0.310	DU	0.310

Sample Location	HEIS Number	Sample Date	Silicon			Silver			Sodium			Vanadium			Zinc		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
600-376:1, Comp-1	J1T1P5	9/17/13	720	*N	1.59	0.106	U	0.106	119		7.44	57.3	D	0.531	49.0	D	2.13
600-376:1, Dplicate of J1T1P5	J1T1P6	9/17/13	847	*N	1.55	0.104	U	0.104	136		7.25	66.1	D	0.518	50.8	D	2.07
600-376:2, Comp-1	J1T1V3	9/24/13	582	*NJ	1.51	0.101	U	0.101	190		7.06	62.0	D	0.504	47.7	D	2.02
600-376:2, Comp-2	J1T1V4	9/24/13	587	*NJ	1.49	0.0995	U	0.0995	170		6.97	62.0	D	0.498	50.2	D	1.99
Equipment Blank	J1T1P7	9/17/13	125	*N	1.30	0.0865	U	0.0865	6.06	U	6.06	0.851		0.0865	1.77	C	0.346

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

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

* = duplicate analysis not within control limits

B = estimated (inorganic)

C = detected in both the sample and the QC blank, and the sample concentration was <= 5X the blank concentration.

D = results are reported from a dilution.

HEIS=Hanford Environmental Information System

J = estimated

M = sample duplicate precision not met.

N = recovery exceeds upper or lower control limits.

PQL = practical quantitation limit

Q = qualifier

U = undetected

Attachment	1	Sheet No.	1 of 1
Originator	I. B. Berezovskiy	Date	10/23/13
Checked	N. K. Schiffern	Date	10/23/13
Calc. No.	0600X-CA-V0151	Rev. No.	0

APPENDIX B

DATA QUALITY ASSESSMENT

APPENDIX B

DATA QUALITY ASSESSMENT

VERIFICATION SAMPLING DATA QUALITY ANALYSIS

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 2013b). 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 2013b), the field logbook (WCH 2013a), and applicable analytical data packages has been performed as part of this DQA. All samples were collected and analyzed per the sample design. To ensure quality data, the 100 Area SAP data assurance requirements and the data validation procedures for chemical analysis (BHI 2000) are used as appropriate. This review involves evaluation of the data to determine if they are of the right type, quality, and quantity to support the intended use (i.e., closeout decisions). The DQA completes the data life cycle (i.e., planning, implementation, and assessment) that was initiated by the data quality objectives process (EPA 2006).

Verification sample data collected at the 600-376 waste site were provided by the laboratories in two sample delivery groups (SDGs): SDG XP0013 and SDG XP0019. The SDG XP0019 was submitted for third-party validation. No major deficiencies were identified in the analytical data set. Minor deficiencies are discussed for the 600-376 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.

SDG XP0013

This SDG comprises one composite soil sample (J1T1P5) collected from the 600-376:1 subsite excavation. This SDG includes one field duplicate pair (J1T1P5/J1T1P6). These samples were analyzed for inductively coupled plasma (ICP) metals and mercury. In addition, a field equipment blank sample (J1T1P7) was collected and analyzed for ICP metals and mercury. Minor deficiencies are as follows.

In the ICP metals analysis, the laboratory duplicate relative percent difference (RPD) for lead and silicon is above the acceptance criteria of 30% at 63.0% and 46.1%, respectively. Elevated RPDs in environmental soil samples are generally attributed to natural heterogeneities in the sample matrix. Although not qualified for the RPDs above the quality control (QC) limits, all lead and silicon results in SDG XP0013 may be considered estimated. Estimated data are usable for decision-making purposes.

In the ICP analysis, aluminum, nickel, and zinc were detected in the method blank (MB) at very low levels at less than 1/25th of the detected field sample result. Although not qualified for the

method blank contamination, all aluminum, nickel, and zinc results may be considered estimated. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, the matrix spike (MS) recoveries are out of project acceptance criteria for three analytes (lead [141%], potassium [134%], silicon [0%]). Post spike (PS) was performed for all three analytes. Silicon [313%] was the only analyte with and PS recovery out of project acceptance criteria. The deficiency in the MS is a reflection of the variability of the native concentration rather than a measure of the recovery from the sample. Lead, potassium, and silicon did not have mismatched spike and native concentrations in the MS. Although not qualified for MS recovery outside of QC limits, lead, potassium, and silicon results for SDG XP0013 may be considered estimated. Estimated data are usable for decision-making purposes.

SDG XP0019

This SDG comprises two composite soil samples (J1T1V3/J1T1V4) collected from the 600-376:2 subsite excavation. These samples were analyzed for inductively coupled plasma (ICP) metals and mercury. SDG XP0019 was submitted for third-party validation. Minor deficiencies are as follows.

In the ICP metals analysis, antimony was detected in the MB. Due to MB contamination, third-party validation qualified all antimony results as undetected with "UJ" flags. The data are usable for decision-making purposes.

In the ICP metals analysis, the matrix spike (MS) recoveries are out of project acceptance criteria for three analytes (barium, potassium, and silicon). A PS was performed on all three analytes and recoveries were as follows: Barium (38.4%), potassium (117%), and silicon (351%). The deficiency in the MS is a reflection of the variability of the native concentration rather than a measure of the recovery from the sample. barium (157%), potassium (242%), and silicon (7.64%) did not have mismatched spike and native concentrations in the MS. All barium, potassium, and silicon results for SDG XP0019 were qualified as estimates by third-party validation with "J" flags. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, the laboratory duplicate RPD for silicon is above the acceptance criteria of 30% at 36.2%. Elevated RPDs in environmental soil samples are generally attributed to natural heterogeneities in the sample matrix. All silicon results for SDG XP0019 were qualified as estimates, by third-party validation, 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 2013a) include 600-376 primary and duplicate sample pair (J1RVJ7/J1RVJ8). The main and QA/QC sample results are presented in Appendix A.

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 (TDL). 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 A provides details on duplicate pair evaluation and RPD calculation.

None of the RPDs calculated for the field duplicate sample are above the acceptance criteria (30%). A secondary check of the data variability is used when one or both of the samples being evaluated (main and duplicate) is less than five times the TDL, including undetected analytes. In these cases, a control limit of ±2 times the TDL is used (Appendix A) to indicate that a visual check of the data is required by the reviewer. None of the data required this check. A visual inspection of all of the data is also performed. No additional major or minor deficiencies are noted. The data are usable for decision-making purposes.

Summary

Limited, random, or sample matrix-specific influenced batch QC issues, such as those discussed above, are a potential for any analysis. The number and types seen in these data sets are within expectations for the matrix types and analyses performed. The DQA review of the 600-376 waste site 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 600-376 waste site 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 A.

REFERENCES

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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.

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WCH, 2013b, *Work Instruction for Verification Sampling of the Combined 600 Area Waste Sites, 600-368, 600-369, 600-370, 600-371, 600-372, 600-373, 600-374, 600-375, 600-376, 600-377, 600-379,* 0600X-WI-G0074, Rev. 0, Washington Closure Hanford, Richland, Washington.