1229863

CVP-2015-00003
Rev. 0

Cleanup Verification Package for the 300-9, Possible Early Burial Ground Sites North of RR and North of 618-8, Solid Waste Burial Ground

Prepared for the U.S. Department of Energy
by Washington Closure Hanford

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EXECUTIVE SUMMARY

This cleanup verification package documents completion of remedial action for the 300-9, Possible Early Burial Ground Sites North of RR and North of 618-8, Solid Waste Burial Ground waste site. The 300-9 waste site is located in the 300-FF-2 Operable Unit in the 300 Area of the Hanford Site in southeastern Washington State. It was identified as a site requiring remediation in the *Hanford Site 300 Area, Record of Decision for 300-FF-2 and 300-FF-5, and Record of Decision Amendment for 300-FF-1, Hanford Site, Benton County, Washington* (300 Area ROD) (EPA 2013).

The 300-9 waste site consists of a possible location for an early solid waste burial ground identified in historical documentation as existing north of the 300 Area. No debris related to a burial ground or other indicative features were identified during excavation of geophysical anomalies at the site. Remedial action was determined to be necessary because confirmatory sampling detected uranium isotopes at activity levels exceeding site lookup values.

Remediation of the 300-9 waste site was performed from November 23 through December 4, 2014. The excavation extended to an approximate maximum depth of 1.5 m (5 ft) below ground surface, resulting in approximately 3,891 bank cubic meters (5,089 bank cubic yards) of contaminated soil being removed for disposal at the Environmental Restoration Disposal Facility. Some laboratory "thimbles" were also removed and disposed. No overburden soil was salvaged from the 300-9 waste site excavation and no staging pile areas were utilized.

Verification sampling within the 300-9 waste site excavation was performed on December 29, 2014. An evaluation of the resulting data found that the waste removal action achieved compliance with the industrial scenario remedial action objectives for the 300-9 waste site. A summary of the cleanup evaluation for the soil sampling results against the applicable criteria is presented in Table ES-1.

Table ES-1. Summary of Cleanup Verification Results for the 300-9 Waste Site. (2 Pages)

Regulatory Requirement	Cleanup Levels	Results	Remedial Action Objectives Attained?
Direct Exposure – Radionuclides	Attain individual radionuclide cleanup levels (CULs) and attain radionuclide total excess cancer risk of <1 x 10^{-4} over 1,000 years or an excess dose of <15 mrem/yr, whichever is lower.	Residual radionuclide activities were all below individual CULs. The total radionuclide excess cancer risk calculated using a sum-of-fractions evaluation is 4.8 x 10^{-9}.	Yes
Direct Exposure – Nonradionuclides	Attain individual contaminant of concern (COC) direct exposure CULs.	All individual COC concentrations are below the industrial direct exposure CULs.	Yes
Nonradionuclide Risk Requirements	Attain a hazard quotient of <1 for all individual noncarcinogenic COCs.	The hazard quotients for individual nonradionuclide COCs are <1.	Yes
	Attain a cumulative hazard quotient of <1 for noncarcinogenic COCs.	The cumulative hazard quotient (1.8 x 10^{-4}) is <1.	
	Attain an excess cancer risk of <1 x 10^{-5} (industrial land use) for individual carcinogenic COCs.	The excess cancer risk values for individual carcinogenic COCs are <1 x 10^{-5} (industrial land use).	
	Attain a total excess cancer risk of <1 x 10^{-5} for carcinogenic COCs.	The total excess cancer risk (1 x 10^{-7}) is <1 x 10^{-5}.	
Groundwater/River Protection – Radionuclides	Attain single radionuclide COC groundwater and river protection CULs.	No radionuclide COCs were quantified above groundwater/river protection CULs.	Yes
	Attain National Primary Drinking Water Standards: 4 mrem/yr (beta/gamma) dose rate to target receptors/organs [a].	No radionuclide COCs were quantified above groundwater/river protection CULs.	
	Meet drinking water standards for nonuranium alpha emitters: the more stringent of the 15 pCi/L MCL or 1/25th of the derived concentration guide per DOE Order 5400.5 [b].	No alpha-emitting radionuclide COCs were quantified above groundwater/river protection CULs.	
	Meet total uranium drinking water standard of 21.2 pCi/L [c].	Uranium was quantified below groundwater protection CULs.	

Table ES-1. Summary of Cleanup Verification Results for the 300-9 Waste Site. (2 Pages)

Regulatory Requirement	Cleanup Levels	Results	Remedial Action Objectives Attained?
Groundwater/River Protection – Nonradionuclides	Attain individual nonradionuclide groundwater and river cleanup requirements.	All individual COC concentrations are below soil CULs for the protection of groundwater and the Columbia River.	Yes

[a] "National Primary Drinking Water Regulations" (40 CFR 141).
[b] *Radiation Protection of the Public and the Environment* (DOE Order 5400.5).
[c] Based on the isotopic distribution of uranium in the Hanford Site background, the 30 µg/L uranium MCL (40 CFR 141.66) 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).

CFR = *Code of Federal Regulations*
COC = contaminant of concern
CUL = cleanup level
DOE = U.S. Department of Energy
MCL = maximum contaminant level (drinking water standard)

The results of the verification sampling are used to make reclassification decisions for the 300-9 waste site in accordance with the TPA-MP-14 procedure in the *Tri-Party Agreement Handbook Management Procedures* (DOE-RL 2011b).

The current site conditions have been evaluated in accordance with the *Remedial Design Report/Remedial Action Work Plan for the 300 Area* (DOE-RL 2009), as modified by TPA-CN-598 (DOE-RL and EPA 2013) to demonstrate attainment of the remedial action objectives and the corresponding cleanup levels (CULs) for industrial land use established in 300 Area ROD (EPA 2013). The 300-9 waste site meets the industrial land use CULs for direct exposure, groundwater protection, and river protection. Verification sampling results for Aroclor-1260 exceed the residential direct exposure CUL. Due to this exceedance, the residual contaminant concentrations do not meet human health direct exposure CULs for residential land use in the shallow zone soils (i.e., surface to 4.6 m [15 ft] deep); therefore, institutional controls to maintain industrial land use are required for the site.

The 300-9 waste site meets cleanup standards and has been reclassified as Final Closed Out in accordance with the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1989) and the Waste Site Reclassification Guideline TPA-MP-14 (RL-TPA-90-0001) (DOE-RL 2011b). A copy of the stand-alone waste site reclassification form is included as part of the Executive Summary of this document.

WASTE SITE RECLASSIFICATION FORM

Operable Unit: 300-FF-2 **Control No.:** 2015-010

Waste Site Code(s)/Subsite Code(s): 300-9

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 300-9, Possible Early Burial Ground Sites North of RR and North of 618-8, Solid Waste Burial Ground waste site, part of the 300-FF-2 Operable Unit, was identified as a waste site requiring remediation in the *Hanford Site 300 Area, Record of Decision for 300-FF-2 and 300-FF-5, and Record of Decision Amendment for 300-FF-1, Hanford Site, Benton County, Washington* (300 Area ROD), U.S. Environmental Protection Agency, Region 10, Seattle, Washington (EPA 2013). 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 Environmental Restoration Disposal Facility (ERDF) in 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 Final Closed Out.

Remediation of the 300-9 waste site was performed from November 23 through December 4, 2014. Approximately 3,891 bank cubic meters (5,089 bank cubic yards) of excavated materials were removed and direct loaded for disposal at the ERDF.

Basis for reclassification:

The verification sampling results were evaluated in comparison to the cleanup levels (CULs) and remedial action objectives (RAOs) from the 300 Area ROD (EPA 2013), as described in the *Remedial Design Report/Remedial Action Work Plan for the 300 Area* (300 Area RDR/RAWP), DOE/RL-2001-47, Rev. 3, U.S. Department of Energy, Richland Operations Office, Richland, Washington (DOE-RL 2009), as modified by TPA-CN-598 (DOE-RL and EPA 2013). In accordance with this evaluation, the verification sampling results support a reclassification of the 300-9 waste site to Final Closed Out. The current site conditions achieve the industrial land use CULs and RAOs established by the 300 Area ROD (EPA 2013). The results of verification sampling show that residual contaminant concentrations do not meet human health direct exposure cleanup levels for residential land use in the shallow zone soils (i.e., surface to 4.6 m [15 ft] deep); therefore, institutional controls to maintain industrial land use are required for the 300-9 waste site. The basis for reclassification is described in detail in the *Cleanup Verification Package for the 300-9, Possible Early Burial Ground Sites North of RR and North of 618-8, Solid Waste Burial Ground.*

Regulator comments:

WASTE SITE RECLASSIFICATION FORM

Operable Unit: 300-FF-2 **Control No.:** 2015-010

Waste Site Code(s)/Subsite Code(s): 300-9

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:

The waste site remediation did not achieve cleanup levels for unlimited use and unrestricted exposure. Therefore, institutional controls to maintain industrial land use are required as established in the 300 Area Final Action ROD (EPA 2013).

M. French		5/12/15
DOE Federal Project Director (printed)	Signature	Date
NA		
Ecology Project Manager (printed)	Signature	Date
B. Simes		5/13/15
EPA Project Manager (printed)	Signature	Date

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ACRONYMS AND ABBREVIATIONS

bgs	below ground surface
COC	contaminant of concern
COPC	contaminant of potential concern
CUL	cleanup level
CVP	cleanup verification package
DQA	data quality assessment
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
HEIS	Hanford Environmental Information System
PCB	polychlorinated biphenyls
RAO	remedial action objective
RDR/RAWP	remedial design report/remedial action work plan
ROD	record of decision
SAP	sampling and analysis plan
UCL	upper confidence limit
WAC	*Washington Administrative Code*

1.0 INTRODUCTION

This cleanup verification package (CVP) documents that the 300-9, Possible Early Burial Ground Sites North of RR and North of 618-8, Solid Waste Burial Ground waste site was remediated in accordance with the *Remedial Design Report/Remedial Action Work Plan for the 300 Area* (300 Area RDR/RAWP) (DOE-RL 2009). Remedial action objectives (RAOs) and associated cleanup levels (CULs) for this site are established in the *Record of Decision for 300-FF-2 and 300-FF-5, and Record of Decision Amendment for 300-FF-1, Hanford Site, Benton County, Washington* (300 Area ROD) (EPA 2013) and incorporated into the 300 Area RDR/RAWP by TPA-CN-598 (DOE-RL and EPA 2013). The 300 Area ROD provides the U.S. Department of Energy, Richland Operations Office with the authority, guidance, and objectives to conduct this remedial action.

