Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

14-AMRP-0085

JAN 09 2014

Mr. D. A. Faulk, Program Manager
Office of Environmental Cleanup
Hanford Project Office
U.S. Environmental Protection Agency
309 Bradley Boulevard, Suite 115
Richland, Washington 99352

Dear Mr. Faulk:

TRANSMITTAL OF APPROVED WASTE SITE RECLASSIFICATION FORM AND SUPPORTING DOCUMENTATION FOR THE 600-370, SEGMENT 4 DEBRIS AREA #1 WASTE SITE, REVISION 0

Attached for your use is the approved Waste Site Reclassification Form No. 2013-084 and supporting, "Remaining Sites Verification Package for the 600-370, Segment 4 Debris Area Waste Site #1," Rev. 0. If you have questions, please contact me or your staff may contact Ellwood Glossbrenner, of my staff, at (509) 376-5828.

Sincerely,

Mark S. French, Federal Project Director
for the River Corridor Closure Project

AMRC:ETG

Attachment

cc w/attach:
C. J. Guzzetti, EPA
Administrative Record, H6-08

cc w/o attach:
S. L. Feaster, WCH
T. Q. Howell, WCH
D. L. Plung, WCH
J. P. Shearer, CHPRC
C. P. Strand, WCH

WASTE SITE RECLASSIFICATION FORM

Operable Unit: 100-IU-2 **Control No.:** 2013-084

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

600-370, Segment 4 Debris Area #1

Reclassification Category: Interim ☒ Final ☐

Reclassification Status: Closed Out ☒ No Action ☐ Rejected ☐

RCRA Postclosure ☐ Consolidated ☐ None ☐

Approvals Needed: DOE ☒ Ecology ☐ EPA ☒

Description of current waste site condition:

The 600-370, Segment 4 Debris Area #1 waste site, located in the 100-IU-2 Operable Unit of the Hanford Site, consisted of multiple burn sites with burn remnants, transite, insulators, wood, and concrete. The 600-370 waste site was located approximately 237 m (778 ft) south of Route 1 and 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), 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 (RTD) without confirmatory sampling and was 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 600-370 waste site was performed from May 8 through July 9, 2013. A single anomaly was discovered and staged outside of the excavation area. Investigation and disposal of the anomaly and the removal of underlying soil was performed on September 9, 2013. A total of approximately 4,853 bank cubic meters (6,347 bank cubic yards) of material was removed and direct loaded for disposal at the Environmental Restoration Disposal Facility (ERDF). Cleanup verification sampling was performed on July 25 and September 10, 2013, to determine if the waste site meets remedial action objectives (RAOs) and remedial action goals (RAGs) established by the Remaining Sites ROD (EPA 1999) and 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 2009). The selected remedy involved (1) excavating the site to the extent required to meet specified soil cleanup levels, (2) disposing of contaminated excavation materials at the ERDF at the 200 Area of the Hanford Site, (3) demonstrating through verification sampling that cleanup goals have been achieved, and (4) proposing the site 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 600-370 waste site to Interim Closed Out. The current site conditions achieve the RAOs and RAGs established by the Remaining Sites ROD (EPA 1999) and the 100 Area RDR/RAWP (DOE-RL 2009). 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 waste site 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 600-370, Segment 4 Debris Area #1 Waste Site* (attached).

WASTE SITE RECLASSIFICATION FORM

Operable Unit: 100-IU-2 **Control No.:** 2013-084

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

600-370, Segment 4 Debris Area #1

Regulator comments:

Waste Site Controls:

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

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

J. P. Neath		12/12/13
DOE Federal Project Director (printed)	Signature	Date
N/A		
Ecology Project Manager (printed)	Signature	Date
C. Guzzetti		12/18/13
EPA Project Manager (printed)	Signature	Date

REMAINING SITES VERIFICATION PACKAGE FOR THE 600-370, SEGMENT 4 DEBRIS AREA #1 WASTE SITE

Attachment to Waste Site Reclassification Form 2013-084

December 2013

REMAINING SITES VERIFICATION PACKAGE FOR THE 600-370, SEGMENT 4 DEBRIS AREA #1 WASTE SITE

EXECUTIVE SUMMARY

The 600-370, Segment 4 Debris Area #1 waste site, located in the 100-IU-2 Operable Unit, consisted of a large area with surface debris and multiple burn sites containing burn remnants, transite, insulators, wood, and concrete debris. The 600-370 waste site is located approximately 237 m (778 ft) south of Route 1 and 2.7 km (1.7 mi) west of Route 2 North. This 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* (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 (RTD) without confirmatory sampling based on the observed presence of stained soils, stressed vegetation, and barren ground (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 600-370 waste site was performed from May 8 through July 9, 2013. During remediation, an anomaly was discovered and staged outside of the excavation boundaries for further investigation. Anomaly investigation and removal of underlying soils occurred on September 9, 2013, with all materials loaded for direct disposal at the Environmental Restoration Disposal Facility (ERDF). Approximately 4,853 bank cubic meters (6,347 bank cubic yards) of excavated materials from the 600-370 waste site was removed and direct loaded for disposal at ERDF. No overburden soil was stockpiled to be used as backfill.

Following remediation, verification sampling was conducted for the 600-370 waste site on July 25 and September 10, 2013. These results indicated that residual contaminant concentrations met the remedial action objectives (RAOs) and remedial action goals (RAGs) for the 600-370 waste site. Verification sampling results support a determination that residual contaminant concentrations in the soil meet cleanup criteria specified in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (100 Area RDR/RAWP) (DOE-RL 2009b) and the Remaining Sites ROD (EPA 1999). The results indicated that the waste removal action achieved compliance with the RAOs and RAGs for the 600-370 waste site.

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 waste site in accordance with the TPA-MP-14 procedure in the *Tri-Party Agreement Handbook Management Procedures* (DOE-RL 2011).

Table ES-1. Summary of Remedial Action Goals for the 600-370 Waste Site.

Regulatory Requirement	Remedial Action Goals	Results	Remedial Action Objectives Attained?
Direct Exposure – Radionuclides	Attain dose rate of <15 mrem/yr above background over 1,000 years.	Radionuclides were not COPCs for the 600-370 waste site.	NA
Direct Exposure – Nonradionuclides	Attain individual COPC RAGs.	All individual COPC concentrations are below the direct exposure criteria.	Yes
Risk Requirements – Nonradionuclides	Attain a hazard quotient of <1 for all individual noncarcinogens.	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 (2.1×10^{-1}) is <1.	
	Attain an excess cancer risk of $<1 \times 10^{-6}$ for individual carcinogens.	The excess cancer risk values for individual nonradionuclide COPCs are all $<1 \times 10^{-6}$.	
	Attain a cumulative excess cancer risk of $<1 \times 10^{-5}$ for carcinogens.	The cumulative excess cancer risk (4.8×10^{-7}) is $<1 \times 10^{-5}$.	
Groundwater/River Protection – Radionuclides	Attain single COC groundwater and river RAGs.	Radionuclides were not COPCs for the 600-370 waste site.	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.	Cadmium, copper, lead, silver, vanadium, zinc, benzo(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene are present at concentrations exceeding soil RAGs for groundwater and/or Columbia River protection. However, an evaluation based upon RESRAD modeling discussed in Appendix C of the RDR/RAWP (DOE-RL 2009b) shows that residual concentrations of these constituents are predicted to be protective of groundwater and the river.	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 RDR/RAWP (DOE-RL 2009b), the residual concentrations of cadmium, copper, lead, silver, benzo(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene are not expected to migrate more than 2.6 m (8.5 ft) vertically in 1,000 years (based on the distribution coefficient of copper, 22 mL/g). The vadose zone underlying the soil below the site is approximately 15 m (49.2 ft). Therefore, residual concentrations of these constituents are predicted to be protective of groundwater and the Columbia River.

COC = contaminant of concern
COPC = contaminant of potential concern
DOE = U.S. Department of Energy
MCL = maximum contaminant level
NA = not applicable
RAG = remedial action goal
RDR/RAWP = Remedial Design Report/Remedial Action Work Plan
RESRAD = RESidual RADioactivity

In accordance with this evaluation, the verification sampling results support a reclassification of this site to interim closed out. The current site conditions achieve the RAOs and the corresponding RAGs established in the 100 Area RDR/RAWP (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 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. The 600-370 waste site contamination does not extend into the deep zone; 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 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 site contaminants of concern, contaminants of potential concern, and other constituents. Those constituents exceeding the ecological screening level in *Washington Administrative Code* 173-340 were boron, vanadium, and zinc. The U.S. Environmental Protection Agency ecological soil screening levels were exceeded for cadmium, copper, 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 manganese are below Hanford Site background levels, it is believed that the presence of manganese 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 600-370, SEGMENT 4 DEBRIS AREA #1 WASTE SITE

STATEMENT OF PROTECTIVENESS

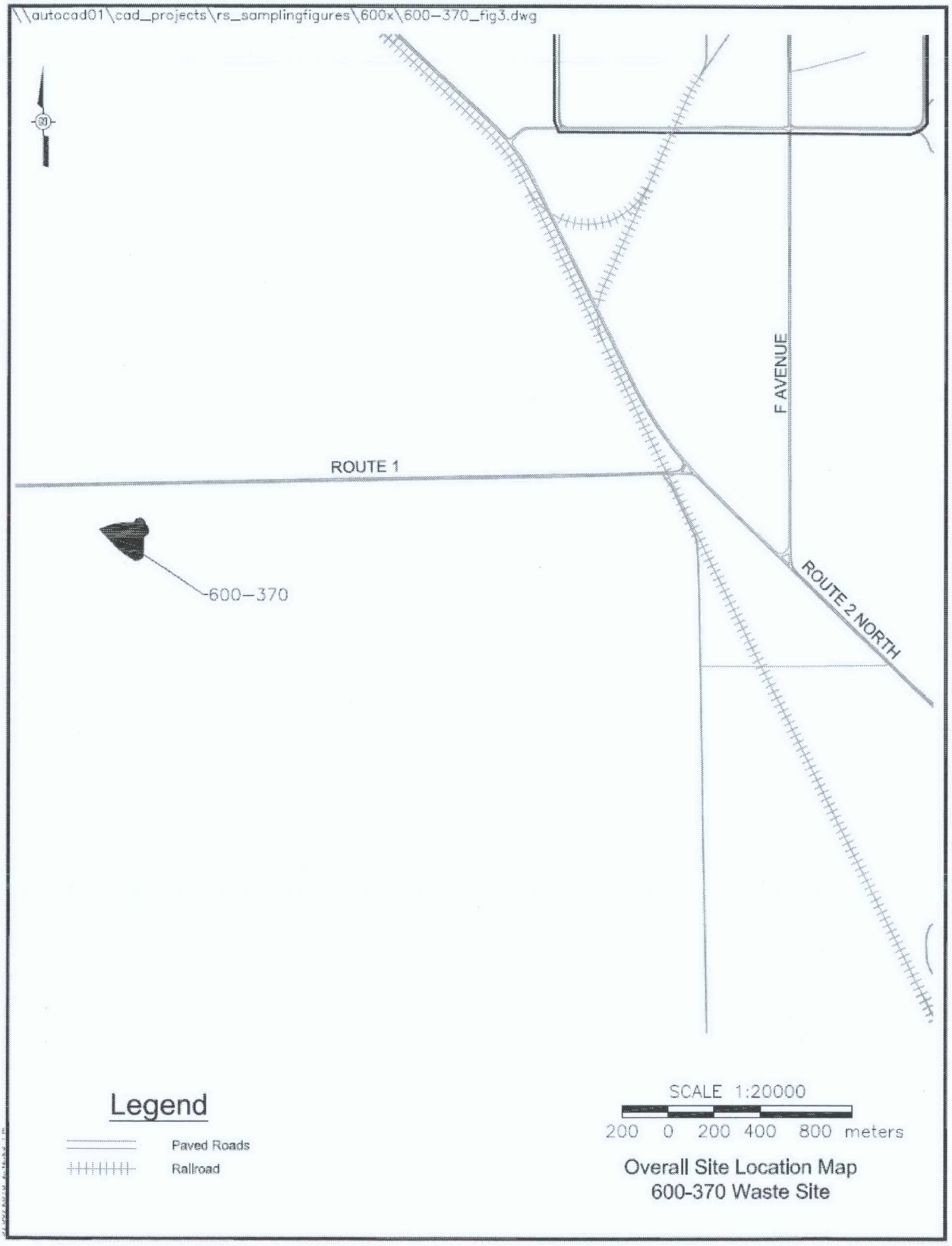
The 600-370, Segment 4 Debris Area #1 waste site verification sampling data, site evaluations, and supporting documentation demonstrate that this waste site meets the objectives established in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (100 Area RDR/RAWP) (DOE-RL 2009b) and the *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington* (Remaining Sites ROD) (EPA 1999). These results show that residual soil concentrations support future land uses that can be represented (or bounded) by a rural-residential scenario. The results also demonstrate that residual contaminant concentrations support unrestricted future use of shallow zone soil (i.e., surface to 4.6 m [15 ft]) and that contaminant levels remaining in the soil are protective of groundwater and the Columbia River. Contamination from the 600-370 waste site does not extend into the deep zone; 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 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 site contaminants of concern, contaminants of potential concern (COPCs), and other constituents. Those constituents exceeding the ecological screening level in *Washington Administrative Code* (WAC) 173-340 were boron, vanadium, and zinc. The U.S. Environmental Protection Agency (EPA) ecological soil screening levels were exceeded for cadmium, copper, 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 manganese are below Hanford Site background levels, it is believed that the presence of manganese 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 600-370 waste site is located within the 100-IU-2 Operable Unit. The 600-370 waste site is reported in the *100-F/IU-2/IU-6 Area-Segment 4 Orphan Sites Evaluation Report* (WCH 2011) as SG4-407, consisting of a 240 m (787 ft) disturbed area with surface debris consisting of multiple burn sites with burn remnants, transite, insulators, wood, and concrete. The 600-370 waste site is located 237 m (778 ft) south of Route 1 and 2.7 km (1.7 mi) west of Route 2 North, at Washington State Plane (WSP) coordinates N 145009.07, E 577743.13 (Figure 1). There is no process history associated with the 600-370 waste site.

Figure 1. The 600-370 Waste Site Location Map.



Geophysical Survey

The objective of the geophysical survey was to determine if any utilities were located in the area of the 600-370 waste site. The geophysical interpretation map is included in Figure 2. No anomalies or utility lines were identified by the geophysical investigation.

Waste Characterization Sampling

Waste characterization sampling was performed to determine the COPCs for each waste site, to determine waste disposal purposes, and to guide remedial efforts. All waste characterization sampling data are included in Appendix A.

REMEDIAL ACTION SUMMARY

The 600-370 waste site was recommended for remediation without confirmatory sampling based on the observed presence of burned debris, stained soils, stressed vegetation, and barren ground at this site (WCH 2013c).

Remedial Action

Remediation of the 600-370 waste site was performed from May 8 through July 9, 2013. A single anomaly was discovered and staged outside of the excavation area. Investigation of the anomaly with the subsequent removal and disposal of underlying soil and associated waste was performed on September 9, 2013. Approximately 4,853 bank cubic meters (6,347 bank cubic yards) of excavated materials from the 600-370 waste site were removed and direct loaded for disposal at the Environmental Restoration Disposal Facility (ERDF). The 600-370 waste site excavation area is approximately 7,369 m^2 (79,319 ft^2), with the approximate depth of 0.3 to 1.5 m (1 to 5 ft) below ground surface. Post-excavation photographs of each subsite excavation are provided in Figures 3 and 4. All excavated materials were direct loaded, and no soil staging pile area or overburden areas were utilized.