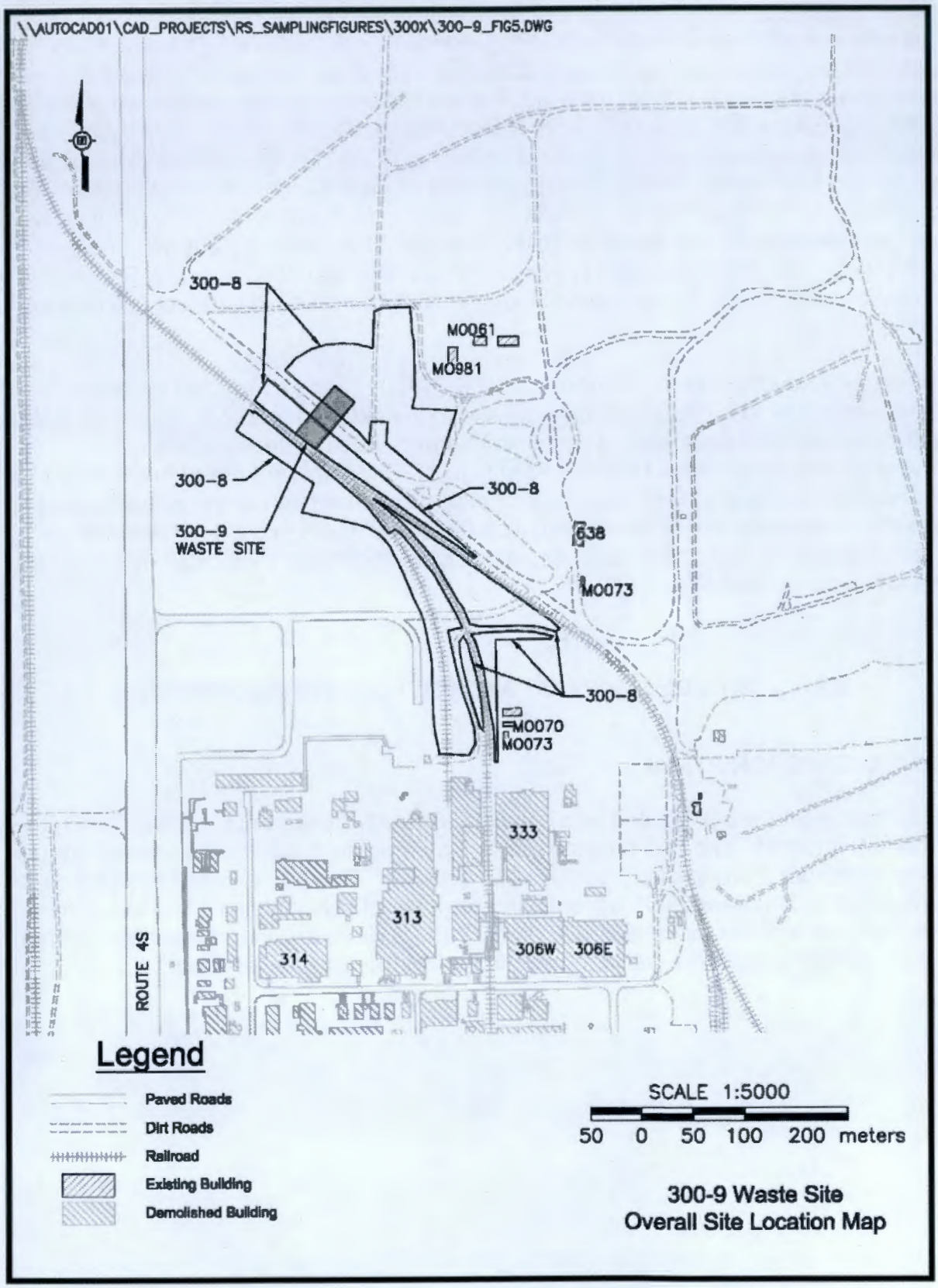
The remedy specified in the 300 Area ROD (EPA 2013) and conducted for the 300-9 waste site included excavating the site to the extent required to meet industrial land-use CULs and disposing of contaminated excavated materials at the Environmental Restoration Disposal Facility (ERDF) in the 200 Area of the Hanford Site. Excavation was driven by RAOs for direct exposure, protection of groundwater, and protection of the Columbia River. Because the 300-9 waste site did not achieve cleanup levels for residential land use, institutional controls to maintain industrial land use are required for the site.

2.0 SITE DESCRIPTION AND SUPPORTING INFORMATION

2.1 SITE DESCRIPTION

The 300-9 waste site is located within the 300-8 waste site and north of the 618-8 Burial Ground (Figure 1). The 300-8 waste site was an area surficially contaminated with scrap aluminum shavings from past historic activities. The 300-8 waste site was remediated in 2004 and 2005 by removing the layer of soil containing the aluminum shavings and was disposed at ERDF (WCH 2005). However, the remediation did not include removing material within the boundaries of the 300-9 waste site.

Figure 1. The 300-9 Waste Site Location Map.



2.2 SITE HISTORY

The 300-9 waste site was identified as the possible location of an early solid waste burial ground. The burial ground was initially identified as a location of unknown dimensions, used in 1943 and 1944 for unknown material disposition, approximately 690 m (2,260 ft) north of the 300 Area (Paas 1955). A 1961 letter report (DeFord et al. 1994, Appendix A, pp. A94-A98) states that two burial grounds were used for approximately 6 months in 1944 for the disposal of solid uranium waste. One of these locations is the 618-6 Burial Ground; the location provided for the other correlates to the burial ground described in Paas (1955). Based on historical photographs, geophysical surveys were performed at two possible locations of the burial ground during the 300-FF-2 Operable Unit limited field investigation, but the location of a burial trench could not be confirmed (DOE-RL 1997; BHI 1995). The current location of the 300-9 waste site was established based on additional historical aerial photography showing that the suspect area extends eastward beyond the area investigated during the limited field investigation. The current boundaries of the 300-9 waste site are less than 100 m (330 ft) from the approximate locations described by Paas (1955) and in the 1961 letter report (DeFord et al. 1994).

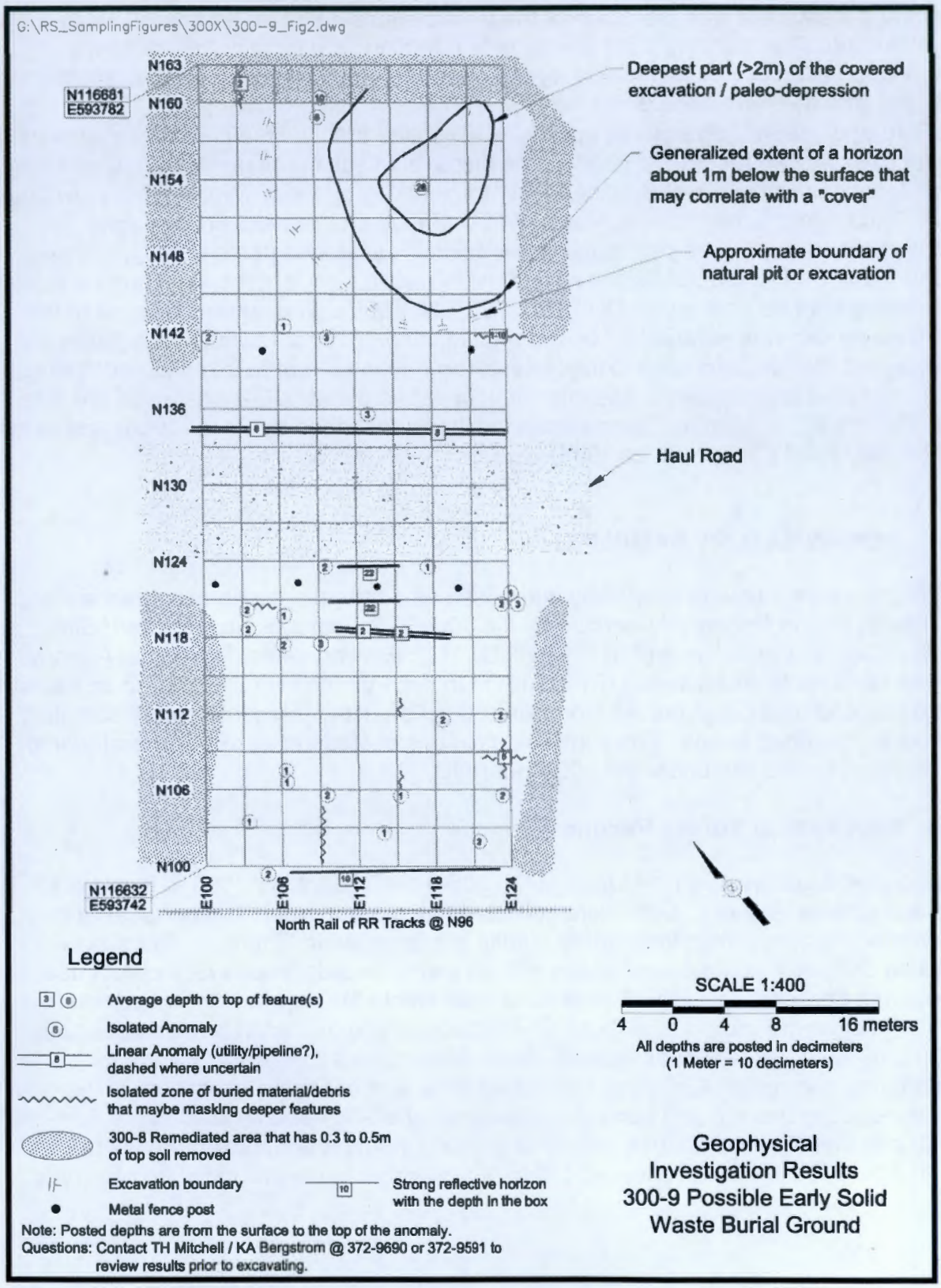
2.3 CONFIRMATORY SAMPLING

The 300-9 waste site was previously addressed as a "plug-in" site in accordance with the *Interim Action Record of Decision for the 300-FF-2 Operable Unit, Hanford Site, Benton County, Washington* (300-FF-2 ROD), U.S. Environmental Protection Agency, Region 10, Seattle, Washington (EPA 2001). In accordance with this approach, the site was evaluated as a candidate site for remedial action using the confirmatory sampling approach described below. The conclusions of this evaluation were incorporated into the decision for the site under the 300 Area ROD.

2.3.1 Geophysical Survey Results

A geophysical survey was performed at the 300-9 site in January 2005 to locate and map subsurface features. Data were collected using ground-penetrating radar and electromagnetic induction; interpreted results are provided in Figure 2. The survey revealed a shallow historic depression with very shallow side slopes (3:1 to 4:1) near the eastern corner of the site. A distinctive layer within the depression (approximately 1 m [3 ft] below ground surface [bgs]) was also observed and interpreted as possible capping material, though subsequently determined to be a thin gravel layer during confirmatory sampling. A second anomalous area was observed southwest of the haul road transecting the site and consisted of suspect metallic material less than 0.5 m (1.6 ft) bgs underlain by a highly reflective geologic horizon at approximately 2 m (6.5 ft) bgs. No other anomalies indicative of a possible burial ground were observed.

Figure 2. 300-9 Waste Site Geophysical Interpretation Map.



2.3.2 Contaminants of Potential Concern

The contaminants of potential concern (COPCs) for confirmatory sampling were identified based on process knowledge of other 300 Area burial grounds and the constituents potentially present at the 300-9 waste site. The COPC list included inductively coupled plasma metals, mercury, uranium, plutonium-238, plutonium-239/240, americium-241, gamma-emitting radionuclides, and polychlorinated biphenyls (PCBs). While not considered COPCs, the potential presence of volatile organic compounds was evaluated by field screening with an organic vapor monitor during confirmatory sampling activities. No volatile organic compounds were detected at the 300-9 waste site, and no further laboratory analysis was performed.

2.3.3 Confirmatory Sampling Activities

Confirmatory sampling of the 300-9 waste site was performed on March 28, 2006, per the *Work Instruction for the 300-9 Possible Early Solid Waste Burial Ground* (BHI 2005). Test excavations were completed within the two identified geophysical anomalous zones to assess the potential presence of a burial ground (Figure 2). Excavation at the eastern geophysical anomaly (test trench 1) revealed an approximately 0.15-m (6-in.)-thick gravel layer between predominant sand layers, but no features suggestive of a burial ground were identified. Excavation continued to approximately 3 m (10 ft) bgs, where a native soil sample was collected. Excavation at the southwestern geophysical anomaly (test trench 2) revealed scrap aluminum tubing in the shallow subsurface (less than 0.9 m [3 ft] bgs), consistent with the debris associated with the 300-8 waste site. Field radiological instrumentation indicated elevated alpha- and beta-particle activity on the aluminum debris, and a sample was collected from soil contained within the tubing. Native soil was encountered at approximately 0.9 m (3 ft) bgs, where a soil sample was collected. No indications of a historic burial ground were identified at the locations of the geophysical anomalies.

3.0 REMEDIAL ACTION FIELD ACTIVITIES

3.1 EXCAVATION AND DISPOSAL

Remediation of the 300-9 waste site began on November 23, 2014, and continued through December 4, 2014. The remediation extended to an approximate maximum depth of 1.5 m (5 ft) bgs, resulting in approximately 3,891 bank cubic meters (5,089 bank cubic yards) of soil being removed for disposal at ERDF. Some laboratory "thimbles" were also removed and disposed. All material was direct loaded from the excavation; therefore, no waste staging pile area was generated. Additionally, no overburden material was stockpiled for use as backfill material. A post-excavation aerial photograph taken December 30, 2014, is provided in Figure 3.

Figure 3. December 2014 Aerial Photograph of the 300-9 Waste Site Remediation.

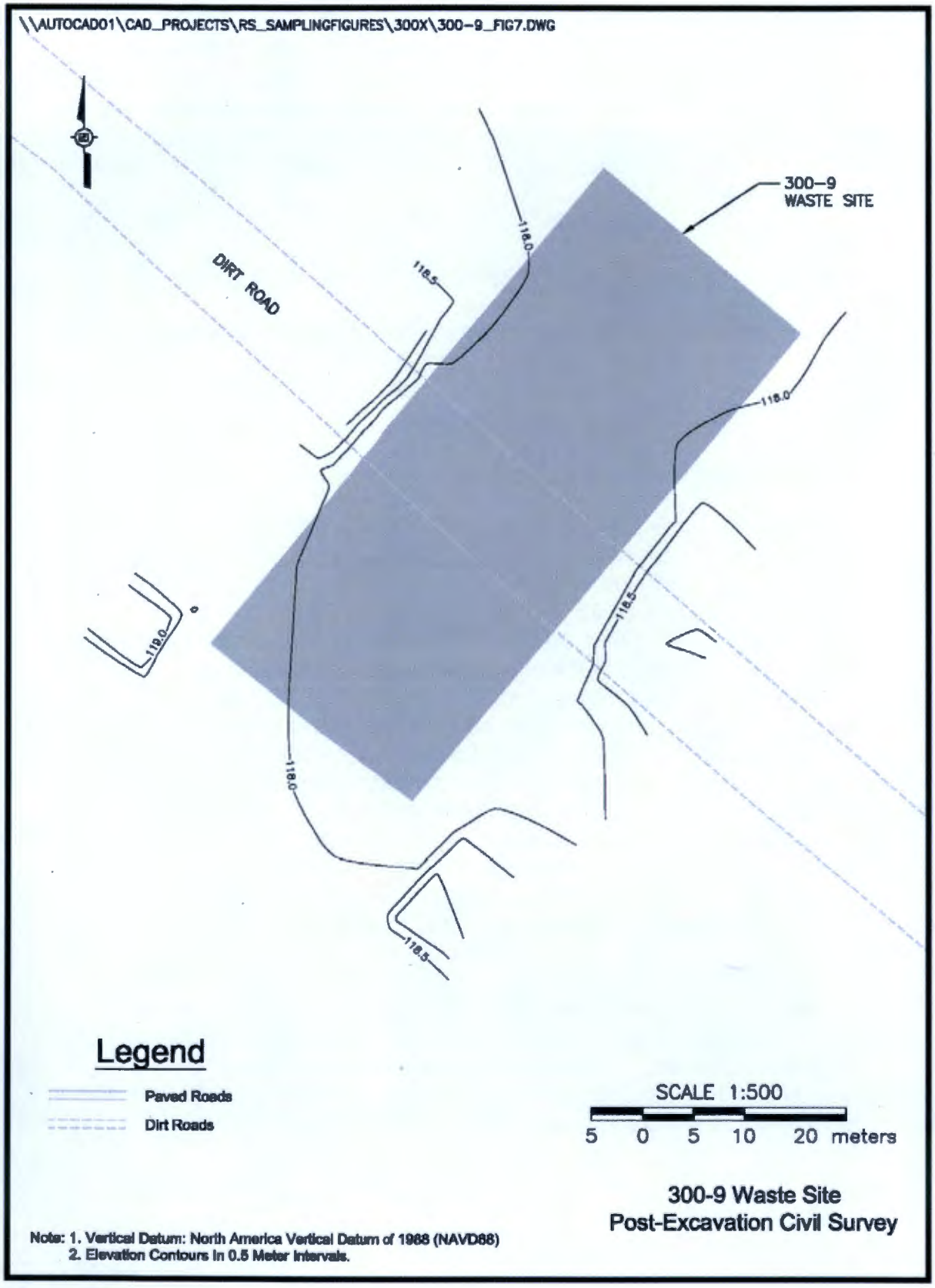
3.2 POST-EXCAVATION TOPOGRAPHIC SURVEY

A post-excavation civil survey was performed at the 300-9 waste site at the completion of remedial action activities. The survey is provided in Figure 4.

4.0 VERIFICATION SAMPLING ACTIVITIES

Verification sampling for the 300-9 waste site was performed on December 29, 2014, per the *Work Instruction for Verification Sampling of the 300-9, Possible Early Burial Ground Sites North of RR and North of 618-8, Solid Waste Burial Ground* (WCH 2015). Verification sampling was conducted to support a determination that residual contaminant concentrations at this site meet the cleanup criteria specified in the 300 Area RDR/RAWP (DOE-RL 2009) and the 300 Area ROD (EPA 2013). The 95% upper confidence limit (UCL) calculations for the verification sample results are provided in Appendix A. These indicate that the remedial action achieved compliance with the applicable RAOs and CULs for the 300-9 waste site. The following subsections provide additional discussion of the information used to develop the verification sampling design.

Figure 4. 300-9 Waste Site Post-Excavation Civil Survey.



4.1 CONTAMINANTS OF CONCERN FOR VERIFICATION SAMPLING

The COCs for verification sampling at the 300-9 waste site were determined based on the confirmatory sampling results and include uranium-233/234, uranium-235, uranium-238, americium-241, chromium, lead, mercury, molybdenum, nickel, and aroclor-1260. While not considered site COCs, analysis for the expanded list of inductively coupled plasma metals (which also includes antimony, arsenic, barium, beryllium, boron, cadmium, cobalt, copper, manganese, selenium, silver, vanadium, and zinc) was requested.

4.2 VERIFICATION SAMPLING DESIGN SELECTION AND BASIS

This section describes the basis for selection of an appropriate sample design and determination of the number of verification samples that were collected. The excavation area footprint is the only decision unit identified for the 300-9 waste site for verification sampling.

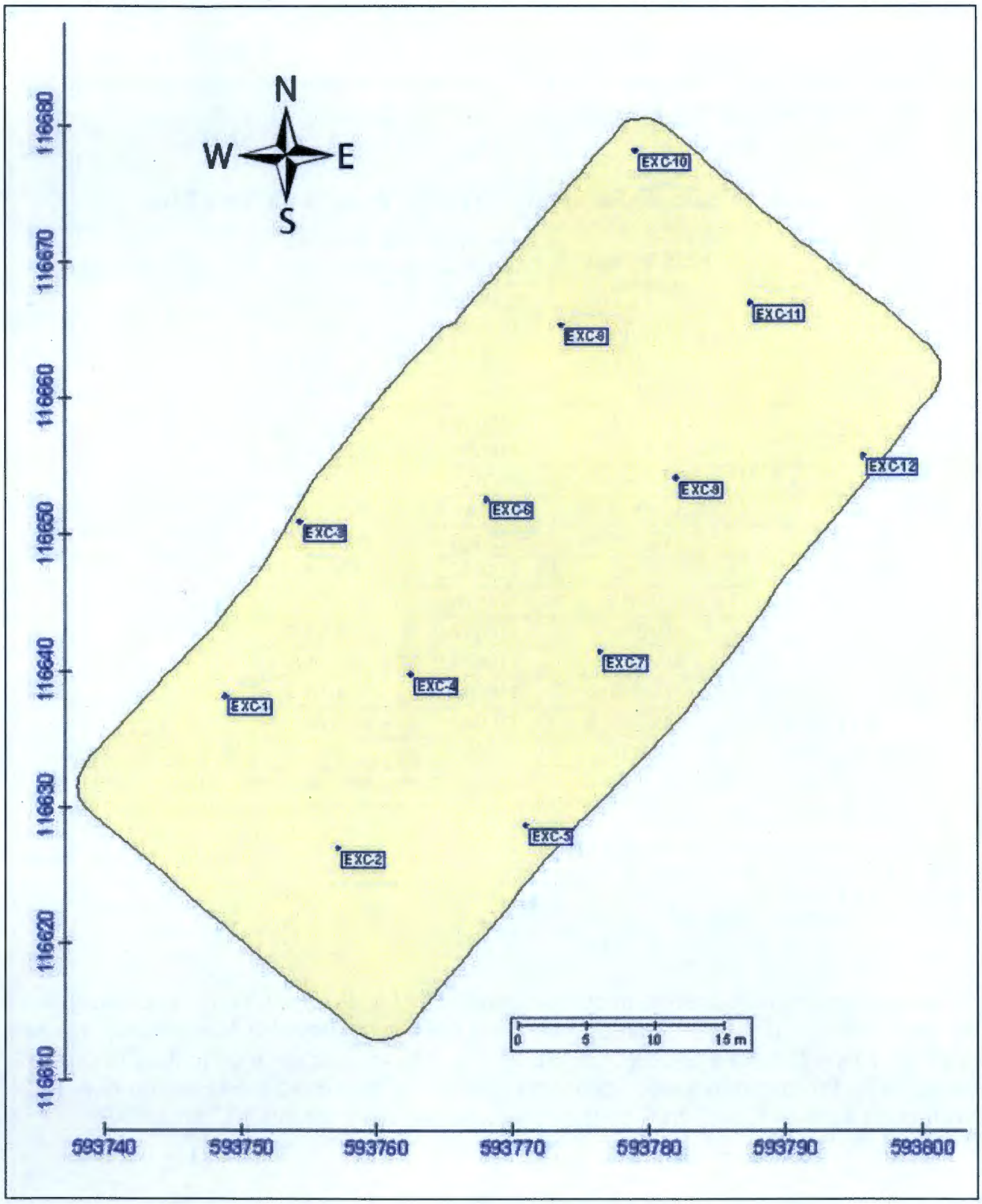
4.2.1 Statistical Verification Sampling Design

The decision rule for demonstrating compliance with the cleanup criteria requires comparison of the true population mean, as estimated by the 95% UCL on the sample mean, with the CUL. Therefore, a statistical sampling design is the preferred verification sampling approach for this site because the distribution of potential residual soil contamination over the site is uncertain. The Washington State Department of Ecology (Ecology) publication *Guidance on Sampling and Data Analysis Methods* (Ecology 1995) recommends that systematic sampling with sample locations distributed over the entire study area be used. This sampling approach is referred to by Ecology as "area-wide sampling." Therefore, sampling locations were distributed over the footprint of the excavation area using a random-start systematic grid in an effort to determine the potential presence of residual contamination. Statistical parameters (i.e., standard deviation within the populations) for residual contaminant levels following remediation at the 300-9 waste site were estimated based on assumptions of residual contamination after remediation. These assumptions were verified using the resulting verification sampling data and considered in the data quality assessment (DQA) for the data set.