During the 600-370 waste site excavation, an anomaly was discovered at WSP coordinates N 145012.2, E 577720.4, and was staged outside of the excavated area for further investigation at WSP coordinates N 145054.9, E 577763.5. The anomaly consisted of a 5-cm (2-in.)-diameter by 46-cm (18-in.)-long steel pipe (Schedule 40) with caps on both ends with a set of mounting brackets. The pipe appeared to be sealed with no other fittings or openings. During the anomaly investigation, the anomaly was remotely sheared and found to be empty. The anomaly was disposed at ERDF with an additional 0.3 m (1 ft) of underlying soil from the anomaly staging location.

Figure 5 shows the walkaround boundary of the excavation, performed following remediation of the 600-370 waste site.

Figure 2. Geophysical Interpretation Map for the 600-370 Waste Site.

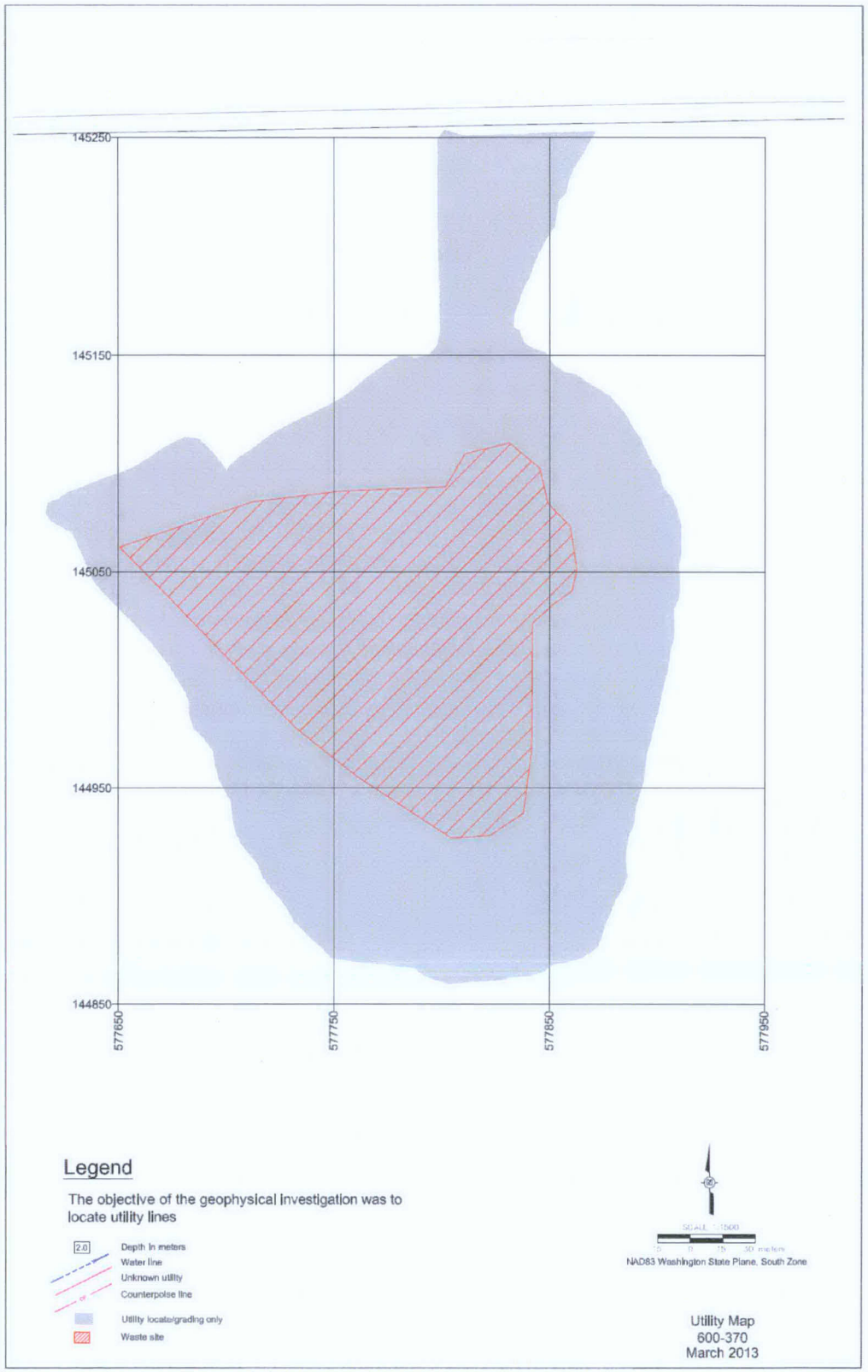
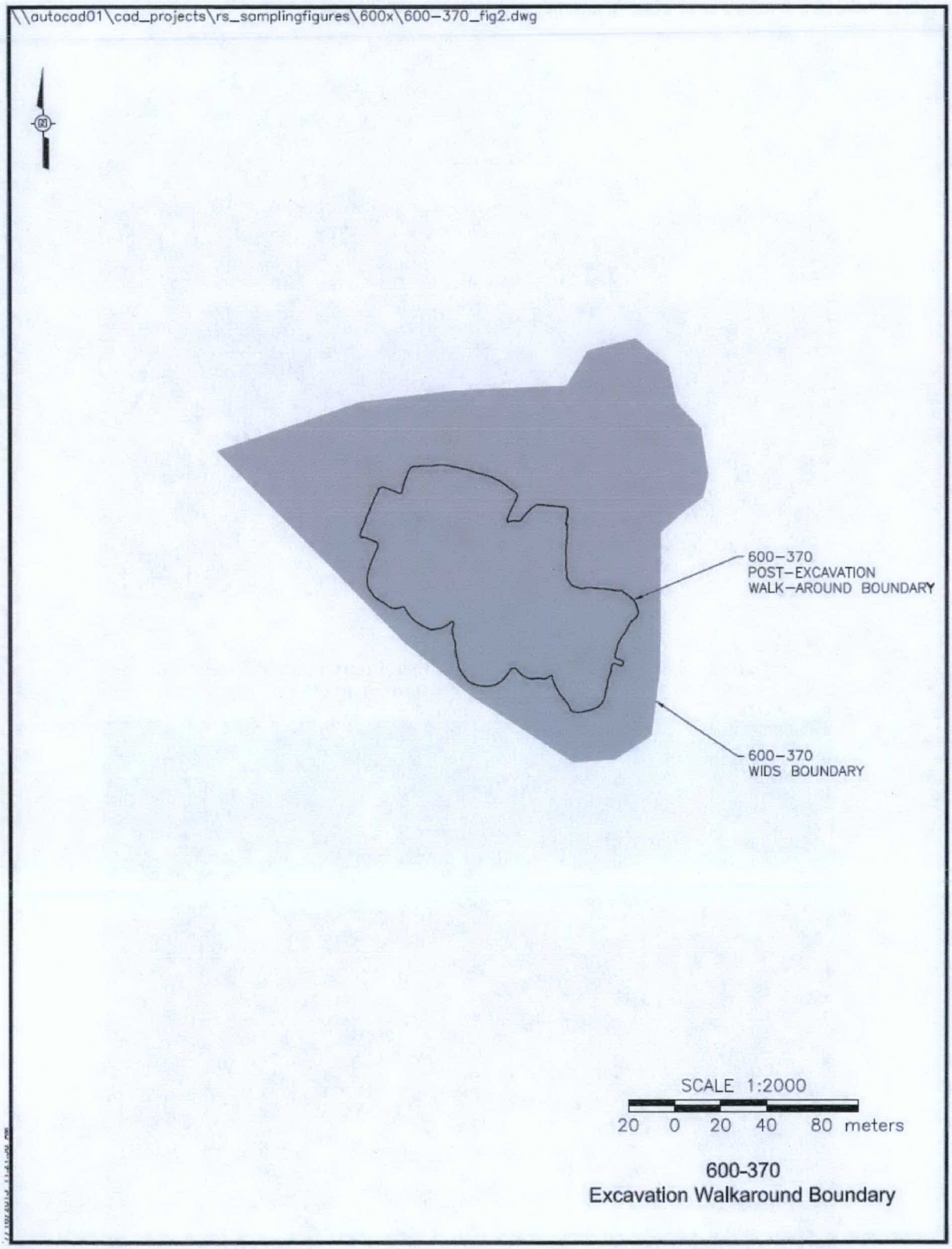


Figure 3. The 600-370 Waste Site Post-Excavation Photograph, Looking North (July 9, 2013).

Figure 4. The 600-370 Waste Site Post-Excavation Photograph, Looking South (July 9, 2013).

Figure 5. 600-370 Waste Site Excavation Walkaround Boundary.



VERIFICATION SAMPLING ACTIVITIES

Cleanup verification sampling was performed at the 600-370 waste site on July 25 and September 10, 2013. Sampling was conducted to support a determination that residual contaminant concentrations in the soil meet cleanup criteria specified in the 100 Area RDR/RAWP (DOE-RL 2009b) and the Remaining Sites ROD (EPA 1999).

The verification sample results are provided in Appendix B and indicate that the waste removal action achieved compliance with the remedial action objectives (RAOs) and remedial action goals (RAGs) for the 600-370 waste site. The following subsections provide additional discussion of the information used to develop the verification sampling design. The statistical and maximum results of verification sampling are 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 2013e).

Contaminants of Potential Concern

The COPCs for the 600-370 waste site were based on site descriptions, the results of waste characterization sampling, and professional judgment. The 600-370 COPCs included inductively coupled plasma (ICP) metals, polycyclic aromatic hydrocarbons (PAH), total petroleum hydrocarbons (TPH), and asbestos. The COPCs for verification sampling and the laboratory analytical methods are identified in Table 1.

Table 1. 600-370 Laboratory Analytical Methods and Contaminants of Potential Concern.

Analysis	Analytical Method	Contaminant of Potential Concern
ICP metals [a]	EPA Method 6010	Metals
PAH	EPA Method 8310	Polycyclic aromatic hydrocarbons
TPH	NWTPH-Dx	Total petroleum hydrocarbons
Bulk asbestos	NIOSH Method 7400	Asbestos

[a] Analysis performed 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.

EPA = U.S. Environmental Protection Agency
ICP = inductively coupled plasma
NIOSH = National Institute of Occupational Safety and Health
NWTPH-Dx = Northwest total petroleum hydrocarbons–diesel range organics
PAH = polycyclic aromatic hydrocarbons
TPH = total petroleum hydrocarbons

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). Statistical sampling occurred based on the size of the 600-370 waste site excavation area in accordance with Table 2.

Table 2. Verification Sampling Design Based on Waste Site Surface Area.

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

Source: WCH (2013d).

Table 2 includes information from the verification sampling instructions (WCH 2013d) that estimated the dimensions of 600-370 waste site and correlated the number of samples to be collected based on the estimated excavation size of 7,369 m^2 (79,319 ft^2). Because the excavation size is greater than 1,000 m^2 a statistical sampling design using Visual Sample Plan[1] (VSP) was determined to be appropriate for the verification sampling of the 600-370 waste site.

The excavation footprint of the 600-370 subsite was delineated in VSP software and used as the basis for the location of a random-start systematic grid for verification soil sampling. Twelve statistical and two focused soil sample locations were identified in the 600-370 waste site excavation. Focused sample number FS-1 is centered at the location where the anomaly was discovered. Focused sample number FS-2 is centered at the location where the anomaly was staged. Figure 6 presents the statistical and focused verification sample design for the 600-370 waste site excavation.

A discrete soil sample was collected at each designated sample point (0 to 0.15 m [0 to 6 in.] below the surface of the excavated waste site) and analyzed using the methods identified in Table 1. The soil sampling locations were global positional surveyed and staked prior to sample collection using the coordinate pairs provided in Table 3.

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 logbooks (WCH 2013a, 2013b).

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

Figure 6. 600-370 Waste Site Verification Sample Locations.

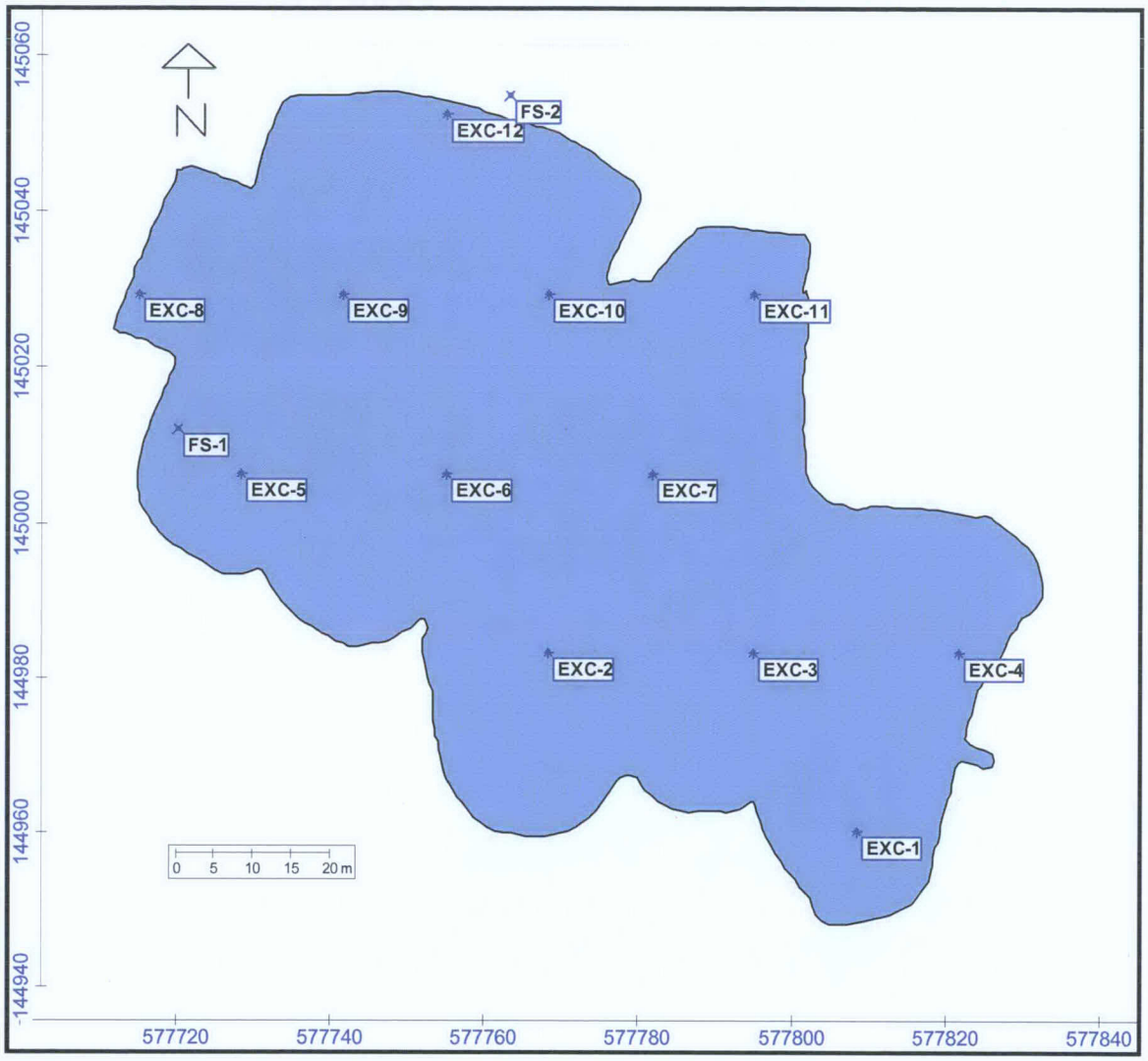

Table 3. 600-370 Sample Summary. (2 Pages)

Sample Location	HEIS Sample Number	Washington State Plane Coordinates (m)		Sample Analysis
		Northing	Easting	
EXC-1	J1RVL2/ J1RVM7	144960.3	577808.4	ICP metals [a], TPH, PAH, asbestos
EXC-2	J1RVL4/ J1RVM9	144983.4	577768.4	
EXC-3	J1RVL5/ J1RVN0	144983.4	577795.1	
EXC-4	J1RVL6/ J1RVN1	144983.4	577821.7	

Table 3. 600-370 Sample Summary. (2 Pages)

Sample Location	HEIS Sample Number	Washington State Plane Coordinates (m)		Sample Analysis
		Northing	Easting	
EXC-5	J1RVL7/ J1RVN2	145006.4	577728.5	ICP metals [a], TPH, PAH, asbestos
EXC-6	J1RVL8/ J1RVN3	145006.4	577755.1	
EXC-7	J1RVL9/ J1RVN4	145006.4	577781.7	
EXC-8	J1RVM0/ J1RVN5	145029.5	577715.2	
EXC-9	J1RVM1/ J1RVN6	145029.5	577741.8	
EXC-10	J1RVM2/ J1RVN7	145029.5	577768.4	
EXC-11	J1RVM3/ J1RVN8	145029.5	577795.1	
EXC-12	J1RVM4/ J1RVN9	145052.6	577755.1	
FS-1	J1RVM5/ J1RVP0	145012.0	577720.4	
FS-2	J1RVM6/ J1RVP1	145054.9	577763.5	
Duplicate of J1RVL2/J1RVM7	J1RVL3/ J1RVM8	144960.3	577808.4	
Equipment blank	J1RVL1	NA	NA	ICP metals [a]

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

HEIS = Hanford Environmental Information System
ICP = inductively coupled plasma
NA = not applicable
PAH = polycyclic aromatic hydrocarbons
TPH = total petroleum hydrocarbons

Verification Sample Results

All verification samples were analyzed using analytical methods approved by EPA (DOE-RL 2009b). Evaluation of the verification data from the 600-370 waste site was performed by direct comparison of the statistical or maximum sample results for each COPC against cleanup criteria. If no detections for a given COPC were reported in the data set, then no maximum evaluation or calculations were performed for that COPC.

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 600-370 decision unit as specified by the 100 Area RDR/RAWP (DOE-RL 2009b). The calculations are provided in Appendix B. When a nonradionuclide COPC was detected in fewer than 50% of the verification samples collected for a decision unit, the maximum detected value was used for comparison to 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 site COPCs with the RAGs for the 600-370 waste site are listed in Tables 4 and 5. 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 2012) 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 (Part A)* (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 laboratory-reported data results for all constituents are stored in the Washington Closure Hanford (WCH) project-specific database prior to archival in the Hanford Environmental Information System, and are presented in Attachment 1 of the 95% UCL calculations (Appendix B).

Table 4. Comparison of Contaminant Concentrations to Action Levels for the 600-370 Excavation Statistical Verification Samples. (2 Pages)

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	3.65 (<BG)	20 [c]	20 [c]	20 [c]	No	--
Barium	87.9 (<BG)	5,600 [d]	200	400	No	--
Beryllium	1.07 (<BG)	10.4 [e]	1.51 [c]	1.51 [c]	No	--
Boron [f]	1.87	7,200 [d]	320	-- [g]	No	--
Cadmium [h]	0.998	13.9 [e]	0.81 [c]	0.81 [c]	Yes	Yes [i]
Chromium	7.67 (<BG)	80,000 [d]	18.5 [c]	18.5 [c]	No	--
Cobalt	10.6 (<BG)	24 [d]	15.7 [c]	-- [g]	No	--
Copper	23.2	2,960 [d]	59.2	22.0 [c]	Yes	Yes [i]
Lead	37.9	353	10.2 [c]	10.2 [c]	Yes	Yes [i]
Manganese	397 (<BG)	3,760 [d]	512 [c]	-- [g]	No	--
Molybdenum [f]	0.475	400 [e]	8	-- [g]	No	--
Nickel	9.36 (<BG)	1,600 [d]	19.1 [c]	27.4	No	--
Silver	0.759	400 [e]	8	0.73 [c]	Yes	Yes [i]
Vanadium	96.1	560 [d]	85.1 [c]	-- [g]	Yes	Yes [i]
Zinc	104	24,000 [d]	480	67.8 [c]	Yes	Yes [i]
TPH-motor oil	9.35	200	200	200	No	--
Benzo(a)anthracene	0.0165	1.37	0.015 [j]	0.015 [j]	Yes	Yes [i]
Benzo(a)pyrene	0.0494	0.137	0.015 [j]	0.015 [j]	Yes	Yes [i]
Benzo(b)fluoranthene	0.0405	1.37	0.015 [j]	0.015 [j]	Yes	Yes [i]
Benzo(ghi)perylene [k]	0.0695	2,400	48	192	No	--

Table 4. Comparison of Contaminant Concentrations to Action Levels for the 600-370 Excavation Statistical Verification Samples. (2 Pages)

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		
Chrysene	0.0155	13.7	0.12	0.1 [j]	No	--
Fluoranthene	0.0116	3,200	64	18.0	No	--
Pyrene	0.0114	2,400	48	192	No	--

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

[b] Maximum or 95% UCL, depending on data censorship, as described in the *600-370 Waste Site Cleanup Verification 95% UCL Calculations* (Appendix B).

[c] Where cleanup levels are less than background, cleanup levels default to background per WAC 173-340-700(4)(d) (Ecology 1996). The arsenic cleanup level 20 mg/kg has been agreed to by the Tri-Party Agreement project managers as discussed in Section 2.1.2.1 of the RDR/RAWP (DOE-RL 2009b).

[d] Noncarcinogenic cleanup level calculated from WAC 173-340-740(3), Method B (Ecology 1996).

[e] Carcinogenic cleanup level calculated based on the inhalation exposure pathway (WAC 173-340-750[3]) using an airborne particulate mass-loading rate of 0.0001 g/m^3 (*Hanford Guidance for Radiological Cleanup* [WDOH 1997]).

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

[g] No parameters (bioconcentration factors or ambient water quality criteria values) are available from the Washington State Department of Ecology Cleanup Levels and Risk Calculations database (Ecology 2012) or other databases to calculate cleanup levels (WAC 173-340-730[3][a][iii], Ecology 1996 [Method B for surface waters]).

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

[i] Based on RESRAD modeling discussed in Appendix C of the RDR/RAWP (DOE-RL 2009b), the residual concentrations of cadmium, copper, lead, silver, vanadium, zinc, benzo(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene are not expected to migrate more than 2.6 m (8.5 ft) vertically in 1,000 years (based on the contaminant with the lowest distribution coefficient, copper, with a value of 22 mL/g). The vadose zone underlying the soil below the site is approximately 15 m (49.2 ft). Therefore, residual concentrations of these constituents are predicted to be protective of groundwater and the Columbia River.

[j] Where cleanup levels are less than RDLs, cleanup levels default to RDLs per WAC 173-340-707(2) (Ecology 1996). The cited RDLs are based on EPA-approved analytical methods that may not be available for rapid-turnaround analyses. Prior notification and concurrence with the laboratory may be necessary to meet this RDL. Actual detection limits may differ from any RDL.

[k] Toxicity data for this chemical are not available. Cleanup levels are based on surrogate chemicals: benzo(ghi)perylene; surrogate: pyrene.

-- = not applicable
BG = background
COPC = contaminant of potential concern
EPA = U.S. Environmental Protection Agency
RAG = remedial action goal
RDL = required detection limit
RDR/RAWP = Remedial Design Report/Remedial Action Work Plan
RESRAD = RESidual RADioactivity (dose model)
TPH = total petroleum hydrocarbons
UCL = upper confidence limit
WAC = *Washington Administrative Code*

Table 5. Comparison of Maximum Contaminant Concentrations to Remedial Action Goals for the 600-370 Excavation Focused Verification Sampling Data.

COPC	Maximum Result (mg/kg)	Remedial Action Goals (mg/kg)[a]			Do the Results Exceed RAGs?	Do the Results Pass RESRAD Modeling?
		Direct Exposure	Soil Cleanup Level for Groundwater Protection	Soil Cleanup Level for River Protection		
Arsenic	2.68 (<BG)	20[b]	20[b]	20[b]	No	--
Barium	80.7 (<BG)	5,600[c]	200	400	No	--
Beryllium	1.01 (<BG)	10.4[d]	1.51[b]	1.51[b]	No	--
Cadmium[e]	0.865	13.9[d]	0.81[b]	0.81[b]	Yes	Yes[f]
Chromium (total)	7.09 (<BG)	80,000[c]	18.5[b]	18.5[b]	No	--
Cobalt	8.94 (<BG)	24	15.7[b]	--[g]	No	--
Copper	42.0	2,960[c]	59.2	22.0[b]	Yes	Yes[f]
Lead	7.85 (<BG)	353	10.2[b]	10.2[b]	No	--
Manganese	384 (<BG)	3,760[c]	512[b]	512[b]	No	--
Molybdenum[e]	0.743	400	8	--[g]	No	--
Nickel	8.79 (<BG)	1,600[c]	19.1[b]	27.4	No	--
Silver	0.223 (<BG)	400	8	0.73[b]	No	--
Vanadium	85.8	560[c]	85.1[b]	--[g]	Yes	Yes[f]
Zinc	71.1	24,000[c]	480	67.8[b]	Yes	Yes[f]
TPH-diesel range	6.59	200	200	200	No	--
Benzo(a)anthracene	0.00104	1.37	0.015[h]	0.015[h]	No	--
Benzo(a)pyrene	0.00187	0.137	0.015[h]	0.015[h]	No	--
Benzo(b)fluoranthene	0.00230	1.37	0.015[h]	0.015[h]	No	--
Benzo(ghi)perylene[i]	0.00181	2,400	48	192	No	--
Chrysene	0.000679	13.7	0.12	0.1[h]	No	--
Fluoranthene	0.00113	3,200	64	18.0	No	--
Pyrene	0.000865	2,400	48	192	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 RDR/RAWP (DOE-RL 2009b).

[c] Noncarcinogenic cleanup level calculated from WAC 173-340-740(3), Method B (Ecology 1996).

[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] Based on RESRAD modeling discussed in Appendix C of the RDR/RAWP (DOE-RL 2009b), the residual concentrations of cadmium, copper, vanadium and zinc are not expected to migrate more than 2.6 m (8.5 ft) vertically in 1,000 years (based on the distribution coefficient of copper, 22 mL/g). The vadose zone underlying the soil below the site is approximately 15 m (49.2 ft). Therefore, residual concentrations of these constituents are predicted to be protective of groundwater and the Columbia River.

[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 (Ecology 2012) or other databases to calculate cleanup levels (WAC 173-340-730[3][a][iii], Ecology 1996 [Method B for surface waters]).

[h] Where cleanup levels are less than RDLs, cleanup levels default to RDLs per WAC 173-340-707(2) (Ecology 1996). The cited RDLs are based on EPA-approved analytical methods that may not be available for rapid-turnaround analyses. Prior notification and concurrence with the laboratory may be necessary to meet this RDL. Actual detection limits may differ from any RDL.

[i] Toxicity data for this chemical are not available. Cleanup levels are based on surrogate chemicals: benzo(ghi)perylene; surrogate: pyrene

-- = not applicable
BG = background
COPC= contaminant of potential concern
EPA = U.S. Environmental Protection Agency
RAG = remedial action goal
RDL = required detection limit
RDR/RAWP = Remedial Design Report/Remedial Action Work Plan
RESRAD = RESidual RADioactivity
TPH = total petroleum hydrocarbons
WAC = *Washington Administrative Code*

VERIFICATION SAMPLE DATA EVALUATION

This section demonstrates that contaminant concentrations at the 600-370 waste site 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).

Direct Comparison to RAGs

Evaluation of the verification sampling results in Tables 4 and 5 shows that all direct exposure RAGs are met for the 600-370 waste site. Groundwater protection and/or Columbia River protection cleanup levels were exceeded for cadmium, copper, lead, silver, vanadium, zinc, benzo(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene.

Based on the RESidual RADioactivity (RESRAD) modeling discussed in Appendix C of the 100 Area RDR/RAWP (DOE-RL 2009b), residual concentrations of cadmium, copper, lead, silver, vanadium, zinc, benzo(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene are not predicted to migrate more than 2.6 m (8.5 ft) vertically within 1,000 years (based on the lowest distribution coefficient of the contaminants exceeding RAGs, with a copper distribution coefficient value of 22 mL/g). The vadose zone underlying the excavation is approximately 15 m (49.2 ft) thick. Therefore, residual concentrations of cadmium, copper, lead, silver, vanadium, zinc, benzo(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene are not predicted to migrate through the soil column to groundwater (and thus the Columbia River) within 1,000 years.

Three-Part Test for Nonradionuclides

When using a statistical sampling approach, a RAG requirement for nonradionuclides is the WAC 173-340-740(7)(e) three-part test. The WAC 173-340 three-part test consists of the following criteria: (1) the cleanup verification 95% UCL value must be less than the cleanup level, (2) no single detection can 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 600-370 excavation is included in the statistical calculations (Appendix B). The results of this evaluation indicate that lead and zinc data sets have sample results that exceeded the cleanup limit by greater than two times in comparison against the soil RAGs for groundwater and river protection in the excavation decision unit. Greater than 10% of the sample results for cadmium, copper, lead, vanadium, and zinc in the excavation decision unit exceed the cleanup levels. However, based on the RESRAD modeling discussed in Appendix C of the 100 Area RDR/RAWP (DOE-RL 2009b), residual concentrations of cadmium, copper, lead, silver, vanadium, and zinc are not predicted to migrate more than 3 m (9.9 ft) vertically within 1,000 years (based on the lowest distribution coefficient of the contaminants exceeding RAGs, with a copper distribution coefficient value of 22 mL/g). Therefore, the residual concentrations of these constituents are predicted to be protective of groundwater and the Columbia River.

Direct Contact Noncarcinogenic Hazard Quotient Remedial Action Goal

Assessment of the risk requirements for the 600-370 waste site was determined by calculation of the hazard quotient and excess carcinogenic risk. The requirements include an individual hazard quotient of less than 1.0, a cumulative hazard quotient of less than 1.0, an individual contaminant carcinogenic risk of less than 1×10^{-6}, and a cumulative excess carcinogenic risk of less than 1×10^{-5}. Hazard quotient and excess carcinogenic risk calculations for direct contact were conservatively performed for the 600-370 waste site in Appendix B using the highest of the focused and statistical values from all decision units. Risk values were not calculated for constituents that were not detected or were detected at concentrations below Hanford Site or Washington State background values. All individual hazard quotients are below 1.0, and all individual excess carcinogenic risk values are below 1×10^{-6}. The direct contact cumulative hazard quotient for the 600-370 waste site is 2.1×10^{-1}, and the cumulative excess carcinogenic risk value is 4.8×10^{-7}, satisfying the criteria to be less than 1.0 and less than 1×10^{-5}, respectively. Therefore, the nonradionuclide risk requirements are met.

DATA QUALITY ASSESSMENT

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

The DQA for the 600-370 waste site established that the data are of the right type, quality, and quantity to support site verification 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 the WCH project-specific database for data evaluation prior to archival in the Hanford Environmental Information System and are summarized in Appendix B. The detailed DQA is presented in Appendix C.

SUMMARY FOR INTERIM CLOSURE

The 600-370 waste site has been evaluated in accordance with the Remaining Sites ROD (EPA 1999) and the 100 Area RDR/RAWP (DOE-RL 2009b). Verification sampling was performed and the analytical results indicate that the residual concentrations of COPCs met the RAGs and associated RAOs for direct exposure, groundwater protection, and river protection. Site contamination did not extend into the deep zone (below 4.6 m [15 ft]) soils; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are not required. In accordance with this evaluation, the verification sampling results support a reclassification of the 600-370 waste site to Interim Closed Out.