The excavation area footprint of the 300-9 waste site was delineated in the Visual Sample Plan[1] and used as the basis for the location of a random-start systematic grid for verification soil sampling. A triangular grid was selected for this investigation based on studies that indicate triangular grids are superior to square grids (Gilbert 1987). Twelve statistical soil sample locations were identified (Figure 5).

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

Figure 5. Verification Sample Locations for the 300-9 Waste Site Excavation.



4.2.2 Verification Sampling

The soil sample locations were global positional surveyed and staked prior to sample collection using the coordinate pairs provided in Table 1. A discrete grab 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). Field quality control samples were also collected and consisted of one equipment blank, one duplicate, and one split sample.

Table 1. Sample Summary Table for the 300-9 Waste Site.

Sample Location	HEIS Sample Number	Washington State Plane Coordinate Locations (m)		Sample Analysis
		Northing	Easting	
EXC-1	J1V2F4	116638.2	593748.8	ICP metals [a], mercury, PCBs, americium-241, isotopic uranium
EXC-2	J1V2F5	116627.0	593757.2	
EXC-3	J1V2F6	116651.0	593754.3	
EXC-4	J1V2F7	116639.8	593762.6	
EXC-5	J1V2F8	116628.7	593771.0	
EXC-6	J1V2F9	116652.6	593768.1	
EXC-7	J1V2H0	116641.5	593776.5	
EXC-8	J1V2H1	116665.4	593773.6	
EXC-9	J1V2H2	116654.2	593781.9	
EXC-10	J1V2H3	116678.2	593779.1	
EXC-11	J1V2H4	116667.0	593787.4	
EXC-12	J1V2H5	116655.9	593795.8	
Duplicate of J1V2H4	J1V2H6	116667.0	593787.4	
Split of J1V2H4	J1V2H8	116667.0	593787.4	
Equipment blank	J1V2H7	NA	NA	ICP metals [a], mercury

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

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

All sampling was performed in accordance with ENV-1, *Environmental Monitoring & Management*, to fulfill the requirements of the *300 Area Remedial Action Sampling and Analysis Plan* (300 Area SAP) (DOE-RL 2014). All samples were submitted to offsite laboratories for full protocol laboratory analysis using approved U.S. Environmental Protection Agency (EPA) analytical methods as required per the 300 Area SAP (DOE-RL 2014). The analytical methods are provided in Table 2.

Table 2. 300-9 Waste Site Laboratory Analytical Methods.

Analytical Method	Contaminants of Concern
ICP metals [a] – EPA Method 6010	Chromium, lead, mercury, molybdenum, nickel
Mercury – EPA Method 7471	Mercury
PCB – EPA Method 8082	Aroclor-1260
Isotopic uranium - AEA	Uranium-233/234, uranium-235, uranium-238
Americium-241 - AEA	Americium-241

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

AEA = alpha energy analysis
EPA = U.S. Environmental Protection Agency
ICP = inductively coupled plasma
PCB = polychlorinated biphenyl

5.0 SAMPLING RESULTS

This section presents the evaluation of the verification sample results for comparison with the data quality criteria and CULs.

5.1 STATISTICAL SAMPLE RESULTS

The laboratory-reported verification sample results for all constituents are stored in a Washington Closure Hanford project-specific database prior to archival in the Hanford Environmental Information System (HEIS), and are presented as an attachment to the 95% UCL calculation (Appendix A).

One decision unit was identified for the 300-9 waste site for verification sampling, and consisted of the excavation footprint. Twelve statistical soil samples were collected from the decision unit and submitted to offsite laboratories for analysis. The resulting data were evaluated by performing a 95% UCL on the true population mean for the residual COC concentrations.

The 95% UCLs on the true population means for residual concentrations of COCs were calculated for the excavation decision unit as specified by the RDR/RAWP (DOE-RL 2009), with calculations provided in Appendix A. When a nonradionuclide COC was detected in fewer than 50% of the verification samples collected, the maximum detected value was used for comparison against the RAGs. If no detections for a given COC were reported in the data set, then no statistical evaluation or calculations were performed for that COC.

Comparison of the statistical results for each COC from the 300-9 waste site against the CULs for the excavation area is presented in Table 3. Contaminants that were not detected by laboratory analysis are excluded from the table. Calculated cleanup levels for calcium, magnesium, potassium, silicon, and sodium are not presented in the RDR/RAWP (DOE-RL 2009). Parameters to calculate cleanup levels for these constituents are not presented in the Cleanup Levels and Risk Calculations Database (Ecology 2011) under WAC 173-340-740(3) or other reference databases. The EPA's *Risk Assessment Guidance for Superfund* (EPA 1989) recommends that aluminum and iron not be considered in site risk evaluations. Therefore, aluminum, calcium, iron, magnesium, potassium, silicon, and sodium are not considered site COCs and are also not included in the table.

The 300 Area COCs and CULs are provided in the 300 Area Final Action ROD (EPA 2013). If a contaminant is discovered during remediation for which a CUL is not established in the ROD, the information will be presented to the U.S. Department of Energy and EPA project managers for determination of a path forward. While not identified as a 300 Area COC, molybdenum was detected in the verification samples above the background value; however, the detection was below risk-based CULs calculated during development of the 300 Area ROD (EPA 2013). Therefore, the detected molybdenum concentration does not require further discussion.

5.2 DATA QUALITY ASSESSMENT PROCESS

A DQA is performed to compare the verification sampling approach and resulting analytical data with the sampling and data quality requirements specified by the project objectives and performance specifications.

The DQA for the 300-9 waste site determined that the data are of the right type, quality, and quantity to support site verification decisions within specified error tolerances. All analytical data were found to be acceptable for decision-making purposes. The evaluation also verified that the sample design was sufficient to support clean site verification. The cleanup verification sample analytical data are stored in a Washington Closure Hanford project-specific database prior to archiving in HEIS and are presented as an attachment to the 95% UCL calculations in Appendix A. The detailed DQA is presented in Appendix B.

Table 3. Comparison of Contaminant Concentrations to Industrial Cleanup Levels for the 300-9 Waste Site Verification Sampling.

COC	Statistical or Maximum Result [a, b] (pCi/g)	Radionuclide Direct Exposure CULs [c] (pCi/g)	Radionuclide Groundwater and River Protection CULs [c] (pCi/g)	Does the Result Exceed CULs?
Americium-241	0.045	210	--	No
Uranium-233/234	0.739 (<BG)	167	--	No
Uranium-235	0.069	16	--	No
Uranium-238	0.688 (<BG)	167	--	No
COC	**Statistical or Maximum Result [a, b] (mg/kg)**	**Nonradionuclide Direct Exposure CULs [c] (mg/kg)**	**Nonradionuclide Groundwater and River Protection CULs [c] (mg/kg)**	**Does the Result Exceed CULs?**
Arsenic	3.68 (<BG)	20	--	No
Barium	84.2 (<BG)	700,000	--	No
Beryllium	0.889 (<BG)	7,000	--	No
Cadmium	0.132 (<BG)	3,500	--	No
Chromium (total)	11.1 (<BG)	>1,000,000	--	No
Cobalt	11.6 (<BG)	1,050	--	No
Copper	12.8 (<BG)	140,000	--	No
Lithium	8.35 (<BG)	7,000	--	No
Manganese	346 (<BG)	490,000	--	No
Mercury	0.00583 (<BG)	1,050	--	No
Nickel	10.3 (<BG)	70,000	--	No
Selenium	2.76	17,500	912	No
Strontium	34.3	>1,000,000	--	No
Tin	3.97	>1,000,000	--	No
Uranium (total)	0.621 (<BG)	505	157	No
Vanadium	61.0 (<BG)	17,500	--	No
Zinc	30.0 (<BG)	>1,000,000	--	No
Aroclor-1242	0.00738	66	--	No
Aroclor-1260	6.58 [d]	66	--	No

[a] 95% upper confidence level or maximum value, depending on data censorship, as described in Appendix A.
[b] Background values from DOE-RL 1996, 2001, and 2013.
[c] CULs obtained from Table 4 of the 300 Area ROD (EPA 2013)
[d] The residential direct exposure CUL of 0.50 mg/kg was exceeded for Aroclor-1260.

-- = not applicable
BG = background
COC = contaminant of concern
CUL = cleanup level
ROD = record of decision

6.0 CLEANUP VERIFICATION DATA EVALUATION

This section describes the evaluation of the sampling data in terms of comparison to the CULs, the radionuclide risk requirements, and the nonradionuclide risk requirements.

6.1 COMPARISON OF SAMPLE DATA TO THE CULS

Evaluation of the results listed in Table 3 from the verification sampling at the 300-9 waste site indicates that all radionuclide and nonradionuclide COCs were quantified below the industrial direct exposure, groundwater protection, and river protection CULs. Residential and industrial soil CULs to be protective of groundwater and the river were calculated based on federal drinking water standards as described in Section 8.2 of the 300 Area Final Action ROD (EPA 2013). Verification sampling results for Aroclor-1260 exceed the residential direct exposure CUL as noted in Table 3; therefore, the residual contaminant concentrations do not meet human health direct exposure CULs for residential land use in the shallow zone soils.

The 300 RDR/RAWP (DOE-RL 2009) also requires comparison of nonradionuclide results against CULs following the components of the WAC 173-340-740(7)(e) three-part test. The application of the three-part test is included in the 95% UCL calculation (Appendix A). All residual COC concentrations pass the three-part test in comparison against the industrial land-use CULs.

The 300 RDR/RAWP (DOE-RL 2009) also requires comparison of verification sampling results against ecological screening values. However, as described in Section 7.2 of the 300 Area ROD (EPA 2013), ecological risk evaluations concluded that, once human health CULs are achieved, residual contamination would not be sufficient to adversely impact populations and communities of ecological receptors. Therefore, no further screening of potential ecological risk has been performed for the 300-9 site.

6.2 EVALUATION OF ATTAINMENT OF RADIONUCLIDE AND NONRADIONUCLIDE RISK REQUIREMENTS

This section discusses how the verification sampling data are used in demonstrating attainment of radionuclide and nonradionuclide risk requirements.

6.2.1 Radionuclide Evaluation of Risk and Dose

The cleanup levels (CULs) for soil radionuclide COCs in the 300 Area ROD (EPA 2013) were set at a 1×10^{-4} risk limit or 15 mrem/yr dose limit, whichever is more conservative. In addition to meeting these individual CULs, a comparison of the radionuclide verification sample results for the statistical data set to the cumulative direct exposure radionuclide excess cancer risk limit of 1×10^{-4} and the radiological dose limit of 15 mrem/yr was conducted using sum of fractions calculations (Appendix A). The sum

of fractions were calculated for the 300-9 waste site data set using the statistical value for each COC detected above background. The calculations were performed using the soil concentrations corresponding to a 1 x 10^{-4} risk and a 15 mrem/yr dose for industrial land use from Table 8-4 of the *Remedial Investigation/Feasibility Study for the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units* (DOE-RL 2013).

The sum of fractions shown in the 300-9 Waste Site Radionuclide Sum of Fractions Calculation in Appendix A determined that the cumulative excess cancer risk value for radionuclides is 4.8 x 10^{-9} and the total radiological dose is 0.0032 mrem/yr. By comparing these values to the risk and dose limits of <1 x 10^{-4} and <15 mrem/yr the risk and dose requirements are met.