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APPENDIX A

WASTE CHARACTERIZATION SAMPLING RESULTS

Table A-1. 600-370 Waste Site Characterization Data - Metals and TPH. (2 Pages)

Sample Location	HEIS Number	Sample Date	Aluminum			Antimony			Arsenic			Barium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
600-370	J1RD37	1/23/13	7440		14.0	1.68	U	1.68	2.65	B	2.81	701		1.4

Sample Location	HEIS Number	Sample Date	Beryllium			Boron			Cadmium			Calcium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
600-370	J1RD37	1/23/13	0.267	B	0.561	2.03	B	5.61	1.46		0.561	10000		281

Sample Location	HEIS Number	Sample Date	Chromium			Cobalt			Copper			Iron		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
600-370	J1RD37	1/23/13	10.2		0.561	7.22		5.61	3700		2.81	24700		56.1

Sample Location	HEIS Number	Sample Date	Lead			Magnesium			Manganese			Mercury		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
600-370	J1RD37	1/23/13	624		1.4	4530		210	361		14.0	0.0255	U	0.0255

Sample Location	HEIS Number	Sample Date	Molybdenum			Nickel			Potassium			Selenium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
600-370	J1RD37	1/23/13	5.61	U	5.61	12.8		11.2	1310		1120	2.25		0.842

Sample Location	HEIS Number	Sample Date	Silicon			Silver			Sodium			Vanadium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
600-370	J1RD37	1/23/13	269		5.61	0.561	U	0.561	370		140	77.9		7.01

Sample Location	HEIS Number	Sample Date	Zinc			TPH - Diesel			TPH - Motor Oil		
			mg/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
600-370	J1RD37	1/23/13	4440		28.1	27400	U	27400	581000		82100

Sample Location	HEIS Number	Sample Date	Mercury (TCLP)			Arsenic (TCLP)			Barium (TCLP)			Cadmium (TCLP)		
			mg/L	Q	PQL	mg/L	Q	PQL	mg/L	Q	PQL	mg/L	Q	PQL
600-370	J1RD37	1/23/13	0.0002	U	0.0002	0.075	U	0.075	2.37		0.005	0.0311		0.015

Sample Location	HEIS Number	Sample Date	Chromium (TCLP)			Lead (TCLP)			Selenium (TCLP)			Silver (TCLP)		
			mg/L	Q	PQL	mg/L	Q	PQL	mg/L	Q	PQL	mg/L	Q	PQL
600-370	J1RD37	1/23/13	0.025	U	0.025	6.14		0.05	0.1	U	0.1	0.03	U	0.03

Table A-1. 600-370 Waste Site Characterization Data - Organics (2 Pages).

CONSTITUENT	CLASS	600-370 J1RD37		
		1/23/13		
		ug/kg	Q	PQL
Acenaphthene	PAH	68.3	UD	68.3
Acenaphthylene	PAH	68.3	UD	68.3
Anthracene	PAH	68.3	UD	68.3
Benzo(a)anthracene	PAH	68.3	UD	68.3
Benzo(a)pyrene	PAH	68.3	UD	68.3
Benzo(b)fluoranthene	PAH	68.3	UD	68.3
Benzo(ghi)perylene	PAH	68.3	UD	68.3
Benzo(k)fluoranthene	PAH	18.0	JD	68.3
Chrysene	PAH	68.3	UD	68.3
Dibenz[a,h]anthracene	PAH	68.3	UD	68.3
Fluoranthene	PAH	68.3	UD	68.3
Fluorene	PAH	68.3	UD	68.3
Indeno(1,2,3-cd)pyrene	PAH	68.3	UD	68.3
Naphthalene	PAH	68.3	UD	68.3
Phenanthrene	PAH	68.3	UD	68.3
Pyrene	PAH	68.3	UD	68.3

APPENDIX B

CALCULATIONS

APPENDIX B

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:

600-370 Waste Site Cleanup Verification 95% UCL Calculation, 0600X-CA-V0161, Rev. 0, Washington Closure Hanford, Richland, Washington.

600-370 Waste Site Direct Contact Hazard Quotient and Carcinogenic Risk Calculation, 0600X-CA-V0162, 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-~~C0073~~ V0161 12/4/13

Subject: 600-370 Waste Site Cleanup Verification 95% UCL 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 Sheets = 9 Attm. 1 = 5 Total = 15	J. D. Skoglie	N. K. Schiffern	I. B. Berezovskiy	D. F. Obenauer	12/3/13

SUMMARY OF REVISION

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

Washington Closure Hanford

CALCULATION SHEET

Originator J. D. Skoglie	**Date** 10/01/13	**Calc. No.** 0600X-CA-~~C0079~~ V0161	**Rev. No.** 0
Project 100-IU-2/6 Remediation	**Job No.** 14655	**Checked** N. K. Schiffern	**Date** 10/01/13
Subject 600-370 Waste Site Cleanup Verification 95% UCL Calculation			**Sheet No.** 1 of 9

Summary

Purpose:
Calculate the 95% upper confidence limit (UCL) values to evaluate compliance with cleanup standards for the subject site. Also, perform the *Washington Administrative Code* (WAC) 173-340-740(7)(e) 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.

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Sheets 1 to 4 - Calculation Sheet Summary
Sheets 5 to 6 - Calculation Sheet Verification Data - 600-370 Excavation
Sheets 7 to 8 - Ecology Software (MTCAStat) Results
Sheet 9 - Calculation Sheet Duplicate Analysis
Attachment 1 - 600-370, Verification Sampling Results (5 sheets)

Given/References:
1) Sample Results (Attachment 1).
2) Background values and remedial action goals (RAGs) are taken from DOE-RL (2009b), DOE-RL (2001), and Ecology (1996).
3) DOE-RL, 2001, *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes*, DOE/RL-92-24, Rev. 4, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
4) DOE-RL, 2009a, *100 Area Remedial Action Sampling and Analysis Plan* (SAP), DOE/RL-96-22, Rev. 5, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
5) DOE-RL, 2009b, *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP), DOE/RL-96-17, Rev. 6, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
6) Ecology, 1992, *Statistical Guidance for Ecology Site Managers*, Publication #92-54, Washington Department of Ecology, Olympia, Washington.
7) Ecology, 1993, *Statistical Guidance for Ecology Site Managers, Supplement S-6, Analyzing Site or Background Data with Below-detection Limit or Below-PQL Values (Censored Data Sets),* Publication #92-54, Washington Department of Ecology, Olympia, Washington.
8) Ecology, 1996, *Model Toxic Control Act Cleanup Levels and Risk Calculations (CLARC II),* Publication #94-145, Washington State Department of Ecology, Olympia, Washington.
9) Ecology, 2011, Cleanup Levels and Risk Calculations (CLARC) Database, Washington State Department of Ecology, Olympia, Washington, <https://fortress.wa.gov/ecy/clarc/CLARCHome.aspx>.
10) 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.
11) 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 and focused data from verification samples (Attachment 1) from the 600-370 waste site. The data were entered into an EXCEL 2003 spreadsheet and calculations performed by using the built-in spreadsheet functions and/or creating formulae within the cells. The statistical evaluation of data for use in accordance with the RDR/RAWP (DOE-RL 2009b) is documented by this calculation. Duplicate RPD results are used in evaluation of data quality within the RSVP for this site.

Methodology:
The 600-370 waste site underwent statistical verification sampling at one decision unit (excavation) and two focused samples. Analytical results for all sampling locations are summarized in the tables provided on sheets 3 and 4. Further information of the sample data quality is presented in the data quality assessment section of the associated RSVP.

Washington Closure Hanford

CALCULATION SHEET

Originator	J. D. Skoglie	Date	10/01/13	Calc. No.	0600X-CA-~~G0073~~ V0161
Rev. No.	0	Project	100-IU-2/6 Remediation	Job No.	14655
Checked	N. K. Schiffern	Date	10/01/13	Subject	600-370 Waste Site Cleanup Verification 95% UCL Calculation
Sheet No.	2 of 9				

Summary (continued)

Methodology, continued:

For nonradioactive analytes with ≤50% of the data below detection limits, the statistical value calculated to evaluate the effectiveness of cleanup is the 95% UCL. For nonradioactive analytes with >50% of the data below detection limits, as determined by direct inspection of the sample results (Attachment 1), the maximum detected value for the data set (which includes primary and duplicate samples) is used instead of the 95% UCL, and no further calculations are performed for those data sets. For convenience, these maximum detected values are included in the summary tables that follow. The 95% UCL was not calculated for data sets with no reported detections. Calculated cleanup levels are not available in Ecology (2011) under WAC 173-340-740(3) for calcium, magnesium, potassium, silicon, and sodium. The EPA's Risk Assessment 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 either the duplicate or split value for a given analyte are above detection limits and are greater than 5 times the target detection limit (TDL). The TDL is a laboratory detection limit pre-determined for each analytical method and is listed in Table 2-1 of the SAP (DOE-RL 2009a) for certain constituents. All other constituents will have their own pre-determined TDL's based on the laboratory and method used. Where direct evaluation of the attached sample data showed that a given analyte was not detected in the primary and/or duplicate sample, further evaluation of the RPD value was not performed. The RPD calculations use the following formula:

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

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

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

Washington Closure Hanford CALCULATION SHEET

B 12/4/13

Originator J. D. Skoglie Date 10/01/13 Calc. No. 0600X-CA-~~G0073~~ V0161 Rev. No. 0
Project 100-IU-2/6 Remediation Job No. 14655 Checked N. K. Schiffern Date 10/01/13
Subject 600-370 Waste Site Cleanup Verification 95% UCL Calculation Sheet No. 3 of 9

Summary (continued)

Results:
The results presented in the tables that follow include the summary of the results of the 95% UCL and maximum calculations for the 600-370 excavation, focused samples, 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.

600-370 Statistical Sampling Results Summary [a]

Analyte	600-370		Focused Samples	Units
	95% UCL	Maximum	Maximum	
Arsenic	3.65	--	2.68	mg/kg
Barium	87.9	--	80.7	mg/kg
Beryllium	1.07	--	1.01	mg/kg
Boron	1.87	--	--	mg/kg
Cadmium	0.998	--	0.865	mg/kg
Chromium	7.67	--	7.09	mg/kg
Cobalt	10.6	--	8.94	mg/kg
Copper	23.2	--	42.0	mg/kg
Lead	37.9	--	7.85	mg/kg
Manganese	397	--	384	mg/kg
Molybdenum	0.475	--	0.743	mg/kg
Nickel	9.36	--	8.79	mg/kg
Silver	--	0.759	0.223	mg/kg
Vanadium	96.1	--	85.8	mg/kg
Zinc	104	--	71.1	mg/kg
TPH - Motor Oil (high boiling)	9.35	--	6.59	mg/kg
Benzo(a)anthracene	--	0.0165	0.00104	mg/kg
Benzo(a)pyrene	--	0.0494	0.00187	mg/kg
Benzo(b)fluoranthene	--	0.0405	0.00230	mg/kg
Benzo(ghi)perylene	--	0.0695	0.00181	mg/kg
Chrysene	--	0.0155	0.000679	mg/kg
Fluoranthene	--	0.0116	0.00113	mg/kg
Pyrene	--	0.0114	0.000865	mg/kg

3-Part Test Evaluation:	**600-370**
95% UCL or maximum[a] > Cleanup Limit?	YES
> 10% above Cleanup Limit?	YES
Any sample > 2x Cleanup Limit?	YES

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

-- = not applicable
* = duplicate analysis not within control limits.
B = blank contamination (inorganic constituents)
D = dilution
DE = direct exposure
EXC = excavation
GW = groundwater
J = estimate
MTCA = *Model Toxics Control Act*
N = spike sample recovery outside control limits
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
T = sample recovery is outside control limits
TDL = target detection limit
TPH = total petroleum hydrocarbons
U = undetected
UCL = upper confidence limit
WAC = Washington Administrative Code

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CALCULATION SHEET

Originator J. D. Skoglie	**Date** 10/01/13	**Calc. No.** 0600X-CA-~~C0073~~ Y0161	**Rev. No.** 0
Project 100-IU-2/6 Remediation	**Job No.** 14655	**Checked** N. K. Schiffern	**Date** 10/01/13
Subject 600-370 Waste Site Cleanup Verification 95% UCL Calculation			**Sheet No.** 4 of 9

Summary (continued)

Results:
The results presented in the tables that follow include the summary of the results of the 95% UCL and maximum calculations for the 600-370 excavation, focused samples, 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
	600-370
Aluminum	3.6%
Barium	5.2%
Beryllium	1.0%
Calcium	3.9%
Chromium	20.4%
Copper	22.3%
Iron	0.0%
Magnesium	0.8%
Manganese	0.3%
Silicon	26.0%
Sodium	0.7%
Vanadium	3.7%
Zinc	13.5%

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

CALCULATION SHEET

Washington Closure Hanford

Originator J. D. Skoglie

Project 100-IU-2/6 Remediation

Subject 600-370 Waste Site Cleanup Verification 95% UCL Calculation

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Sheet No. 5 of 9

1 **600-370 Statistical Calculations**

2 **Verification Data - 600-370 (EXC)**

3	Sample	Sample	Sample	Arsenic			Barium			Beryllium			Boron			Cadmium			Chromium			Cobalt			Copper		
4	Area	Number	Date	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
5	EXC-1	J1RVL2	7/25/13	3510		463	95800	*	92.7	1010		92.7	2580	B	927	988		92.7	9200		139	10100	D	1390	19900		278
6	Duplicate of J1RVL2	J1RVL3	7/25/13	3910		486	90900	*	97.2	1020		97.2	2350	B	972	847		97.2	7500		146	9990	D	1460	15900		292
7	EXC-2	J1RVL4	7/25/13	3590		476	70500	*	95.2	1020		95.2	1770	B	952	911		95.2	8270		143	10100	D	1430	17500		286
8	EXC-3	J1RVL5	7/25/13	1820	B	483	71400	*	96.7	1020		96.7	1640	B	967	962		96.7	5880		145	11400	D	1450	16700		290
9	EXC-4	J1RVL6	7/25/13	1660	B	496	58500	*	99.1	1090		99.1	1370	B	991	992		99.1	5900		149	10900	D	1490	20200		297
10	EXC-5	J1RVL7	7/25/13	4100		484	56900	*	96.9	940		96.9	1020	B	969	868		96.9	5100		145	8200	D	1450	12300		291
11	EXC-6	J1RVL8	7/25/13	2900		459	70500	*	91.8	1040		91.8	1170	B	918	997		91.8	5840		138	9520	D	1380	13600		275
12	EXC-7	J1RVL9	7/25/13	2180	B	503	67000	*	101	907		101	1340	B	1010	817		101	6000		151	10600	D	1510	40600		302
13	EXC-8	J1RVM0	7/25/13	3660		494	138000	*	98.8	946		98.8	2940	B	988	1100		98.8	8310		148	9060	D	1480	30400		296
14	EXC-9	J1RVM1	7/25/13	3460		490	83300	*	98.0	1150		98.0	1730	B	980	1040		98.0	8590		147	11300	D	1470	14700		294
15	EXC-10	J1RVM2	7/25/13	4060		488	74900	*	97.5	1080		97.5	1260	B	975	979		97.5	8220		146	10300	D	1460	19800		293
16	EXC-11	J1RVM3	7/25/13	3810		460	78100	*	92.1	1030		92.1	921	U	921	895		92.1	7720		138	9660	D	1380	14600		276
17	EXC-12	J1RVM4	7/25/13	3900		494	70400	*	98.9	1090		98.9	1250	B	989	985		98.9	6570		148	9520	D	1480	12800		297

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19 **Statistical Computation Input Data**

20	Sample	Sample	Sample	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper
21	Area	Number	Date	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
22	EXC-1	J1RVL2/ J1RVL3	7/25/13	3710	93350	1015	2465	918	8350	10045	17900
23	EXC-2	J1RVL4	7/25/13	3590	70500	1020	1770	911	8270	10100	17500
24	EXC-3	J1RVL5	7/25/13	1820	71400	1020	1640	962	5880	11400	16700
25	EXC-4	J1RVL6	7/25/13	1660	58500	1090	1370	992	5900	10900	20200
26	EXC-5	J1RVL7	7/25/13	4100	56900	940	1020	868	5100	8200	12300
27	EXC-6	J1RVL8	7/25/13	2900	70500	1040	1170	997	5840	9520	13600
28	EXC-7	J1RVL9	7/25/13	2180	67000	907	1340	817	6000	10600	40600
29	EXC-8	J1RVM0	7/25/13	3660	138000	946	2940	1100	8310	9060	30400
30	EXC-9	J1RVM1	7/25/13	3460	83300	1150	1730	1040	8590	11300	14700
31	EXC-10	J1RVM2	7/25/13	4060	74900	1080	1260	979	8220	10300	19800
32	EXC-11	J1RVM3	7/25/13	3810	78100	1030	461	895	7720	9660	14600
33	EXC-12	J1RVM4	7/25/13	3900	70400	1090	1250	985	6570	9520	12800

34 **Statistical Computations**

35		Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper
36	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 normal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.
37	N	12	12	12	12	12	12	12	12
38	% < Detection limit	0%	0%	0%	8%	0%	0%	0%	0%
39	Mean	3238	77738	1027	1535	955	7063	10050	19258
40	Standard deviation	879	21390	70.6	655	77.7	1288	934	8295
41	95% UCL on mean	3655	87895	1066	1874	998	7674	10578	23197
42	Maximum value	4100	138000	1150	2940	1100	9200	11400	40600
43	**Most Stringent Cleanup Limit for nonradionuclide and RAG type (ug/kg)**	20000 DE, GW, & River Protection	200000 GW Protection	1510 GW & River Protection	320000 GW Protection	810 GW & River Protection	18500 GW & River Protection	15700 GW Protection	22000 River Protection
44	**WAC 173-340 3-PART TEST**								
45	95% UCL > Cleanup Limit?	NA	NO	NA	NO	YES	NA	NA	YES
46	> 10% above Cleanup Limit?	NA	NO	NA	NO	YES	NA	NA	YES
47	Any sample > 2X Cleanup Limit?	NA	NO	NA	NO	NO	NA	NA	NO
48	**WAC 173-340 Compliance?**	Because all values are below background (6500 ug/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 (1510 ug/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 (18500 ug/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (15700 ug/kg) the WAC 173-340 3-part test is not required.	A detailed assessment will be performed. The data set meets the 3-part test criteria when compared to the direct exposure RAG.

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CALCULATION SHEET

12/4/13

Washington Closure Hanford

Originator J. D. Skoglie
Project 100-IU-2/6 Remediation
Subject 600-370 Waste Site Cleanup Verification 95% UCL Calculation

Date 10/01/13
Job No. 14655

Calc. No. 0600X-CA-~~C0073~~ V0161
Checked N. K. Schiffern

Rev. No. 0
Date 10/01/13
Sheet No. 6 of 9

1 **600-370 Statistical Calculations**
2 **Verification Data - 600-370 (EXC)**

3	Sample	Sample	Sample	Lead			Manganese			Molybdenum			Nickel			Vanadium			Zinc			TPH - motor oil (high boiling)		
4	Area	Number	Date	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
5	EXC-1	J1RVL2	7/25/13	62000	D	3060	399000	*NJ	185	528	B	185	9010		139	85200	*D	927	77500	D	3710	3190	JT	2170
6	Duplicate of J1RVL2	J1RVL3	7/25/13	12100	D	3210	400000	*NJ	194	391	B	194	8430		146	88400	*D	972	67700	D	3890	20900	T	2160
7	EXC-2	J1RVL4	7/25/13	5180	BD	3140	375000	*NJ	190	393	B	190	10600		143	88200	*D	952	56300	D	3810	5130	JT	2150
8	EXC-3	J1RVL5	7/25/13	3720	BD	3190	389000	*NJ	193	445	B	193	8650		145	103000	*D	967	56800	D	3870	3100	JT	2190
9	EXC-4	J1RVL6	7/25/13	5040	BD	3270	370000	*NJ	198	524	B	198	8670		149	111000	*D	991	74800	D	3960	3680	JT	2180
10	EXC-5	J1RVL7	7/25/13	4930	BD	3200	341000	*NJ	194	493	B	194	7550		145	80600	*D	969	50300	D	3870	2580	JT	2160
11	EXC-6	J1RVL8	7/25/13	5540	BD	3030	383000	*NJ	184	477	B	184	7940		138	89900	*D	918	56400	D	3670	3030	JT	2180
12	EXC-7	J1RVL9	7/25/13	6080	BD	3320	348000	*NJ	201	409	B	201	8950		151	80000	*D	1010	61800	D	4020	3180	JT	2180
13	EXC-8	J1RVM0	7/25/13	140000	D	3260	392000	*NJ	198	496	B	198	10200		148	82700	*D	988	257000	D	3950	26500	T	2140
14	EXC-9	J1RVM1	7/25/13	6200	BD	3230	431000	*NJ	196	458	B	196	8940		147	101000	*D	980	62700	D	3920	3570	JT	2170
15	EXC-10	J1RVM2	7/25/13	8780	BD	3220	402000	*NJ	195	398	B	195	9350		146	93500	*D	975	63900	D	3900	3690	JT	2160
16	EXC-11	J1RVM3	7/25/13	4500	BD	3040	382000	*NJ	184	435	B	184	8840		138	88200	*D	921	56600	D	3680	3300	JT	2170
17	EXC-12	J1RVM4	7/25/13	4910	BD	3260	391000	*NJ	198	338	B	198	8370		148	87500	*D	989	55500	D	3960	2960	JT	2180

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19 **Statistical Computation Input Data**

20	Sample	Sample	Sample	Lead	Manganese	Molybdenum	Nickel	Vanadium	Zinc	TPH - motor oil (high boiling)
21	Area	Number	Date	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
22	EXC-1	J1RVL2/ J1RVL3	7/25/13	37050	399500	460	8720	86800	72600	12045
23	EXC-2	J1RVL4	7/25/13	5180	375000	393	10600	88200	56300	5130
24	EXC-3	J1RVL5	7/25/13	3720	389000	445	8650	103000	56800	3100
25	EXC-4	J1RVL6	7/25/13	5040	370000	524	8670	111000	74800	3680
26	EXC-5	J1RVL7	7/25/13	4930	341000	493	7550	80600	50300	2580
27	EXC-6	J1RVL8	7/25/13	5540	383000	477	7940	89900	56400	3030
28	EXC-7	J1RVL9	7/25/13	6080	348000	409	8950	80000	61800	3180
29	EXC-8	J1RVM0	7/25/13	140000	392000	496	10200	82700	257000	26500
30	EXC-9	J1RVM1	7/25/13	6200	431000	458	8940	101000	62700	3570
31	EXC-10	J1RVM2	7/25/13	8780	402000	398	9350	93500	63900	3690
32	EXC-11	J1RVM3	7/25/13	4500	382000	435	8840	88200	56600	3300
33	EXC-12	J1RVM4	7/25/13	4910	391000	338	8370	87500	55500	2960

34 **Statistical Computations**

35		Lead	Manganese	Molybdenum	Nickel	Vanadium	Zinc	TPH - motor oil (high boiling)
36	95% UCL based on	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), 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.
37	N	12	12	12	12	12	12	12
38	% < Detection limit	0%	0%	0%	0%	0%	0%	0%
39	Mean	19328	383625	444	8898	91033	77058	6064
40	Standard deviation	39090	24001	52.5	851	9511	57115	6925
41	95% UCL on mean	37890	396649	475	9359	96130	104181	9352
42	Maximum value	140000	431000	528	10600	111000	257000	26500
43	**Most Stringent Cleanup Limit for nonradionuclide and RAG type (ug/kg)**	10200 GW & River Protection	512000 GW & River Protection	8000 GW Protection	19100 GW Protection	85100 GW Protection	67800 River Protection	200000 DE, GW & River Protection
44	**WAC 173-340 3-PART TEST**							
45	95% UCL > Cleanup Limit?	YES	NA	NO	NA	YES	YES	NO
46	> 10% above Cleanup Limit?	YES	NA	NO	NA	YES	YES	NO
47	Any sample > 2X Cleanup Limit?	YES	NA	NO	NA	NO	YES	NO
48	**WAC 173-340 Compliance?**	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 (512000 ug/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 (19100 ug/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.

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CALCULATION SHEET

Washington Closure Hanford

Originator J. D. Skoglie

Project 100-IU-2/6 Remediation

Subject 600-370 Waste Site Cleanup Verification 95% UCL Calculation

Date 10/01/13

Job No. 14655

Calc. No. 0600X-CA-~~C0079~~ V0161

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Date 10/01/13

Sheet No. 7 of 9

Ecology Software (MTCAStat) Results, 600-370 Waste Site

Arsenic 95% UCL Calculation

DATA	ID
	J1RVL2/
3710	J1RVL3
3590	J1RVL4
1820	J1RVL5
1660	J1RVL6
4100	J1RVL7
2900	J1RVL8
2180	J1RVL9
3660	J1RVM0
3460	J1RVM1
4060	J1RVM2
3810	J1RVM3
3900	J1RVM4

Number of samples		Uncensored values	
Uncensored	12	Mean	3238
Censored		Lognormal mean	3268
Detection limit or PQL		Std. devn.	879
Method detection limit		Median	3625
TOTAL	12	Min.	1660
		Max.	4100

Lognormal distribution? r-squared is: 0.800

Normal distribution? r-squared is: 0.845

Recommendations:

Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 3655

Barium 95% UCL Calculation

DATA	ID
	J1RVL2/
93350	J1RVL3
70500	J1RVL4
71400	J1RVL5
58500	J1RVL6
56900	J1RVL7
70500	J1RVL8
67000	J1RVL9
138000	J1RVM0
83300	J1RVM1
74900	J1RVM2
78100	J1RVM3
70400	J1RVM4

Number of samples		Uncensored values	
Uncensored	12	Mean	77738
Censored		Lognormal mean	77700
Detection limit or PQL		Std. devn.	21390
Method detection limit		Median	70950
TOTAL	12	Min.	56900
		Max.	138000

Lognormal distribution? r-squared is: 0.835

Normal distribution? r-squared is: 0.726

Recommendations:

Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 87895

Beryllium 95% UCL Calculation

DATA	ID
	J1RVL2/
1015	J1RVL3
1020	J1RVL4
1020	J1RVL5
1090	J1RVL6
940	J1RVL7
1040	J1RVL8
907	J1RVL9
946	J1RVM0
1150	J1RVM1
1080	J1RVM2
1030	J1RVM3
1090	J1RVM4

Number of samples		Uncensored values	
Uncensored	12	Mean	1027
Censored		Lognormal mean	1028
Detection limit or PQL		Std. devn.	70.6
Method detection limit		Median	1025
TOTAL	12	Min.	907
		Max.	1150

Lognormal distribution? r-squared is: 0.955

Normal distribution? r-squared is: 0.959

Recommendations:

Use lognormal distribution.

UCL (Land's method) is 1066

Boron 95% UCL Calculation

DATA	ID
	J1RVL2/
2465	J1RVL3
1770	J1RVL4
1640	J1RVL5
1370	J1RVL6
1020	J1RVL7
1170	J1RVL8
1340	J1RVL9
2940	J1RVM0
1730	J1RVM1
1260	J1RVM2
461	J1RVM3
1250	J1RVM4

Number of samples		Uncensored values	
Uncensored	12	Mean	1535
Censored		Lognormal mean	1563
Detection limit or PQL		Std. devn.	655
Method detection limit		Median	1355
TOTAL	12	Min.	461
		Max.	2940

Lognormal distribution? r-squared is: 0.897

Normal distribution? r-squared is: 0.912

Recommendations:

Use normal distribution.

UCL (based on t-statistic) is 1874

Cadmium 95% UCL Calculation

DATA	ID
	J1RVL2/
918	J1RVL3
911	J1RVL4
962	J1RVL5
992	J1RVL6
868	J1RVL7
997	J1RVL8
817	J1RVL9
1100	J1RVM0
1040	J1RVM1
979	J1RVM2
895	J1RVM3
985	J1RVM4

Number of samples		Uncensored values	
Uncensored	12	Mean	955
Censored		Lognormal mean	956
Detection limit or PQL		Std. devn.	77.7
Method detection limit		Median	971
TOTAL	12	Min.	817
		Max.	1100

Lognormal distribution? r-squared is: 0.977

Normal distribution? r-squared is: 0.979

Recommendations:

Use lognormal distribution.

UCL (Land's method) is 998

Chromium 95% UCL Calculation

DATA	ID
	J1RVL2/
8350	J1RVL3
8270	J1RVL4
5880	J1RVL5
5900	J1RVL6
5100	J1RVL7
5840	J1RVL8
6000	J1RVL9
8310	J1RVM0
8590	J1RVM1
8220	J1RVM2
7720	J1RVM3
6570	J1RVM4

Number of samples		Uncensored values	
Uncensored	12	Mean	7063
Censored		Lognormal mean	7075
Detection limit or PQL		Std. devn.	1288
Method detection limit		Median	7145
TOTAL	12	Min.	5100
		Max.	8590

Lognormal distribution? r-squared is: 0.871

Normal distribution? r-squared is: 0.868

Recommendations:

Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 7674

Cobalt 95% UCL Calculation

DATA	ID
	J1RVL2/
10045	J1RVL3
10100	J1RVL4
11400	J1RVL5
10900	J1RVL6
8200	J1RVL7
9520	J1RVL8
10600	J1RVL9
9060	J1RVM0
11300	J1RVM1
10300	J1RVM2
9660	J1RVM3
9520	J1RVM4

Number of samples		Uncensored values	
Uncensored	12	Mean	10050
Censored		Lognormal mean	10055
Detection limit or PQL		Std. devn.	934
Method detection limit		Median	10073
TOTAL	12	Min.	8200
		Max.	11400

Lognormal distribution? r-squared is: 0.962

Normal distribution? r-squared is: 0.974

Recommendations:

Use lognormal distribution.