6.2.2 Attainment of Nonradionuclide Noncarcinogenic and Carcinogenic Risk Standards

For COCs with noncarcinogenic effects, *Washington Administrative Code* (WAC) 173-340, "Model Toxics Control Act – Cleanup," specified the evaluation of the hazard quotient, which is given as daily intake divided by a reference dose (WAC 173-340-200). The solutions and details of the hazard quotient calculations for 300-9 waste site are provided in Appendix A.

Nonradionuclide risk requirements for the industrial scenario include an individual hazard quotient of less than 1.0, a cumulative hazard quotient of less than 1.0, an individual contaminant carcinogenic risk of less than 1 x 10^{-5}, and a cumulative carcinogenic risk of less than 1 x 10^{-5}. Hazard quotient and excess carcinogenic risk calculations were performed for the 300-9 waste site using the 95% UCL statistical values from the cleanup verification samples. 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 x 10^{-5}. The cumulative hazard quotient for the 300-9 waste site is 1.8 x 10^{-4}, satisfying the criteria of less than 1.0. The cumulative excess cancer risk for the 300-9 waste site is 1.0 x 10^{-7}, satisfying the criteria of less than 1 x 10^{-5}.

7.0 STATEMENT OF PROTECTIVENESS

This CVP demonstrates that remedial action at the 300-9 waste site achieved the RAOs and corresponding CULs established for the industrial land-use scenario in the 300 Area ROD (EPA 2013) and meets the requirements of the 300 Area RDR/RAWP (DOE-RL 2009), as modified by TPA-CN-598 (DOE-RL and EPA 2013). The contaminated materials from the site have been excavated and disposed of at ERDF. The remaining soil at the 300-9 waste site has been sampled, analyzed, and evaluated. Results indicate that the site supports future land uses that can be represented (or bounded) by the industrial land-use scenario and poses no threat to groundwater or

the Columbia River. Verification sampling results for Aroclor-1260 exceed the residential direct exposure CUL. Due to this exceedance, the residual contaminant concentrations do not meet human health direct exposure CULs for residential land use in the shallow zone soils. Because the waste site was remediated to achieve CULs for industrial land use, institutional controls to maintain industrial land use are required. The 300-9 waste site is verified to be remediated in accordance with the 300 Area ROD (EPA 2013) and has been reclassified to a status of Final Closed Out.

8.0 REFERENCES

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APPENDIX A

CALCULATIONS

APPENDIX A

CALCULATIONS

The calculations in this appendix are kept in the active Washington Closure Hanford project files and are available upon request. When the project is completed, the files will be stored in a U.S. Department of Energy, Richland Operations Office repository. These 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:

300-9 Waste Site Cleanup Verification 95% UCL Calculations, (MTCAStat) 0300X-CA-V0212, Rev. 0, Washington Closure Hanford, Richland, Washington A-3

300-9 Waste Site Direct Contact Hazard Quotient and Carcinogenic Risk Calculations, (MTCAStat) 0300X-CA-V0213, Rev. 0, Washington Closure Hanford, Richland, Washington A-21

300-9 Waste Site Radionuclide Sum of Fractions Calculations, (MTCAStat) 0300X-CA-V0214, Rev. 0, Washington Closure Hanford, Richland, Washington A-25

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.

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CALCULATION COVER SHEET

Project Title: 300 Area Closure Operations **Job No. 14655**

Area: 300

Discipline: Environmental *Calculation No: 0300X-CA-V0212

Subject: 300-9 Waste Site Cleanup Verification 95% UCL Calculations (MTCAStat)

Computer Program: Excel Program No: Excel 2010

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

Committed Calculation ☒ Preliminary ☐ Superseded ☐ Voided ☐

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover = 1 Sheets = 10 Attm. 1 = 6 Total = 17	J. D. Skoglie	I. B. Berezovskiy	R. J. Nielson	S. G. Wilkinson	5/14/15

SUMMARY OF REVISION

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

Washington Closure Hanford **CALCULATION SHEET**

Originator J. D. Skoglie	**Date** 04/28/15	**Calc. No.** 0300X-CA-V0212	**Rev. No.** 0
Project 300 Area Closure Operations	**Job No.** 14655	**Checked** I. B. Berezovskiy	**Date** 04/28/15
Subject 300-9 Waste Site Cleanup Verification 95% UCL Calculations (MTCAStat)			**Sheet No.** 1 of 10

Summary

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

Table of Contents:
Sheets 1 to 4 - Calculation Sheet Summary
Sheet 5 to 7 - Calculation Sheet Verification Data Excavation
Sheet 8 to 9 - MTCA Results
Sheet 10 - Calculation Sheet Duplicate and Split Analysis
Attachment 1 - 300-9 Waste Site Verification Sampling Results (6 sheets)

Given/References:
1) Sample Results (Attachment 1).
2) Background values and cleanup levels (CULs) are taken from DOE-RL (1996), DOE-RL (2001), and DOE-RL (2014b).
3) DOE-RL, 1996, *Hanford Site Background: Part 2, Soil Background for radioactive Analytes*, DOE/RL-96-12, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
4) 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.
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6) DOE-RL, 2014a, *300 Area Remedial Action Sampling and Analysis Plan* (SAP), DOE/RL-2001-48, Rev. 4, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
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13) EPA, 1994, *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*, EPA 540/R-94/013. U.S. Environmental Protection Agency, Washington, D. C.
14) 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 2009). 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 Cleanup Verification Package (CVP).

Calculation Description:
The subject calculations were performed on statistical data from soil verification samples (Attachment 1) from the 300-9 waste site. The data were entered into an EXCEL 2010 spreadsheet and calculations performed by using the built-in spreadsheet functions and/or creating formulae within the cells. The statistical evaluation of data for use in accordance with the RDR/RAWP (DOE-RL 2009) is documented by this calculation. Duplicate and split RPD results are used in evaluation of data quality within the RSVP for these sites.

Methodology:
The 300-9 waste site consists of one desicion unit for verification sampling: the excavation. Analytical data for all sampling locations is provided in the summary tables on sheet 4.

Summary (continued)

Methodology (continued):
For nonradioactive analytes with ≤50% of the data below detection limits, the statistical value calculated to evaluate the effectiveness of cleanup is the 95% UCL. For nonradioactive analytes with >50% of the data below detection limits, as determined by direct inspection of the sample results (Attachment 1), the maximum detected value for the data set is used instead of the 95% UCL, and no further calculations are performed for those data sets. For convenience, these maximum detected values are included in the summary tables that follow. The 95% UCL was not calculated for data sets with no reported detections. Calculated cleanup levels are not available in Ecology (2011) under WAC 173-340-740(3) for calcium, magnesium, potassium, silicon, and sodium. The EPA's Risk Assessment Guidance for Superfund (EPA 1989) recommends that aluminum and iron not be considered in site risk evaluations. Therefore, aluminum, calcium, iron, magnesium, potassium, silicon, and sodium are not considered site COCs/COPCs and are also not included in these calculations. The 95% UCL values were not calculated for potassium-40, radium-226, radium-228, thorium-228, and thorium-232 based on natural occurence at the Hanford Site.

All nonradionuclide data reported as being undetected are set to ½ the detection limit value for calculation of the statistics (Ecology 1993). 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 2009) 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 WAC 173-340-740(7)(e) 3-part test is not performed for COPCs where the statistical value defaults to the maximum value in the data set. Instead, direct comparison of the maximum value against site cleanup levels (CULs) (within the CVP) is used as the compliance basis.

The RPD is calculated when both the primary value and the duplicate value for a given analyte are above detection limits and are greater than 5 times the target detection limit (TDL). The TDL is a laboratory detection limit pre-determined for each analytical method and is listed in Table 2-1 of the SAP (DOE-RL 2014a) for certain constituents with cleanup levels or shown in laboratory-specific documents; 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) split and duplicate RPD calculations, a value less than 30% indicates the data compare favorably. For regulatory splits, a threshold of 35% is used (EPA 1994). If the RPD is greater than 30% (or 35% for regulatory split data), further investigation regarding the usability of the data is performed. 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 results exceeds a control limit of 2 times the TDL, further assessment regarding the usability of the data is performed. Additional discussion as necessary is provided in the data quality assessment section of the applicable CVP.

Washington Closure Hanford	CALCULATION SHEET				
Originator J. D. Skoglie	Date 04/22/15	Calc. No. 0300X-CA-V0212		Rev. No. 0	
Project 300 Area Closure Operations	Job No. 14655	Checked I. B. Berezovskiy		Date 04/22/15	
Subject 300-9 Waste Site Cleanup Verification 95% UCL Calculations (MTCAStat)				Sheet No. 3 of 10	

Summary (continued)

Qualifiers

* Indicates that a quality control parameter was not within specifications
B = Estimated result. Result is less than the RL, but greater than MDL.
C = Target analyte was detected in the sample and the associated blank
D = dilution
J = estimate
M = sample duplicate precision not met
N = recovery is outside the control limits
U = undetected

Acronyms

CUL = cleanup limit
CVP = cleanup verification package
DE = direct exposure
DS = detected sample
EXC = excavation
GW = groundwater
MDA = minimum detectable activity
MDL = method detection limit
PCB = polychlorinated biphenyls
PQL = practical quantitation limit
Q = qualifier
QA/QC = quality assurance/quality control
RDR/RAWP = remedial design report/remedial action work plan
RESRAD = RESidual RADioactivity (dose model)
RPD = relative percent difference
SAP = sampling and analysis plan
SVOA = semivolatile organic analysis
TDL = target detection limit
UCL = upper confidence limit
WAC = Washington Administrative Code

Washington Closure Hanford

CALCULATION SHEET

Originator J. D. Skoglie **Date** 04/23/15 **Calc. No.** 0300X-CA-V0212 **Rev. No.** 0
Project 300 Area Closure Operations **Job No.** 14655 **Checked** I. B. Berezovskiy **Date** 04/23/15
Subject 300-9 Waste Site Cleanup Verification 95% UCL Calculations (MTCAStat) **Sheet No.** 4 of 10

Summary (continued)

Results:
The results presented in the tables that follow include the summary of the results of the 95% UCL calculations for the excavation, the WAC 173-340-740(7)(e) 3-part test evaluation, and the RPD calculations, and are for use in risk analysis and the CVP for these sites.

Results Summary - Excavation[a]

Analyte	EXC		Units
	95% UCL Result	Maximum Result	
Americium-241	0.045	--	pCi/g
Uranium-233/234	0.739	--	pCi/g
Uranium-235	0.069	--	pCi/g
Uranium-238	0.688	--	pCi/g
Arsenic	3.68	--	mg/kg
Barium	84.2	--	mg/kg
Beryllium	0.889	--	mg/kg
Cadmium	--	0.132	mg/kg
Chromium	11.1	--	mg/kg
Cobalt	11.6	--	mg/kg
Copper	12.8	--	mg/kg
Lithium	8.35	--	mg/kg
Manganese	346	--	mg/kg
Mercury	--	0.00583	mg/kg
Nickel	10.3	--	mg/kg
Selenium	2.76	--	mg/kg
Strontium	34.3	--	mg/kg
Tin	--	3.97	mg/kg
Uranium	0.621	--	mg/kg
Vanadium	61.0	--	mg/kg
Zinc	30.0	--	mg/kg
Aroclor-1242	--	0.00738	mg/kg
Aroclor-1260	6.58	--	mg/kg

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

WAC 173-340 3-Part Test for most stringent CUL:

95% UCL > Cleanup Limit?	NO
> 10% above Cleanup Limit?	NO
Any sample > 2x Cleanup Limit?	NO

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

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

Analyte	Excavation	
	Duplicate	Split
Aluminum	1.9%	12.1%
Barium	23.0%	15.5%
Calcium	8.6%	2.7%
Chromium	2.8%	16.5%
Copper	6.8%	11.3%
Iron	0.5%	6.4%
Magnesium	3.1%	4.0%
Manganese	2.4%	2.7%
Silicon	5.7%	***164.1%***
Strontium	6.7%	15.4%
Vanadium	2.1%	11.8%
Zinc	0.8%	32.7%
Zirconium	1.6%	14.0%

[a]RPD listed where result produced, based on criteria. If RPD not required, no value is listed. The significance of the reported RPD values, including values greater than 30% (35% for regulatory split data), is addressed in the data quality assessment section of the CVP.

CALCULATION SHEET

Washington Closure Hanford

Originator J. D. Skoglie
Project 300 Area Closure Operations
Subject 300-9 Waste Site Cleanup Verification 95% UCL Calculations (MTCAStat)

Date 04/23/15
Job No. 14655

Calc. No. 0300X-CA-V0212
Checked I. B. Berezovskiy

Rev. No. 0
Date 04/23/15
Sheet No. 5 of 10

300-9 Statistical Calculations - EXC
Verification Data -Excavation

Sample Area	Sample Number	Sample Date	Americium-241			Uranium-233/234			Uranium-235			Uranium-238		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
EXC-11	J1V2H4	12/29/14	0.002	U	0.07	0.383		0.07	0.039	U	0.07	0.440		0.07
Duplicate of J1V2H4	J1V2H6	12/29/14	0.004	U	0.07	0.808		0.08	0.123		0.08	0.578		0.06
EXC-1	J1V2F4	12/29/14	0.026	U	0.07	0.641		0.07	0.065	U	0.08	0.624		0.07
EXC-2	J1V2F5	12/29/14	-0.0005	U	0.09	0.722		0.06	0.081		0.07	0.708		0.08
EXC-3	J1V2F6	12/29/14	0.056	U	0.13	0.692		0.07	0.041	U	0.12	0.590		0.07
EXC-4	J1V2F7	12/29/14	0.057	U	0.07	0.885		0.07	0.122		0.10	0.746		0.08
EXC-5	J1V2F8	12/29/14	0.016	U	0.10	0.588		0.11	0.009	U	0.10	0.657		0.09
EXC-6	J1V2F9	12/29/14	0.013	U	0.08	0.837		0.06	0.077	U	0.12	0.723		0.07
EXC-7	J1V2H0	12/29/14	0.101		0.09	0.746		0.16	-0.024	U	0.13	0.723		0.15
EXC-8	J1V2H1	12/29/14	0.039	U	0.11	0.763		0.08	0.030	U	0.09	0.706		0.06
EXC-9	J1V2H2	12/29/14	0.042	U	0.10	0.682		0.09	-0.003	U	0.08	0.588		0.06
EXC-10	J1V2H3	12/29/14	0.018	U	0.10	0.581		0.07	0.042	U	0.13	0.479		0.10
EXC-12	J1V2H5	12/29/14	-0.021	U	0.12	0.473		0.08	0.074	U	0.11	0.698		0.07

Statistical Computation Input Data

Sample Area	Sample Number	Sample Date	Americium-241 pCi/g			Uranium-233/234 pCi/g			Uranium-235 pCi/g			Uranium-238 pCi/g		
EXC-11	J1V2H4/ J1V2H6	12/29/14	0.003			0.596			0.081			0.509		
EXC-1	J1V2F4	12/29/14	0.026			0.641			0.065			0.624		
EXC-2	J1V2F5	12/29/14	-0.001			0.722			0.081			0.708		
EXC-3	J1V2F6	12/29/14	0.056			0.692			0.041			0.590		
EXC-4	J1V2F7	12/29/14	0.057			0.885			0.122			0.746		
EXC-5	J1V2F8	12/29/14	0.016			0.588			0.009			0.657		
EXC-6	J1V2F9	12/29/14	0.013			0.837			0.077			0.723		
EXC-7	J1V2H0	12/29/14	0.101			0.746			-0.024			0.723		
EXC-8	J1V2H1	12/29/14	0.039			0.763			0.030			0.706		
EXC-9	J1V2H2	12/29/14	0.042			0.682			-0.003			0.588		
EXC-10	J1V2H3	12/29/14	0.018			0.581			0.042			0.479		
EXC-12	J1V2H5	12/29/14	-0.021			0.473			0.074			0.698		

Statistical Computations

	Americium-241			Uranium-233/234			Uranium-235			Uranium-238		
95% UCL based on	Radionuclide data set. Use nonparametric z-statistic.			Radionuclide data set. Use nonparametric z-statistic.			Radionuclide data set. Use nonparametric z-statistic.			Radionuclide data set. Use nonparametric z-statistic.		
N	12			12			12			12		
% < Detection limit	92%			0%			75%			0%		
Mean	0.029			0.684			0.050			0.646		
Standard deviation	0.032			0.117			0.042			0.088		
Z-statistic	1.64			1.64			1.64			1.64		
95% UCL on mean	0.045			0.739			0.069			0.688		
Maximum value	0.101			0.885			0.123			0.746		

CALCULATION SHEET

Washington Closure Hanford

Originator J. D. Skoglie
Project 300 Area Closure Operations
Subject 300-9 Waste Site Cleanup Verification 95% UCL Calculations (MTCAStat)

Date 04/23/15
Job No. 14655

Calc. No. 0300X-CA-V0212
Checked I. B. Berezovskiy

Rev. No. 0
Date 04/23/15
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300-9 Statistical Calculations - EXC

Verification Data - Statistical

Sample Area	Sample Number	Sample Date	Arsenic mg/kg	Arsenic Q	Arsenic PQL	Barium mg/kg	Barium Q	Barium PQL	Beryllium mg/kg	Beryllium Q	Beryllium PQL	Chromium mg/kg	Chromium Q	Chromium PQL	Cobalt mg/kg	Cobalt Q	Cobalt PQL	Copper mg/kg	Copper Q	Copper PQL	Lithium mg/kg	Lithium Q	Lithium PQL	Manganese mg/kg	Manganese Q	Manganese PQL	Nickel mg/kg	Nickel Q	Nickel PQL
EXC-11	J1V2H4	12/29/14	3.94		0.472	86.7		0.0944	0.800		0.0944	9.20		0.142	9.67		0.142	12.2		0.283	7.67	D	0.410	293		0.189	9.78		0.142
Duplicate of J1V2H4	J1V2H6	12/29/14	2.58	B	0.513	68.8		0.103	0.823		0.103	8.95		0.154	9.84		0.154	11.4		0.308	7.72	D	0.378	300		0.205	9.26		0.154
EXC-1	J1V2F4	12/29/14	3.37		0.526	75.9		0.105	0.915		0.105	11.5		0.158	11.5		0.158	13.1		0.316	8.30	D	0.427	352		0.210	10.9		0.158
EXC-2	J1V2F5	12/29/14	4.13		0.505	81.2		0.101	0.967		0.101	11.1		0.152	12.7		0.152	12.7		0.303	8.33	D	0.400	347		0.202	10.1		0.152
EXC-3	J1V2F6	12/29/14	3.22		0.495	64.4		0.0989	0.715		0.0989	8.54		0.148	8.78		0.148	11.0		0.297	7.26	D	0.381	268		0.198	8.09		0.148
EXC-4	J1V2F7	12/29/14	3.77		0.499	98.1		0.0997	0.931		0.0997	11.9		0.150	12.3		0.150	14.3		0.299	7.86	D	0.427	386		0.199	10.3		0.150
EXC-5	J1V2F8	12/29/14	3.28		0.482	81.5		0.0965	0.958		0.0965	11.2		0.145	11.8		0.145	12.4		0.289	9.30	D	0.383	346		0.193	10.9		0.145
EXC-6	J1V2F9	12/29/14	4.23		0.535	89.6		0.107	0.820		0.107	9.92		0.160	10.9		0.160	13.8		0.321	8.17	D	0.374	375		0.214	10.2		0.160
EXC-7	J1V2H0	12/29/14	3.63		0.533	83.4		0.107	0.840		0.107	10.4		0.160	12.8		0.160	12.0		0.320	7.99	D	0.406	324		0.213	9.06		0.160
EXC-8	J1V2H1	12/29/14	2.43	B	0.510	54.8		0.102	0.743		0.102	8.91		0.153	9.15		0.153	10.5		0.306	7.24	D	0.381	255		0.204	8.85		0.153
EXC-9	J1V2H2	12/29/14	2.88	B	0.541	67.3		0.108	0.777		0.108	9.19		0.162	9.51		0.162	11.0		0.325	8.29	D	0.435	275		0.216	8.78		0.162
EXC-10	J1V2H3	12/29/14	3.31		0.469	80.7		0.0937	0.864		0.0937	10.6		0.141	10.2		0.141	12.0		0.281	8.29	D	0.384	323		0.187	9.72		0.141
EXC-12	J1V2H5	12/29/14	3.07		0.480	72.8		0.0959	0.737		0.0959	12.2		0.144	9.20		0.144	11.9		0.288	8.02	D	0.403	315		0.192	10.6		0.144

Statistical Computation Input Data

Sample Area	Sample Number	Sample Date	Arsenic mg/kg	Barium mg/kg	Beryllium mg/kg	Chromium mg/kg	Cobalt mg/kg	Copper mg/kg	Lithium mg/kg	Manganese mg/kg	Nickel mg/kg
EXC-11	J1V2H4/ J1V2H6	12/29/14	3.26	77.8	0.812	9.08	9.76	11.8	7.70	297	9.52
EXC-1	J1V2F4	12/29/14	3.37	75.9	0.915	11.5	11.5	13.1	8.30	352	10.9
EXC-2	J1V2F5	12/29/14	4.13	81.2	0.967	11.1	12.7	12.7	8.33	347	10.1
EXC-3	J1V2F6	12/29/14	3.22	64.4	0.715	8.54	8.78	11.0	7.26	268	8.09
EXC-4	J1V2F7	12/29/14	3.77	98.1	0.931	11.9	12.3	14.3	7.86	386	10.3
EXC-5	J1V2F8	12/29/14	3.28	81.5	0.958	11.2	11.8	12.4	9.30	346	10.9
EXC-6	J1V2F9	12/29/14	4.23	89.6	0.820	9.92	10.9	13.8	8.17	375	10.2
EXC-7	J1V2H0	12/29/14	3.63	83.4	0.840	10.4	12.8	12.0	7.99	324	9.06
EXC-8	J1V2H1	12/29/14	2.43	54.8	0.743	8.91	9.15	10.5	7.24	255	8.85
EXC-9	J1V2H2	12/29/14	2.88	67.3	0.777	9.19	9.51	11.0	8.29	275	8.78
EXC-10	J1V2H3	12/29/14	3.31	80.7	0.864	10.6	10.2	12.0	8.29	323	9.72
EXC-12	J1V2H5	12/29/14	3.07	72.8	0.737	12.2	9.20	11.9	8.02	315	10.6

Statistical Computations

	Arsenic	Barium	Beryllium	Chromium	Cobalt	Copper	Lithium	Manganese	Nickel
95% UCL based on	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), 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), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.
N	12	12	12	12	12	12	12	12	12
% < Detection limit	0%	0%	0%	0%	0%	0%	0%	0%	0%
mean	3.38	77.3	0.840	10.4	10.7	12.2	8.06	322	9.75
st. dev.	0.505	11.5	0.088	1.24	1.47	1.13	0.546	41.9	0.906
95% UCL on mean	3.68	84.2	0.889	11.1	11.6	12.8	8.35	346	10.3
max value	4.23	98.1	0.967	12.2	12.8	14.3	9.30	386	10.9
Most Stringent Cleanup Limit for nonradionuclide and CUL type (mg/kg)	20 DE, GW & River Protection	700,000 DE Protection	7,000 DE Protection	1,000,000 DE Protection	1,050 DE Protection	140,000 DE Protection	7,000 DE Protection	490,000 DE Protection	70,000 DE Protection
WAC 173-340 3-PART TEST									
95% UCL > Cleanup Limit?	NA	NA	NA	NA	NA	NA	NA	NA	NA
> 10% above Cleanup Limit?	NA	NA	NA	NA	NA	NA	NA	NA	NA
Any sample > 2X Cleanup Limit?	NA	NA	NA	NA	NA	NA	NA	NA	NA
WAC 173-340 Compliance?	Because all values are below background (6.5 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (132 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (1.51 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (19 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (16 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (22 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (13.3 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (512 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (19 mg/kg) the WAC 173-340 3-part test is not required.