UCL (Land's method) is 10578

Copper 95% UCL Calculation

DATA	ID
	J1RVL2/
17900	J1RVL3
17500	J1RVL4
16700	J1RVL5
20200	J1RVL6
12300	J1RVL7
13600	J1RVL8
40600	J1RVL9
30400	J1RVM0
14700	J1RVM1
19800	J1RVM2
14600	J1RVM3
12800	J1RVM4

Number of samples		Uncensored values	
Uncensored	12	Mean	19258
Censored		Lognormal mean	19214
Detection limit or PQL		Std. devn.	8295
Method detection limit		Median	17100
TOTAL	12	Min.	12300
		Max.	40600

Lognormal distribution? r-squared is: 0.872

Normal distribution? r-squared is: 0.752

Recommendations:

Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 23197

Lead 95% UCL Calculation

DATA	ID
	J1RVL2/
37050	J1RVL3
5180	J1RVL4
3720	J1RVL5
5040	J1RVL6
4930	J1RVL7
5540	J1RVL8
6080	J1RVL9
140000	J1RVM0
6200	J1RVM1
8780	J1RVM2
4500	J1RVM3
4910	J1RVM4

Number of samples		Uncensored values	
Uncensored	12	Mean	19328
Censored		Lognormal mean	14647
Detection limit or PQL		Std. devn.	39090
Method detection limit		Median	5360
TOTAL	12	Min.	3720
		Max.	140000

Lognormal distribution? r-squared is: 0.641

Normal distribution? r-squared is: 0.417

Recommendations:

Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 37890

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CALCULATION SHEET

V0161

Washington Closure Hanford

Originator J. D. Skoglie
Project 100-IU-2/6 Remediation
Subject 600-370 Waste Site Cleanup Verification 95% UCL Calculation

Date 10/01/13
Job No. 14655

Calc. No. 0600X-CA-~~G0073~~
Checked N. K. Schiffern m

Rev. No. 0
Date 10/01/13
Sheet No. 8 of 9

Ecology Software (MTCAStat) Results, 600-370 Waste Site

Manganese 95% UCL Calculation

DATA	ID
399500	J1RVL2/ J1RVL3
375000	J1RVL4
389000	J1RVL5
370000	J1RVL6
341000	J1RVL7
383000	J1RVL8
348000	J1RVL9
392000	J1RVM0
431000	J1RVM1
402000	J1RVM2
382000	J1RVM3
391000	J1RVM4

Number of samples		Uncensored values	
Uncensored	12	Mean	383625
Censored		Lognormal mean	383692
Detection limit or PQL		Std. devn.	24001
Method detection limit		Median	386000
TOTAL	12	Min.	341000
		Max.	431000

Lognormal distribution? r-squared is: 0.943
Normal distribution? r-squared is: 0.945
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 396649

Molybdenum 95% UCL Calculation

DATA	ID
460	J1RVL2/ J1RVL3
393	J1RVL4
445	J1RVL5
524	J1RVL6
493	J1RVL7
477	J1RVL8
409	J1RVL9
496	J1RVM0
458	J1RVM1
398	J1RVM2
435	J1RVM3
338	J1RVM4

Number of samples		Uncensored values	
Uncensored	12	Mean	444
Censored		Lognormal mean	444
Detection limit or PQL		Std. devn.	52.5
Method detection limit		Median	452
TOTAL	12	Min.	338
		Max.	524

Lognormal distribution? r-squared is: 0.952
Normal distribution? r-squared is: 0.973
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 475

Nickel 95% UCL Calculation

DATA	ID
8720	J1RVL2/ J1RVL3
10600	J1RVL4
8650	J1RVL5
8670	J1RVL6
7550	J1RVL7
7940	J1RVL8
8950	J1RVL9
10200	J1RVM0
8940	J1RVM1
9350	J1RVM2
8840	J1RVM3
8370	J1RVM4

Number of samples		Uncensored values	
Uncensored	12	Mean	8898
Censored		Lognormal mean	8901
Detection limit or PQL		Std. devn.	851
Method detection limit		Median	8780
TOTAL	12	Min.	7550
		Max.	10600

Lognormal distribution? r-squared is: 0.942
Normal distribution? r-squared is: 0.927
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 9359

Vanadium 95% UCL Calculation

DATA	ID
86800	J1RVL2/ J1RVL3
88200	J1RVL4
103000	J1RVL5
111000	J1RVL6
80600	J1RVL7
89900	J1RVL8
80000	J1RVL9
82700	J1RVM0
101000	J1RVM1
93500	J1RVM2
88200	J1RVM3
87500	J1RVM4

Number of samples		Uncensored values	
Uncensored	12	Mean	91033
Censored		Lognormal mean	91063
Detection limit or PQL		Std. devn.	9511
Method detection limit		Median	88200
TOTAL	12	Min.	80000
		Max.	111000

Lognormal distribution? r-squared is: 0.928
Normal distribution? r-squared is: 0.908
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 96130

Zinc 95% UCL Calculation

DATA	ID
72600	J1RVL2/ J1RVL3
56300	J1RVL4
56800	J1RVL5
74800	J1RVL6
50300	J1RVL7
56400	J1RVL8
61800	J1RVL9
257000	J1RVM0
62700	J1RVM1
63900	J1RVM2
56600	J1RVM3
55500	J1RVM4

Number of samples		Uncensored values	
Uncensored	12	Mean	77058
Censored		Lognormal mean	74754
Detection limit or PQL		Std. devn.	57115
Method detection limit		Median	59300
TOTAL	12	Min.	50300
		Max.	257000

Lognormal distribution? r-squared is: 0.536
Normal distribution? r-squared is: 0.405
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 104181

TPH - Motor Oil (high boiling) 95% UCL Calculation

DATA	ID
12045	J1RVL2/ J1RVL3
5130	J1RVL4
3100	J1RVL5
3680	J1RVL6
2580	J1RVL7
3030	J1RVL8
3180	J1RVL9
26500	J1RVM0
3570	J1RVM1
3690	J1RVM2
3300	J1RVM3
2960	J1RVM4

Number of samples		Uncensored values	
Uncensored	12	Mean	6064
Censored		Lognormal mean	5647
Detection limit or PQL		Std. devn.	6925
Method detection limit		Median	3435
TOTAL	12	Min.	2580
		Max.	26500

Lognormal distribution? r-squared is: 0.679
Normal distribution? r-squared is: 0.507
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 9352

CALCULATION SHEET

Washington Closure Hanford

Originator J. D. Skoglie

Project 100-IU-2/6 Remediation

Subject 600-370 Waste Site Cleanup Verification 95% UCL Calculation

Date 10/01/13

Job No. 14655

Calc. No. 0600X-CA-~~C0073~~ V0161

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Duplicate Analysis - 600-370

Sampling Area	Sample Number	Sample Date	Aluminum			Arsenic			Barium			Beryllium			Boron			Cadmium			Calcium			Chromium			Cobalt		
			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
EXC-1	J1RVL2	7/25/13	7020000	NJ	6300	3510		463	95800	*	92.7	1010		92.7	2580	B	927	988		92.7	4470000		7410	9200		139	10100	D	1390
Duplicate of J1RVL2	J1RVL3	7/25/13	6770000	NJ	6610	3910		486	90900	*	97.2	1020		97.2	2350	B	972	847		97.2	4300000		7770	7500		146	9990	D	1460

Analysis:

	TDL	5000	10000	2000	200	2000	200	100000	1000	2000
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	Yes (calc RPD)	No-Stop (acceptable)	Yes (calc RPD)	Yes (calc RPD)	No-Stop (acceptable)	No-Stop (acceptable)	Yes (calc RPD)	Yes (calc RPD)	No-Stop (acceptable)
	RPD	3.6%		5.2%	1.0%			3.9%	20.4%	
	Difference > 2 TDL?	Not applicable	No - acceptable	Not applicable	Not applicable	No - acceptable	No - acceptable	Not applicable	Not applicable	No - acceptable

Duplicate Analysis - 600-370

Sampling Area	HEIS Number	Sample Date	Copper			Iron			Lead			Magnesium			Manganese			Molybdenum			Nickel			Potassium			Silicon		
			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
EXC-1	J1RVL2	7/25/13	19900		278	28000000	NJ	7410	62000	D	3060	5000000		7880	399000	*NJ	185	528	B	185	9010		139	1800000		5930	431000	NJ	1390
Duplicate of J1RVL2	J1RVL3	7/25/13	15900		292	28000000	NJ	7770	12100	D	3210	4960000		8260	400000	*NJ	194	391	B	194	8430		146	1650000		6220	332000	NJ	1460

Analysis:

	TDL	1000	5000	5000	75000	5000	2000	4000	400000	2000
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	Yes (calc RPD)	Yes (calc RPD)	No-Stop (acceptable)	Yes (calc RPD)	Yes (calc RPD)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	Yes (calc RPD)
	RPD	22.3%	0.0%		0.8%	0.3%				26.0%
	Difference > 2 TDL?	Not applicable	Not applicable	Yes - assess further	Not applicable	Not applicable	No - acceptable	No - acceptable	No - acceptable	Not applicable

Duplicate Analysis - 600-370

Sampling Area	HEIS Number	Sample Date	Sodium			Vanadium			Zinc			TPH - motor oil (high boiling)		
			ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
EXC-1	J1RVL2	7/25/13	300000		6490	85200	*D	927	77500	D	3710	3190	JT	2170
Duplicate of J1RVL2	J1RVL3	7/25/13	302000		6800	88400	*D	972	67700	D	3890	20900	T	2160

Analysis:

	TDL	50000	2500	1000	5000
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	Yes (calc RPD)	Yes (calc RPD)	Yes (calc RPD)	No-Stop (acceptable)
	RPD	0.7%	3.7%	13.5%	
	Difference > 2 TDL?	Not applicable	Not applicable	Not applicable	Yes - assess further

Attachment 1. 600-370 Waste Site Verification Sample Results (Metals)

Sample Location	HEIS Number	Sample Date	Aluminum			Antimony			Arsenic			Barium			Beryllium		
			ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
EXC-1	J1RVL2	7/25/13	7020000	NJ	6300	3060	UD	3060	3510		463	95800	*	92.7	1010		92.7
Duplicate of J1RVL2	J1RVL3	7/25/13	6770000	NJ	6610	3210	UD	3210	3910		486	90900	*	97.2	1020		97.2
EXC-2	J1RVL4	7/25/13	6550000	NJ	6480	3140	UD	3140	3590		476	70500	*	95.2	1020		95.2
EXC-3	J1RVL5	7/25/13	4760000	NJ	6570	3190	UD	3190	1820	B	483	71400	*	96.7	1020		96.7
EXC-4	J1RVL6	7/25/13	5080000	NJ	6740	3270	UD	3270	1660	B	496	58500	*	99.1	1090		99.1
EXC-5	J1RVL7	7/25/13	4780000	NJ	6590	3200	UD	3200	4100		484	56900	*	96.9	940		96.9
EXC-6	J1RVL8	7/25/13	5100000	NJ	6240	3030	UD	3030	2900		459	70500	*	91.8	1040		91.8
EXC-7	J1RVL9	7/25/13	5260000	NJ	6840	3320	UD	3320	2180	B	503	67000	*	101	907		101
EXC-8	J1RVM0	7/25/13	5780000	NJ	6720	3260	UD	3260	3660		494	138000	*	98.8	946		98.8
EXC-9	J1RVM1	7/25/13	7240000	NJ	6670	3230	UD	3230	3460		490	83300	*	98.0	1150		98.0
EXC-10	J1RVM2	7/25/13	6470000	NJ	6630	3220	UD	3220	4060		488	74900	*	97.5	1080		97.5
EXC-11	J1RVM3	7/25/13	6460000	NJ	6260	3040	UD	3040	3810		460	78100	*	92.1	1030		92.1
EXC-12	J1RVM4	7/25/13	5550000	NJ	6720	3260	UD	3260	3900		494	70400	*	98.9	1090		98.9
FS-1	J1RVM5	7/25/13	4710000	NJ	6560	3180	UD	3180	2680	B	482	80700	*	96.5	961		96.5
FS-2	J1RVM6	9/10/13	5230000		6780	1640	UD	1640	2440	B	498	72800		99.6	1010		99.6
Equipment Blank	J1RVL1	7/25/13	151000	NJ	6280	305	U	305	650	B	462	2700	*	92.4	92.4	U	92.4

Sample Location	HEIS Number	Sample Date	Boron			Cadmium			Calcium			Chromium			Cobalt		
			ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
EXC-1	J1RVL2	7/25/13	2580	B	927	988		92.7	4470000		7410	9200		139	10100	D	1390
Duplicate of J1RVL2	J1RVL3	7/25/13	2350	B	972	847		97.2	4300000		7770	7500		146	9990	D	1460
EXC-2	J1RVL4	7/25/13	1770	B	952	911		95.2	4470000		7620	8270		143	10100	D	1430
EXC-3	J1RVL5	7/25/13	1640	B	967	962		96.7	4900000		7730	5880		145	11400	D	1450
EXC-4	J1RVL6	7/25/13	1370	B	991	992		99.1	5360000		7930	5900		149	10900	D	1490
EXC-5	J1RVL7	7/25/13	1020	B	969	868		96.9	3760000		7750	5100		145	8200	D	1450
EXC-6	J1RVL8	7/25/13	1170	B	918	997		91.8	4190000		7350	5840		138	9520	D	1380
EXC-7	J1RVL9	7/25/13	1340	B	1010	817		101	6020000		8040	6000		151	10600	D	1510
EXC-8	J1RVM0	7/25/13	2940	B	988	1100		98.8	6260000		7910	8310		148	9060	D	1480
EXC-9	J1RVM1	7/25/13	1730	B	980	1040		98.0	4020000		7840	8590		147	11300	D	1470
EXC-10	J1RVM2	7/25/13	1260	B	975	979		97.5	4270000		7800	8220		146	10300	D	1460
EXC-11	J1RVM3	7/25/13	921	U	921	895		92.1	4250000		7360	7720		138	9660	D	1380
EXC-12	J1RVM4	7/25/13	1250	B	989	985		98.9	4160000		7910	6570		148	9520	D	1480
FS-1	J1RVM5	7/25/13	965	U	965	865		96.5	4040000		7720	5060		145	8940	D	1450
FS-2	J1RVM6	9/10/13	996	U	996	654		99.6	3730000		7970	7090		149	8550	D	747
Equipment Blank	J1RVL1	7/25/13	924	U	924	92.4	U	92.4	40800		7390	198	B	139	248	B	139

Sample Location	HEIS Number	Sample Date	Copper			Iron			Lead			Magnesium			Manganese		
			ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
EXC-1	J1RVL2	7/25/13	19900		278	28000000	NJ	7410	62000	D	3060	5000000		7880	399000	*NJ	185
Duplicate of J1RVL2	J1RVL3	7/25/13	15900		292	28000000	NJ	7770	12100	D	3210	4960000		8260	400000	*NJ	194
EXC-2	J1RVL4	7/25/13	17500		286	28400000	NJ	7620	5180	BD	3140	5370000		8090	375000	*NJ	190
EXC-3	J1RVL5	7/25/13	16700		290	26400000	NJ	7730	3720	BD	3190	4540000		8220	389000	*NJ	193
EXC-4	J1RVL6	7/25/13	20200		297	29500000	NJ	7930	5040	BD	3270	4570000		8420	370000	*NJ	198
EXC-5	J1RVL7	7/25/13	12300		291	25500000	NJ	7750	4930	BD	3200	4900000		8230	341000	*NJ	194
EXC-6	J1RVL8	7/25/13	13600		275	26300000	NJ	7350	5540	BD	3030	4790000		7800	383000	*NJ	184
EXC-7	J1RVL9	7/25/13	40600		302	24900000	NJ	8040	6080	BD	3320	4630000		8550	348000	*NJ	201
EXC-8	J1RVM0	7/25/13	30400		296	25600000	NJ	7910	140000	D	3260	4780000		8400	392000	*NJ	198
EXC-9	J1RVM1	7/25/13	14700		294	29900000	NJ	7840	6200	BD	3230	5070000		8330	431000	*NJ	196
EXC-10	J1RVM2	7/25/13	19800		293	29100000	NJ	7800	8780	BD	3220	5290000		8290	402000	*NJ	195
EXC-11	J1RVM3	7/25/13	14600		276	28200000	NJ	7360	4500	BD	3040	5300000		7820	382000	*NJ	184
EXC-12	J1RVM4	7/25/13	12800		297	27000000	NJ	7910	4910	BD	3260	4860000		8410	391000	*NJ	198
FS-1	J1RVM5	7/25/13	12700		289	26100000	NJ	7720	7850	BD	3180	4670000		8200	343000	*NJ	193
FS-2	J1RVM6	9/10/13	42100		299	28600000		7970	7440	D	1640	4660000		8470	384000		199
Equipment Blank	J1RVL1	7/25/13	277	U	277	823000	NJ	7390	1150		305	20000	B	7860	12800	*NJ	185

Note: Gray cells indicate not applicable.

[a] = selenium was re-analyzed and the "add on data" will be used in place of the original data.