CALCULATION SHEET

Washington Closure Hanford

Originator J. D. Skoglie
Project 300 Area Closure Operations
Subject 300-9 Waste Site Cleanup Verification 95% UCL Calculations (MTCAStat)

Date 04/23/15
Job No. 14655

Calc. No. 0300X-CA-V0212
Checked I. B. Berezovskiy

Rev. No. 0
Date 04/23/15
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300-9 Statistical Calculations - EXC
Verification Data - Statistical

Sample Area	Sample Number	Sample Date	Selenium mg/kg	Q	PQL	Strontium mg/kg	Q	PQL	Uranium mg/kg	Q	PQL	Vanadium mg/kg	Q	PQL	Zinc mg/kg	Q	PQL	Aroclor-1260 ug/kg	Q	PQL
EXC-11	J1V2H4	12/29/14	2.50	D	0.338	18.6		0.0944	0.385	*D	0.0135	52.1		0.0944	26.6		0.378	1.18	U	1.18
Duplicate of J1V2H4	J1V2H6	12/29/14	2.50	D	0.312	17.4		0.103	0.418	*D	0.0125	51.0		0.103	26.4		0.410	1.17	U	1.17
EXC-1	J1V2F4	12/29/14	3.00	D	0.353	29.8		0.105	0.625	*D	0.0141	63.7		0.105	30.7		0.421	1.23	U	1.23
EXC-2	J1V2F5	12/29/14	3.04	D	0.330	32.0		0.101	0.632	*D	0.0132	69.4		0.101	32.0		0.404	8.46		1.22
EXC-3	J1V2F6	12/29/14	2.08	D	0.315	34.3		0.0989	0.400	*D	0.0126	49.1		0.0989	26.2		0.396	30.1		1.21
EXC-4	J1V2F7	12/29/14	2.79	D	0.352	42.6		0.0997	0.776	*D	0.0141	66.8		0.0997	32.6		0.399	56.0	D	2.50
EXC-5	J1V2F8	12/29/14	2.74	D	0.316	25.6		0.0965	0.671	*D	0.0126	67.3		0.0965	30.8		0.386	58.6	D	2.42
EXC-6	J1V2F9	12/29/14	2.64	D	0.309	35.9		0.107	0.719	*D	0.0123	57.3		0.107	29.3		0.428	1070	D	60.4
EXC-7	J1V2H0	12/29/14	2.66	D	0.335	41.1		0.107	0.509	*D	0.0134	59.3		0.107	28.4		0.427	6980	D	242
EXC-8	J1V2H1	12/29/14	2.53	D	0.314	18.9		0.102	0.362	*D	0.0126	50.1		0.102	25.2		0.408	2.36	J	1.17
EXC-9	J1V2H2	12/29/14	2.29	D	0.359	21.2		0.108	0.350	*D	0.0144	50.4		0.108	27.8		0.433	35.4		1.22
EXC-10	J1V2H3	12/29/14	2.63	D	0.317	19.2		0.0937	0.454	*D	0.0127	53.1		0.0937	28.1		0.375	1.18	U	1.18
EXC-12	J1V2H5	12/29/14	2.20	D	0.332	16.6		0.0959	0.362	*D	0.0133	50.5		0.0959	25.3		0.384	1.17	U	1.17

Statistical Computation Input Data

Sample Area	Sample Number	Sample Date	Selenium mg/kg	Strontium mg/kg	Uranium mg/kg	Vanadium mg/kg	Zinc mg/kg	Aroclor-1260 ug/kg
EXC-11	J1V2H4/ J1V2H6	12/29/14	2.50	18.0	0.402	51.6	26.5	0.588
EXC-1	J1V2F4	12/29/14	3.00	29.8	0.625	63.7	30.7	0.615
EXC-2	J1V2F5	12/29/14	3.04	32.0	0.632	69.4	32.0	8.46
EXC-3	J1V2F6	12/29/14	2.08	34.3	0.400	49.1	26.2	30.1
EXC-4	J1V2F7	12/29/14	2.79	42.6	0.776	66.8	32.6	56.0
EXC-5	J1V2F8	12/29/14	2.74	25.6	0.671	67.3	30.8	58.6
EXC-6	J1V2F9	12/29/14	2.64	35.9	0.719	57.3	29.3	1070
EXC-7	J1V2H0	12/29/14	2.66	41.1	0.509	59.3	28.4	6980
EXC-8	J1V2H1	12/29/14	2.53	18.9	0.362	50.1	25.2	2.36
EXC-9	J1V2H2	12/29/14	2.29	21.2	0.350	50.4	27.8	35.4
EXC-10	J1V2H3	12/29/14	2.63	19.2	0.454	53.1	28.1	0.590
EXC-12	J1V2H5	12/29/14	2.20	16.6	0.362	50.5	25.3	0.585

Statistical Computations

	Selenium	Strontium	Uranium	Vanadium	Zinc	Aroclor-1260
95% UCL based on	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use ProUCL 99% KM (Chebyshev) UCL.
N	12	12	12	12	12	12
% < Detection limit	0%	0%	0%	0%	0%	33%
mean	2.59	27.9	0.522	57.4	28.6	1030
st. dev.	0.295	9.28	0.155	7.66	2.54	2431
95% UCL on mean	2.76	34.3	0.621	61.0	30.0	6581
max value	3.04	42.6	0.776	69.4	32.6	6980
Most Stringent Cleanup Limit for nonradionuclide and CUL type (mg/kg)	912 GW and River Protection	1,000,000 DE Protection	157 GW and River Protection	17,500 DE Protection	1,000,000 DE Protection	66,000 ug/kg DE Protection
WAC 173-340 3-PART TEST						
95% UCL > Cleanup Limit?	NO	NO	NA	NA	NA	NO
> 10% above Cleanup Limit?	NO	NO	NA	NA	NA	NO
Any sample > 2X Cleanup Limit?	NO	NO	NA	NA	NA	NO
WAC 173-340 Compliance?	The data set meets the 3-part test criteria when compared to the most stringent CUL.	The data set meets the 3-part test criteria when compared to the most stringent CUL.	Because all values are below background (3.21 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (85 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (68 mg/kg) the WAC 173-340 3-part test is not required.	The data set meets the 3-part test criteria when compared to the most stringent CUL.

CALCULATION SHEET

Washington Closure Hanford

Originator J. D. Skoglie
Project 300 Area Closure Operations
Subject 300-9 Waste Site Cleanup Verification 95% UCL Calculations (MTCAStat)

Date 04/23/15
Job No. 14655

Calc. No. 0300X-CA-V0212
Checked I. B. Berezovskiy

Rev. No. 0
Date 04/23/15
Sheet No. 8 of 10

Ecology Software (MTCAStat) Results, 300-9 Waste Site Statistical Samples - Excavation

Arsenic 95% UCL Calculation

DATA	ID
3.26	J1V2H4/ J1V2H6
3.37	J1V2F4
4.13	J1V2F5
3.22	J1V2F6
3.77	J1V2F7
3.28	J1V2F8
4.23	J1V2F9
3.63	J1V2H0
2.43	J1V2H1
2.88	J1V2H2
3.31	J1V2H3
3.07	J1V2H5

Number of samples		Uncensored values	
Uncensored	12	Mean	3.38
Censored	,	Lognormal mean	3.39
Detection limit or PQL		Std. devn.	0.505
Method detection limit		Median	3.30
TOTAL	12	Min.	2.43
		Max.	4.23

Lognormal distribution? r-squared is: 0.949
Normal distribution? r-squared is: 0.957
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 3.68

Barium 95% UCL Calculation

DATA	ID
77.8	J1V2H4/ J1V2H6
75.9	J1V2F4
81.2	J1V2F5
64.4	J1V2F6
98.1	J1V2F7
81.5	J1V2F8
89.6	J1V2F9
83.4	J1V2H0
54.8	J1V2H1
67.3	J1V2H2
80.7	J1V2H3
72.8	J1V2H5

Number of samples		Uncensored values	
Uncensored	12	Mean	77.3
Censored		Lognormal mean	77.4
Detection limit or PQL		Std. devn.	11.5
Method detection limit		Median	79.2
TOTAL	12	Min.	54.8
		Max.	98.1

Lognormal distribution? r-squared is: 0.949
Normal distribution? r-squared is: 0.969
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 84.2

Beryllium 95% UCL Calculation

DATA	ID
0.812	J1V2H4/ J1V2H6
0.915	J1V2F4
0.967	J1V2F5
0.715	J1V2F6
0.931	J1V2F7
0.958	J1V2F8
0.820	J1V2F9
0.840	J1V2H0
0.743	J1V2H1
0.777	J1V2H2
0.864	J1V2H3
0.737	J1V2H5

Number of samples		Uncensored values	
Uncensored	12	Mean	0.840
Censored		Lognormal mean	0.840
Detection limit or PQL		Std. devn.	0.088
Method detection limit		Median	0.830
TOTAL	12	Min.	0.715
		Max.	0.967

Lognormal distribution? r-squared is: 0.962
Normal distribution? r-squared is: 0.960
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 0.889

Chromium 95% UCL Calculation

DATA	ID
9.08	J1V2H4/ J1V2H6
11.5	J1V2F4
11.1	J1V2F5
8.54	J1V2F6
11.9	J1V2F7
11.2	J1V2F8
9.92	J1V2F9
10.4	J1V2H0
8.91	J1V2H1
9.19	J1V2H2
10.6	J1V2H3
12.2	J1V2H5

Number of samples		Uncensored values	
Uncensored	12	Mean	10.4
Censored		Lognormal mean	10.4
Detection limit or PQL		Std. devn.	1.24
Method detection limit		Median	10.5
TOTAL	12	Min.	8.54
		Max.	12.2

Lognormal distribution? r-squared is: 0.957
Normal distribution? r-squared is: 0.962
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 11.1

Cobalt 95% UCL Calculation

DATA	ID
9.76	J1V2H4/ J1V2H6
11.5	J1V2F4
12.7	J1V2F5
8.78	J1V2F6
12.3	J1V2F7
11.8	J1V2F8
10.9	J1V2F9
12.8	J1V2H0
9.15	J1V2H1
9.51	J1V2H2
10.2	J1V2H3
9.20	J1V2H5

Number of samples		Uncensored values	
Uncensored	12	Mean	10.7
Censored		Lognormal mean	10.7
Detection limit or PQL		Std. devn.	1.47
Method detection limit		Median	10.6
TOTAL	12	Min.	8.78
		Max.	12.8

Lognormal distribution? r-squared is: 0.941
Normal distribution? r-squared is: 0.937
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 11.6