* = duplicate analysis not within control limits

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

D = reported from a dilution

EXC = excavation

FS = focused sample

HEIS = Hanford Environmental Information System

J = estimate

N = recovery is outside control limits

ND = not detected

P = aroclor target analyte with greater than 25% difference between column analyses

PAH = polycyclic aromatic hydrocarbons

PQL = practical quantitation limit

Q = qualifier

T = spike and/or spike duplicate sample recovery is outside control limits.

TPH = total petroleum hydrocarbons

U = undetected

Attachment	1	Sheet No.	1 of 5
Originator	J. D. Skoglie	Date	10/1/13
Checked	N. K. Schiffern	Date	10/1/13
Calc. No.	0600X-CA-~~C0073~~ V0161	Rev. No.	0

12/4/13

Attachment 1. 600-370 Waste Site Verification Sample Results (Metals)

Sample Location	HEIS Number	Sample Date	Mercury			Molybdenum			Nickel			Potassium			Selenium [a]		
			ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
EXC-1	J1RVL2	7/25/13	3.71	U	3.71	528	B	185	9010		139	1800000		5930	4630	UD	4630
Duplicate of J1RVL2	J1RVL3	7/25/13	3.57	U	3.57	391	B	194	8430		146	1650000		6220	4860	UD	4860
EXC-2	J1RVL4	7/25/13	3.74	U	3.74	393	B	190	10600		143	1620000		6090	4760	UD	4760
EXC-3	J1RVL5	7/25/13	3.77	U	3.77	445	B	193	8650		145	784000		6190	483	UD	483
EXC-4	J1RVL6	7/25/13	3.98	U	3.98	524	B	198	8670		149	886000		6340	4960	UD	4960
EXC-5	J1RVL7	7/25/13	3.74	U	3.74	493	B	194	7550		145	1000000		6200	484	UD	484
EXC-6	J1RVL8	7/25/13	3.77	U	3.77	477	B	184	7940		138	1230000		5880	4590	UD	4590
EXC-7	J1RVL9	7/25/13	3.94	U	3.94	409	B	201	8950		151	828000		6430	5030	UD	5030
EXC-8	J1RVM0	7/25/13	4.00	U	4.00	496	B	198	10200		148	1880000		6320	4940	UD	4940
EXC-9	J1RVM1	7/25/13	4.04	U	4.04	458	B	196	8940		147	2160000		6270	4900	UD	4900
EXC-10	J1RVM2	7/25/13	4.00	U	4.00	398	B	195	9350		146	1320000		6240	4880	UD	4880
EXC-11	J1RVM3	7/25/13	3.83	U	3.83	435	B	184	8840		138	1470000		5890	460	UD	460
EXC-12	J1RVM4	7/25/13	4.01	U	4.01	338	B	198	8370		148	1410000		6330	4940	UD	4940
FS-1	J1RVM5	7/25/13	3.77	U	3.77	356	B	193	7380		145	1090000		6170	4820	UD	4820
FS-2	J1RVM6	9/10/13	4.06	U	4.06	743	B	199	8790		149	1380000		6380			
Equipment Blank	J1RVL1	7/25/13	4.01	U	4.01	185	U	185	290	B	139	39000		5920	462	U	462

Sample Location	HEIS Number	Sample Date	Selenium [a] (add on data)			Silicon			Silver			Sodium			Vanadium		
			ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
EXC-1	J1RVL2	7/25/13	324	UD	324	431000	NJ	1390	92.7	U	92.7	300000		6490	85200	*D	927
Duplicate of J1RVL2	J1RVL3	7/25/13	316	UD	316	332000	NJ	1460	242	B	97.2	302000		6800	88400	*D	972
EXC-2	J1RVL4	7/25/13	303	UD	303	286000	NJ	1430	95.2	U	95.2	174000		6670	88200	*D	952
EXC-3	J1RVL5	7/25/13	297	UD	297	303000	NJ	1450	96.7	U	96.7	338000		6770	103000	*D	967
EXC-4	J1RVL6	7/25/13	303	UD	303	266000	NJ	1490	114	B	99.1	203000		6940	111000	*D	991
EXC-5	J1RVL7	7/25/13	320	UD	320	542000	NJ	1450	185	B	96.9	184000		6780	80600	*D	969
EXC-6	J1RVL8	7/25/13	308	UD	308	609000	NJ	1380	91.8	U	91.8	184000		6430	89900	*D	918
EXC-7	J1RVL9	7/25/13	301	UD	301	397000	NJ	1510	101	U	101	187000		7040	80000	*D	1010
EXC-8	J1RVM0	7/25/13	279	UD	279	347000	NJ	1480	759		98.8	330000		6920	82700	*D	988
EXC-9	J1RVM1	7/25/13	288	UD	288	640000	NJ	1470	98.0	U	98.0	153000		6860	101000	*D	980
EXC-10	J1RVM2	7/25/13	313	UD	313	568000	NJ	1460	97.5	U	97.5	200000		6830	93500	*D	975
EXC-11	J1RVM3	7/25/13	325	UD	325	658000	NJ	1380	108	B	92.1	195000		6440	88200	*D	921
EXC-12	J1RVM4	7/25/13	305	UD	305	620000	NJ	1480	98.9	U	98.9	177000		6920	87500	*D	989
FS-1	J1RVM5	7/25/13	323	UD	323	349000	NJ	1450	96.5	U	96.5	167000		6750	83700	*D	965
FS-2	J1RVM6	9/10/13	320	UD	320	672000	*N	1490	223	B	99.6	135000		6980	85800	D	498
Equipment Blank	J1RVL1	7/25/13	309	UD	309	138000	NJ	1390	92.4	U	92.4	6470	U	6470	1390	*	92.4

Sample Location	HEIS Number	Sample Date	Zinc		
			ug/kg	Q	PQL
EXC-1	J1RVL2	7/25/13	77500	D	3710
Duplicate of J1RVL2	J1RVL3	7/25/13	67700	D	3890
EXC-2	J1RVL4	7/25/13	56300	D	3810
EXC-3	J1RVL5	7/25/13	56800	D	3870
EXC-4	J1RVL6	7/25/13	74800	D	3960
EXC-5	J1RVL7	7/25/13	50300	D	3870
EXC-6	J1RVL8	7/25/13	56400	D	3670
EXC-7	J1RVL9	7/25/13	61800	D	4020
EXC-8	J1RVM0	7/25/13	257000	D	3950
EXC-9	J1RVM1	7/25/13	62700	D	3920
EXC-10	J1RVM2	7/25/13	63900	D	3900
EXC-11	J1RVM3	7/25/13	56600	D	3680
EXC-12	J1RVM4	7/25/13	55500	D	3960
FS-1	J1RVM5	7/25/13	61700	D	3860
FS-2	J1RVM6	9/10/13	71100	D	1990
Equipment Blank	J1RVL1	7/25/13	2810		370

Attachment	1	Sheet No.	2 of 5
Originator	J. D. Skoglie	Date	10/1/13
Checked	N. K. Schiffern	Date	10/1/13
Calc. No.	0600X-CA-C0073	Rev. No.	0

Attachment 1. 600-370 Waste Site Verification Sample Results (TPH)

Sample Location	HEIS Number	Sample Date	TPH - Diesel Range			TPH - motor oil (high boiling)		
			ug/kg	Q	PQL	ug/kg	Q	PQL
EXC-1	J1RVL2	7/25/13	2170	U	2170	3190	JT	2170
Duplicate of J1RVL2	J1RVL3	7/25/13	2160	U	2160	20900	T	2160
EXC-2	J1RVL4	7/25/13	2150	U	2150	5130	JT	2150
EXC-3	J1RVL5	7/25/13	2190	U	2190	3100	JT	2190
EXC-4	J1RVL6	7/25/13	2180	U	2180	3680	JT	2180
EXC-5	J1RVL7	7/25/13	2160	U	2160	2580	JT	2160
EXC-6	J1RVL8	7/25/13	2180	U	2180	3030	JT	2180
EXC-7	J1RVL9	7/25/13	2180	U	2180	3180	JT	2180
EXC-8	J1RVM0	7/25/13	2140	U	2140	26500	T	2140
EXC-9	J1RVM1	7/25/13	2170	U	2170	3570	JT	2170
EXC-10	J1RVM2	7/25/13	2160	U	2160	3690	JT	2160
EXC-11	J1RVM3	7/25/13	2170	U	2170	3300	JT	2170
EXC-12	J1RVM4	7/25/13	2180	U	2180	2960	JT	2180
FS-1	J1RVM5	7/25/13	2170	U	2170	2970	JT	2170
FS-2	J1RVM6	9/10/13	2240	U	2240	6590	JB	2240

Attachment	1	Sheet No.	3 of 5
Originator	J. D. Skoglie	Date	10/1/13
Checked	N. K. Schiffern	Date	10/1/13
Calc. No.	0600X-CA-C0073	Rev. No.	0

Attachment 1. 600-370 Waste Site Verification Sample Results (Organics - PAH)

SAMPLE LOCATION	EXC-1 - J1RVL2			Duplicate of J1RVL2 - J1RVL3			EXC-2 - J1RVL4			EXC-3 - J1RVL5			EXC-4 - J1RVL6			EXC-5 - J1RVL7		
CONSTITUENT	7/25/13			7/25/13			7/25/13			7/25/13			7/25/13			7/25/13		
	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
Acenaphthene	5.04	U	5.04	5.02	U	5.02	5.02	U	5.02	5.02	U	5.02	5.03	U	5.03	4.99	U	4.99
Acenaphthylene	5.04	U	5.04	5.02	U	5.02	5.02	U	5.02	5.02	U	5.02	5.03	U	5.03	4.99	U	4.99
Anthracene	1.68	U	1.68	1.67	U	1.67	1.67	U	1.67	1.67	U	1.67	1.68	U	1.68	1.66	U	1.66
Benzo(a)anthracene	0.537	U	0.537	0.536	U	0.536	0.536	U	0.536	0.536	U	0.536	0.537	U	0.537	0.532	U	0.532
Benzo(a)pyrene	0.537	U	0.537	0.536	U	0.536	0.536	U	0.536	0.536	U	0.536	0.537	U	0.537	0.532	U	0.532
Benzo(b)fluoranthene	0.537	U	0.537	0.536	U	0.536	0.536	U	0.536	0.536	U	0.536	0.537	U	0.537	0.532	U	0.532
Benzo(ghi)perylene	0.537	U	0.537	0.536	U	0.536	0.536	U	0.536	0.536	U	0.536	0.537	U	0.537	0.532	U	0.532
Benzo(k)fluoranthene	0.269	U	0.269	0.268	U	0.268	0.268	U	0.268	0.268	U	0.268	0.268	U	0.268	0.266	U	0.266
Chrysene	0.537	U	0.537	0.536	U	0.536	0.536	U	0.536	0.536	U	0.536	0.537	U	0.537	0.532	U	0.532
Dibenz[a,h]anthracene	0.537	U	0.537	0.536	U	0.536	0.536	U	0.536	0.536	U	0.536	0.537	U	0.537	0.532	U	0.532
Fluoranthene	0.537	U	0.537	0.536	U	0.536	0.536	U	0.536	0.536	U	0.536	0.537	U	0.537	0.532	U	0.532
Fluorene	5.04	U	5.04	5.02	U	5.02	5.02	U	5.02	5.02	U	5.02	5.03	U	5.03	4.99	U	4.99
Indeno(1,2,3-cd)pyrene	0.537	U	0.537	0.536	U	0.536	0.536	U	0.536	0.536	U	0.536	0.537	U	0.537	0.532	U	0.532
Naphthalene	5.04	U	5.04	5.02	U	5.02	5.02	U	5.02	5.02	U	5.02	5.03	U	5.03	4.99	U	4.99
Phenanthrene	5.04	U	5.04	5.02	U	5.02	5.02	U	5.02	5.02	U	5.02	5.03	U	5.03	4.99	U	4.99
Pyrene	0.537	U	0.537	0.536	U	0.536	0.536	U	0.536	0.536	U	0.536	0.537	U	0.537	0.532	U	0.532

SAMPLE LOCATION	EXC-6 - J1RVL8			EXC-7 - J1RVL9			EXC-8 - J1RVM0			EXC-9 - J1RVM1			EXC-10 - J1RVM2			EXC-11 - J1RVM3		
CONSTITUENT	7/25/13			7/25/13			7/25/13			7/25/13			7/25/13			7/25/13		
	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
Acenaphthene	5.01	U	5.01	5.02	U	5.02	5.00	U	5.00	5.01	U	5.01	5.04	U	5.04	5.01	U	5.01
Acenaphthylene	5.01	U	5.01	5.02	U	5.02	5.00	U	5.00	5.01	U	5.01	5.04	U	5.04	5.01	U	5.01
Anthracene	1.67	U	1.67	1.67	U	1.67	1.67	U	1.67	1.67	U	1.67	1.68	U	1.68	1.67	U	1.67
Benzo(a)anthracene	0.534	U	0.534	0.536	U	0.536	16.5		0.534	0.534	U	0.534	0.537	U	0.537	0.535	U	0.535
Benzo(a)pyrene	0.534	U	0.534	0.536	U	0.536	49.4		0.534	0.534	U	0.534	0.537	U	0.537	0.535	U	0.535
Benzo(b)fluoranthene	0.534	U	0.534	0.536	U	0.536	40.5		0.534	0.534	U	0.534	0.537	U	0.537	0.535	U	0.535
Benzo(ghi)perylene	0.534	U	0.534	0.536	U	0.536	69.5		0.534	0.534	U	0.534	0.537	U	0.537	0.535	U	0.535
Benzo(k)fluoranthene	0.267	U	0.267	0.268	U	0.268	0.267	U	0.267	0.267	U	0.267	0.269	U	0.269	0.267	U	0.267
Chrysene	0.534	U	0.534	0.536	U	0.536	15.5		0.534	0.534	U	0.534	0.537	U	0.537	0.535	U	0.535
Dibenz[a,h]anthracene	0.534	U	0.534	0.536	U	0.536	0.534	U	0.534	0.534	U	0.534	0.537	U	0.537	0.535	U	0.535
Fluoranthene	0.534	U	0.534	0.536	U	0.536	11.6		0.534	0.534	U	0.534	0.537	U	0.537	0.535	U	0.535
Fluorene	5.01	U	5.01	5.02	U	5.02	5.00	U	5.00	5.01	U	5.01	5.04	U	5.04	5.01	U	5.01
Indeno(1,2,3-cd)pyrene	0.534	U	0.534	0.536	U	0.536	0.534	U	0.534	0.534	U	0.534	0.537	U	0.537	0.535	U	0.535
Naphthalene	5.01	U	5.01	5.02	U	5.02	5.00	U	5.00	5.01	U	5.01	5.04	U	5.04	5.01	U	5.01
Phenanthrene	5.01	U	5.01	5.02	U	5.02	5.00	U	5.00	5.01	U	5.01	5.04	U	5.04	5.01	U	5.01
Pyrene	0.534	U	0.534	0.536	U	0.536	11.4		0.534	0.534	U	0.534	0.537	U	0.537	0.535	U	0.535

SAMPLE LOCATION	EXC-12 - J1RVM4			FS-1 - J1RVM5			FS-2 - J1RVM6		
CONSTITUENT	7/25/13			7/25/13			9/10/13		
	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
Acenaphthene	5.04	U	5.04	5.01	U	5.01	5.18	U	5.18
Acenaphthylene	5.04	U	5.04	5.01	U	5.01	5.18	U	5.18
Anthracene	1.68	U	1.68	1.67	U	1.67	1.73	UT	1.73
Benzo(a)anthracene	0.537	U	0.537	1.04	J	0.534	0.553	U	0.553
Benzo(a)pyrene	0.537	U	0.537	1.87		0.534	0.553	U	0.553
Benzo(b)fluoranthene	0.537	U	0.537	2.30		0.534	0.553	U	0.553
Benzo(ghi)perylene	0.537	U	0.537	1.81		0.534	0.553	U	0.553
Benzo(k)fluoranthene	0.269	U	0.269	0.267	U	0.267	0.276	U	0.276
Chrysene	0.537	U	0.537	0.679	JP	0.534	0.553	U	0.553
Dibenz[a,h]anthracene	0.537	U	0.537	0.534	U	0.534	0.553	U	0.553
Fluoranthene	0.537	U	0.537	1.13	JP	0.534	0.553	U	0.553
Fluorene	5.04	U	5.04	5.01	U	5.01	5.18	U	5.18
Indeno(1,2,3-cd)pyrene	0.537	U	0.537	0.534	U	0.534	0.553	U	0.553
Naphthalene	5.04	U	5.04	5.01	U	5.01	5.18	U	5.18
Phenanthrene	5.04	U	5.04	5.01	U	5.01	5.18	U	5.18
Pyrene	0.537	U	0.537	0.865	J	0.534	0.553	U	0.553

Attachment	1	Sheet No.	4 of 5
Originator	J. D. Skoglie	Date	10/1/13
Checked	N. K. Schiffern	Date	10/1/13
Calc. No.	0600X-CA-C0073	Rev. No.	0

Attachment 1. 600-370 Waste Site Verification Sample Results (Asbestos)[a].

Sample Location	HEIS Number	Sample Date	Chrysotile %	Amosite %	Crocidolite %	Tremolite %	Actinolite %	Anthophyllite %
EXC-1	J1RVM7	7/25/13	ND	ND	ND	ND	ND	ND
Duplicate of J1RVL2	J1RVM8	7/25/13	ND	ND	ND	ND	ND	ND
EXC-2	J1RVM9	7/25/13	ND	ND	ND	ND	ND	ND
EXC-3	J1RVN0	7/25/13	ND	ND	ND	ND	ND	ND
EXC-4	J1RVN1	7/25/13	ND	ND	ND	ND	ND	ND
EXC-5	J1RVN2	7/25/13	ND	ND	ND	ND	ND	ND
EXC-6	J1RVN3	7/25/13	ND	ND	ND	ND	ND	ND
EXC-7	J1RVN4	7/25/13	ND	ND	ND	ND	ND	ND
EXC-8	J1RVN5	7/25/13	ND	ND	ND	ND	ND	ND
EXC-9	J1RVN6	7/25/13	ND	ND	ND	ND	ND	ND
EXC-10	J1RVN7	7/25/13	ND	ND	ND	ND	ND	ND
EXC-11	J1RVN8	7/25/13	ND	ND	ND	ND	ND	ND
EXC-12	J1RVN9	7/25/13	ND	ND	ND	ND	ND	ND
FS-1	J1RVP0	7/25/13	ND	ND	ND	ND	ND	ND
FS-2	J1RVP1	9/10/13	ND	ND	ND	ND	ND	ND

[a] The required detection limit asbestos is 1%.

Attachment	1	Sheet No.	5 of 5
Originator	J. D. Skoglie	Date	10/1/13
Checked	N. K. Schiffern	Date	10/1/13
Calc. No.	0600X-CA-C0073	Rev. No.	0

Acrobat 8.0

CALCULATION COVER SHEET

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

Area: 600

Discipline: Environmental Calculation No: 0600X-CA-~~C0074~~ V0162 12/4/13

Subject: 600-370 Waste Site Direct Contact Hazard Quotient and Carcinogenic Risk Calculations

Computer Program: Excel Program No: Excel 2003

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

Committed Calculation ☒ Preliminary ☐ Superseded ☐ Voided ☐

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover = 1 Summary = 4 Total = 5	J. D. Skoglie	N. K. Schiffern	I. B. Berezovskiy	D. F. Obenauer	12/3/13

SUMMARY OF REVISION

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

DE01-437.03

12/4/13

Washington Closure Hanford Inc. CALCULATION SHEET V0162

Originator:	J. D. Skoglie	Date:	10/3/2013	Calc. No.:	0600X-CA-~~C0074~~	Rev.:	0
Project:	100-IU-2/6 Field Remediation	Job No:	14655	Checked:	N. K. Schiffern	Date:	10/3/2013
Subject:	600-370 Waste Site Direct Contact Hazard Quotient and Carcinogenic Risk Calculations					Sheet No. 1 of 4	

PURPOSE:

Provide documentation to support the calculation of the direct contact hazard quotient (HQ) and excess carcinogenic risk for the 600-370 waste site. In accordance with the remedial action goals (RAGs) in the remedial design report/remedial action work plan (RDR/RAWP) (DOE-RL 2009a), 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, *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.

2) DOE-RL, 2009b, *100 Area Remedial Action Sampling and Analysis Plan,* DOE/RL-96-22, Rev. 5, 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, 2013, *Remaining Sites Verification Package for the 600-370, Segment 4 Debris Area #1 Waste Site*, Attachment to Waste Site Reclassification Form 2013-084, 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 2009a).

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 2009a).

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

Washington Closure Hanford, Inc. CALCULATION SHEET

Originator:	J. D. Skoglie	Date:	10/3/2013	Calc. No.:	0600X-CA-~~C0074~~	Rev.:	0
Project:	100-IU-2/6 Field Remediation	Job No:	14655	Checked:	N. K. Schiffern	Date:	10/3/2013
Subject:	600-370 Waste Site Direct Contact Hazard Quotient and Carcinogenic Risk Calculations					Sheet No. 2 of 4	

METHODOLOGY:

The 600-370 waste site is comprised of one statistical decision unit (excavation) and two focused samples for verification sampling. The direct contact hazard quotient and carcinogenic risk calculations for the 600-370 waste site were conservatively calculated for the entire waste site using the greater of the statistical and focused verification soil sample results (WCH 2013). Of the contaminants of potential concern (COPCs) for this site, boron, molybdenum, and the detected polycyclic aromatic hyrdrocarbons (PAHs) require HQ and risk calculations because these analytes were detected and a Washington State or Hanford Site background value is not available. Cadmium, copper, silver, vanadium, and zinc require HQ and risk calculations because these analytes were detected above a Washington State or Hanford Site background value. Lead is not included in the calculation based on modeling of child blood levels, which is fundamentally different from the oral-reference dose and cancer slope factors used to calculate typical cleanup levels and associated HQs and cancer risks. Although total petroleum hydrocarbon (motor oil) was detected and no background value is available, the risk associated with total petroleum hydrocarbons do not contribute to the cumulative toxicity calculation. 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 1.87 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 2.6×10^{-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 2.1×10^{-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, then multiplied by 1.0×10^{-6}. For example, the maximum value for benzo(a)pyrene is 0.0494 mg/kg, divided by 0.137 mg/kg, and multiplied as indicated, is 3.6×10^{-7}. Comparing this value, and all other individual values, to the requirement of $<1 \times 10^{-6}$, this criterion is met.

4) After these calculations are completed for the carcinogenic analytes, the cumulative excess cancer risk can be obtained by summing the individual values. To avoid errors due to intermediate rounding, the individual cancer risk values prior to rounding are used for this calculation. The sum of the excess cancer risk values is 4.8×10^{-7}. Comparing this value to the requirement of $<1 \times 10^{-5}$, this criterion is 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 hazard quotient and excess cancer risk calculations.

Washington Closure Hanford, Inc. CALCULATION SHEET

Originator:	J. D. Skoglie	Date:	10/3/2013	Calc. No.:	0600X-CA-~~C0074~~ V0162	Rev.:	0
Project:	100-IU-2/6 Field Remediation	Job No:	14655	Checked:	N. K. Schiffern	Date:	10/3/2013
Subject:	600-370 Waste Site Direct Contact Hazard Quotient and Carcinogenic Risk Calculations					Sheet No. 3 of 4	

Table 1. Direct Contact Hazard Quotient and Excess Cancer Risk Results for the 600-370 Waste Site.

Contaminants of Potential Concern	Maximum or Statistical Value [a] (mg/kg)	Noncarcinogen RAG [b] (mg/kg)	Hazard Quotient	Carcinogen RAG [b] (mg/kg)	Carcinogen Risk
Metals					
Boron	1.87	7,200	2.6E-04	--	--
Cadmium	0.998	80	1.2E-02	13.9	7.2E-08
Copper	42.0	2,960	1.4E-02	--	--
Lead [c]	37.9	353	--	--	--
Molybdenum	0.743	400	1.9E-03	--	--
Silver	0.759	400	1.9E-03	--	--
Vanadium	96.1	560	1.7E-01	--	--
Zinc	104	24,000	4.3E-03	--	--
Polycyclic Aromatic Hydrocarbons					
Benzo(a)anthracene	0.0165	--	--	1.37	1.2E-08
Benzo(a)pyrene	0.0494	--	--	0.137	3.6E-07
Benzo(b)fluoranthene	0.0405	--	--	1.37	3.0E-08
Benzo(ghi)perylene [d]	0.0695	2,400	2.9E-05	--	--
Chrysene	0.0155	--	--	13.7	1.1E-09
Fluoranthene	0.0116	3,200	3.6E-06	--	--
Pyrene	0.0114	2,400	4.8E-06	--	--
Total Petroleum Hydrocarbons					
TPH - Motor Oil (high boiling) [e]	9.35	200	--	--	--
Totals					
Cumulative Hazard Quotient:			**2.1E-01**		
Cumulative Excess Cancer Risk:					**4.8E-07**

Notes:

[a] = From WCH 2013

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

[c] = Value for the 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.

[d] = Toxicity data for these chemicals are not available. The cleanup levels are based on use of surrogate chemicals. benzo(g,h,i)perylene surrogate: pyrene

[e] = The risk associated with total petroleum hydrocarbons do not contribute to the cumulative toxicity calculation.

-- = not applicable

RAG = remedial action goal

Washington Closure Hanford, Inc. CALCULATION SHEET

Originator:	J. D. Skoglie	Date:	10/3/2013	Calc. No.:	0600X-CA-~~C0074~~	Rev.:	0
Project:	100-IU-2/6 Field Remediation	Job No:	14655	Checked:	N. K. Schiffern	Date:	10/3/2013
Subject:	600-370 Waste Site Direct Contact Hazard Quotient and Carcinogenic Risk Calculations					Sheet No.	4 of 4

CONCLUSION:

The calculations in Table 1 demonstrates that the 600-370 waste site meets the requirements for the direct contact hazard quotients and carcinogenic (excess cancer) risk, respectively, as identified in the RDR/RAWP (DOE-RL 2009a) and SAP (DOE-RL 2009b). The direct contact hazard quotients and carcinogenic (excess cancer) risk calculations are for use in the RSVP for this site.

APPENDIX C

DATA QUALITY ASSESSMENT

APPENDIX C

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 designs (WCH 2013c, 2013d). This DQA was performed in accordance with site-specific data quality objectives found in the *100 Area Remedial Action Sampling and Analysis Plan* (SAP) (DOE-RL 2009).

A review of the sample designs (WCH 2013c, 2013d), the field logbooks (WCH 2013a, 2013b), and applicable analytical data packages has been performed as part of this DQA. All samples were collected and analyzed per the sample designs. To ensure quality data, the 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 600-370 waste site were provided by the laboratories in four sample delivery groups (SDGs): SDG MA06793, SDG MA07004, SDG XP0004, and SDG XP0011. SDG XP0004 was submitted for third-party validation. No major deficiencies were identified in the analytical data set. Minor deficiencies are discussed for the 600-370 waste site 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 MA06793

This SDG comprises 13 statistical soil samples (J1RVN2 through J1RVN6, J1RVM7 through J1RVM9, J1RVN0 through J1RVN9, and J1RVP0) and 1 focused soil sample (J1RVP0) collected from the excavation area and analyzed for asbestos. This SDG includes a field duplicate pair (J1RVM7/J1RVM8).

No minor deficiencies were found in SDG MA06793.

SDG MA07004

This SDG comprises one focused soil sample (J1RVP1) collected from the anomaly staging area and analyzed for asbestos.

No minor deficiencies were found in SDG MA07004.

SDG XP0004

This SDG comprises 13 statistical soil samples (J1RVL2 through J1RVL9, J1RVM0 through J1RVM4) and 1 focused soil sample (J1RVM5) from the 600-370 waste site. This SDG includes a field duplicate pair (J1RVL2/J1RVL3). These samples were analyzed for inductively coupled plasma (ICP) metals, mercury, total petroleum hydrocarbons (TPH), and polycyclic aromatic hydrocarbons (PAH). In addition, one equipment blank (J1RVL1) was collected and analyzed for ICP metals and mercury. SDG XP0004 was submitted for third-party validation. Minor deficiencies are as follows:

In the ICP metals analysis, the matrix spike (MS) recoveries are out of project acceptance criteria for four analytes (aluminum [167%], iron [388%], manganese [134%], and silicon [137%]). Aluminum, iron, manganese, and silicon are not regulated constituents under *Washington Administrative Code* (WAC) 173-340, "Model Toxics Control Act – Cleanup." All aluminum, iron, manganese, and silicon results for SDG XP0004 are qualified as estimates by third-party validation, with "J" flags. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, initial results for selenium were undetected but diluted such that the method detection limit (MDL) exceeded the applicable remedial action goals (RAGS). The laboratory was able to perform a more robust method for selenium and prevent the high dilutions. Subsequently, the samples were reanalyzed with MDLs less than the most restrictive RAGS. The second data set will be used for site evaluation. The data are usable for decision-making purposes.

SDG XP0011

This SDG comprises one focused soil sample (J1RVM6) from the anomaly staging area. This sample was analyzed for ICP metals, mercury, TPH, and PAH. Minor deficiencies are as follows:

In the TPH analysis, contamination was detected at less than twice the MDL in the method blank (MB) for motor oil. There is no significant impact to the sample data, and the data are usable for decision-making purposes.

In the ICP metals analysis, arsenic, sodium, and zinc were detected at less than twice the MDL in the MB. Arsenic, sodium, and zinc were detected in the field sample at significantly higher levels. Therefore, there is no significant impact to the sample data, and the data are usable for decision-making purposes.

In the ICP metals analysis, the MS recovery is out of project acceptance criteria for silicon (17%). Although not qualified for MS recovery outside of quality control (QC) limits, all silicon results may be considered estimated. Estimated data are usable for decision-making purposes.

FIELD QUALITY ASSURANCE/QUALITY CONTROL

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

Field quality assurance (QA)/QC measures are used to assess potential sources of error and cross contamination of samples that could bias results. Field QA/QC samples, listed in the field logbooks (WCH 2013a, 2013b), are the 600-370 primary and duplicate samples (J1RVM7/J1RVM8 and J1RVL2/J1RVL3). The main and QA/QC sample results are presented in Appendix B.

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 (COPC). 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 B 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 B) to indicate that a visual check of the data is required by the reviewer. Lead and TPH (motor oil) 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 600-370 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 600-370 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 B.

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, U.S. Environmental Protection Agency, Office of Environmental Information, Washington, D.C.

WAC 173-340, "Model Toxics Control Act – Cleanup," *Washington Administrative Code*, as amended.

WCH, 2013a, *100-K and IU-2/6 Miscellaneous Restoration and Failed Remaining Sites Sampling*, Logbook EL-1666, pp. 95-99, Washington Closure Hanford, Richland, Washington.

WCH, 2013b, *100-K and IU-2/6 Miscellaneous Restoration and Failed Remaining Sites Sampling*, Logbook EL-1666, pp. 27-28, Washington Closure Hanford, Richland, Washington.

WCH, 2013c, "600-370 Statistical Design (Regulatory Concurrence)," CCN 171922, to C. Guzzetti, U.S Environmental Protection Agency, and T. H. Howell, Washington Closure Hanford, from E. T. Glossbrenner, U.S. Department of Energy, Richland Operations Office, Richland, Washington, July 23.

WCH, 2013d, *Work Instruction for Verification Sampling of the Combines 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.