Copper 95% UCL Calculation

DATA	ID
11.8	J1V2H4/ J1V2H6
13.1	J1V2F4
12.7	J1V2F5
11.0	J1V2F6
14.3	J1V2F7
12.4	J1V2F8
13.8	J1V2F9
12.0	J1V2H0
10.5	J1V2H1
11.0	J1V2H2
12.0	J1V2H3
11.9	J1V2H5

Number of samples		Uncensored values	
Uncensored	12	Mean	12.2
Censored		Lognormal mean	12.2
Detection limit or PQL		Std. devn.	1.13
Method detection limit		Median	12.0
TOTAL	12	Min.	10.5
		Max.	14.3

Lognormal distribution? r-squared is: 0.974
Normal distribution? r-squared is: 0.967
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 12.8

Lithium 95% UCL Calculation

DATA	ID
7.70	J1V2H4/ J1V2H6
8.30	J1V2F4
8.33	J1V2F5
7.26	J1V2F6
7.86	J1V2F7
9.30	J1V2F8
8.17	J1V2F9
7.99	J1V2H0
7.24	J1V2H1
8.29	J1V2H2
8.29	J1V2H3
8.02	J1V2H5

Number of samples		Uncensored values	
Uncensored	12	Mean	8.06
Censored		Lognormal mean	8.06
Detection limit or PQL		Std. devn.	0.546
Method detection limit		Median	8.10
TOTAL	12	Min.	7.24
		Max.	9.30

Lognormal distribution? r-squared is: 0.904
Normal distribution? r-squared is: 0.894
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 8.35

Manganese 95% UCL Calculation

DATA	ID
297	J1V2H4/ J1V2H6
352	J1V2F4
347	J1V2F5
268	J1V2F6
386	J1V2F7
346	J1V2F8
375	J1V2F9
324	J1V2H0
255	J1V2H1
275	J1V2H2
323	J1V2H3
315	J1V2H5

Number of samples		Uncensored values	
Uncensored	12	Mean	322
Censored		Lognormal mean	322
Detection limit or PQL		Std. devn.	41.9
Method detection limit		Median	324
TOTAL	12	Min.	255
		Max.	386

Lognormal distribution? r-squared is: 0.966
Normal distribution? r-squared is: 0.975
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 346

Nickel 95% UCL Calculation

DATA	ID
9.52	J1V2H4/ J1V2H6
10.9	J1V2F4
10.1	J1V2F5
8.09	J1V2F6
10.3	J1V2F7
10.9	J1V2F8
10.2	J1V2F9
9.06	J1V2H0
8.85	J1V2H1
8.78	J1V2H2
9.72	J1V2H3
10.6	J1V2H5

Number of samples		Uncensored values	
Uncensored	12	Mean	9.75
Censored		Lognormal mean	9.76
Detection limit or PQL		Std. devn.	0.906
Method detection limit		Median	9.91
TOTAL	12	Min.	8.09
		Max.	10.9

Lognormal distribution? r-squared is: 0.953
Normal distribution? r-squared is: 0.961
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 10.3

CALCULATION SHEET

Washington Closure Hanford
Originator J. D. Skoglie
Project 300 Area Closure Operations
Subject 300-9 Waste Site Cleanup Verification 95% UCL Calculations (MTCAStat)

Date 04/23/15
Job No. 14655

Calc. No. 0300X-CA-V0212
Checked I. B. Berezovskiy

Rev. No. 0
Date 04/23/15
Sheet No. 9 of 10

Ecology Software (MTCAStat) Results, 300-9 Waste Site Statistical Samples - Excavation

Selenium 95% UCL Calculation

DATA	ID				
2.50	J1V2H4/ J1V2H6				
3.00	J1V2F4				
3.04	J1V2F5	Number of samples		Uncensored values	
2.08	J1V2F6	Uncensored	12	Mean	2.59
2.79	J1V2F7	Censored		Lognormal mean	2.59
2.74	J1V2F8	Detection limit or PQL		Std. devn.	0.295
2.64	J1V2F9	Method detection limit		Median	2.64
2.66	J1V2H0	TOTAL	12	Min.	2.08
2.53	J1V2H1			Max.	3.04
2.29	J1V2H2				
2.63	J1V2H3				
2.20	J1V2H5				

Lognormal distribution? r-squared is: 0.961
Normal distribution? r-squared is: 0.971
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 2.76

Strontium 95% UCL Calculation

DATA	ID				
18.0	J1V2H4/ J1V2H6				
29.8	J1V2F4				
32.0	J1V2F5	Number of samples		Uncensored values	
34.3	J1V2F6	Uncensored	12	Mean	27.9
42.6	J1V2F7	Censored		Lognormal mean	28.1
25.6	J1V2F8	Detection limit or PQL		Std. devn.	9.28
35.9	J1V2F9	Method detection limit		Median	27.7
41.1	J1V2H0	TOTAL	12	Min.	16.6
18.9	J1V2H1			Max.	42.6
21.2	J1V2H2				
19.2	J1V2H3				
16.6	J1V2H5				

Lognormal distribution? r-squared is: 0.940
Normal distribution? r-squared is: 0.936
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 34.3

Uranium 95% UCL Calculation

DATA	ID				
0.402	J1V2H4/ J1V2H6				
0.625	J1V2F4				
0.632	J1V2F5	Number of samples		Uncensored values	
0.400	J1V2F6	Uncensored	12	Mean	0.522
0.776	J1V2F7	Censored		Lognormal mean	0.524
0.671	J1V2F8	Detection limit or PQL		Std. devn.	0.155
0.719	J1V2F9	Method detection limit		Median	0.482
0.509	J1V2H0	TOTAL	12	Min.	0.350
0.362	J1V2H1			Max.	0.776
0.350	J1V2H2				
0.454	J1V2H3				
0.362	J1V2H5				

Lognormal distribution? r-squared is: 0.918
Normal distribution? r-squared is: 0.911
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 0.621

Vanadium 95% UCL Calculation

DATA	ID				
51.6	J1V2H4/ J1V2H6				
63.7	J1V2F4				
69.4	J1V2F5	Number of samples		Uncensored values	
49.1	J1V2F6	Uncensored	12	Mean	57.4
66.8	J1V2F7	Censored		Lognormal mean	57.4
67.3	J1V2F8	Detection limit or PQL		Std. devn.	7.66
57.3	J1V2F9	Method detection limit		Median	55.2
59.3	J1V2H0	TOTAL	12	Min.	49.1
50.1	J1V2H1			Max.	69.4
50.4	J1V2H2				
53.1	J1V2H3				
50.5	J1V2H5				

Lognormal distribution? r-squared is: 0.896
Normal distribution? r-squared is: 0.889
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 61.0

Zinc 95% UCL Calculation

DATA	ID				
26.5	J1V2H4/ J1V2H6				
30.7	J1V2F4				
32.0	J1V2F5	Number of samples		Uncensored values	
26.2	J1V2F6	Uncensored	12	Mean	28.6
32.6	J1V2F7	Censored		Lognormal mean	28.6
30.8	J1V2F8	Detection limit or PQL		Std. devn.	2.54
29.3	J1V2F9	Method detection limit		Median	28.3
28.4	J1V2H0	TOTAL	12	Min.	25.2
25.2	J1V2H1			Max.	32.6
27.8	J1V2H2				
28.1	J1V2H3				
25.3	J1V2H5				

Lognormal distribution? r-squared is: 0.965
Normal distribution? r-squared is: 0.963
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 30.0

Aroclor-1260 95% UCL Calculation

DATA	ID				
0.588	J1V2H4/ J1V2H6				
0.615	J1V2F4				
8.46	J1V2F5	Number of samples		Uncensored values	
30.1	J1V2F6	Uncensored	12	Mean	1030
56.0	J1V2F7	Censored		Lognormal mean	1765
58.6	J1V2F8	Detection limit or PQL		Std. devn.	2431
1070	J1V2F9	Method detection limit		Median	19.3
6980	J1V2H0	TOTAL	12	Min.	0.585
2.36	J1V2H1			Max.	6980
35.4	J1V2H2				
0.590	J1V2H3				
0.585	J1V2H5				

Lognormal distribution? r-squared is: 0.902
Normal distribution? r-squared is: 0.958
Recommendations:
Use ProUCL 99% KM.

UCL (Chebyshev's method) is 6581

CALCULATION SHEET

Washington Closure Hanford

Originator J. D. Skoglie **Date** 04/22/15 **Calc. No.** 0300X-CA-V0212 **Rev. No.** 0
Project 300 Area Closure Operations **Job No.** 14655 **Checked** I. B. Berezovskiy **Date** 04/22/15
Subject 300-9 Waste Site Cleanup Verification 95% UCL Calculations (MTCAStat) **Sheet No.** 10 of 10

Duplicate/Split Analysis - 300-9 Excavation Samples

Sampling Area	Sample Number	Sample Date	Uranium-233/234 - AEA			Uranium-238 - AEA			Aluminum			Arsenic			Barium			Beryllium			Cadmium			Calcium			Chromium		
			pCi/g	Q	MDA	pCi/g	Q	MDA	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-11	J1V2H4	12/29/14	0.383		0.07	0.440		0.07	6000		6.42	3.94		0.472	86.7		0.0944	0.800		0.0944	0.107	B	0.0944	3740		7.55	9.20		0.142
Duplicate of J1V2H4	J1V2H6	12/29/14	0.808		0.08	0.578		0.06	5890		6.97	2.58	B	0.513	68.8		0.103	0.823		0.103	0.103	U	0.103	3430		8.20	8.95		0.154
Split of J1V2H4	J1V2H8	12/29/14	0.150		0.0287	0.200		0.0253	6770	X	1.5	3.3		0.63	74.2		0.072	0.031	U	0.031	0.071	B	0.039	3640	X	13.4	7.8		0.055

Analysis:

		Uranium-233/234 - AEA	Uranium-238 - AEA	Aluminum	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium
TDL		1	1	5	10	2	0.5	0.5	100	1
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	No-Stop (acceptable)	Yes (continue)	Yes (continue)
	Both >5xTDL?	No-Stop (acceptable)	No-Stop (acceptable)	Yes (calc RPD)	No-Stop (acceptable)	Yes (calc RPD)	No-Stop (acceptable)		Yes (calc RPD)	Yes (calc RPD)
	RPD			1.9%		23.0%			8.6%	2.8%
	Difference > 2 TDL?	No - acceptable	No - acceptable	Yes - assess further	No - acceptable	Yes - assess further	No - acceptable	No - acceptable	Yes - assess further	No - acceptable
Split Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	No-Stop (acceptable)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	No-Stop (acceptable)	No-Stop (acceptable)	Yes (calc RPD)	No-Stop (acceptable)	Yes (calc RPD)		No-Stop (acceptable)	Yes (calc RPD)	Yes (calc RPD)
	RPD			12.1%		15.5%			2.7%	16.5%
	Difference > 2 TDL?	No - acceptable	No - acceptable	Yes - assess further	No - acceptable	Yes - assess further	No - acceptable	No - acceptable	No - acceptable	No - acceptable

Duplicate/Split Analysis - 300-9 Excavation Samples

Sampling Area	Sample Number	Sample Date	Cobalt			Copper			Iron			Lithium			Magnesium			Manganese			Molybdenum			Nickel			Potassium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-11	J1V2H4	12/29/14	9.67		0.142	12.2		0.283	21100		7.55	7.67	D	0.410	4210		8.02	293		0.189	0.373	B	0.189	9.78		0.142	1200		6.04
Duplicate of J1V2H4	J1V2H6	12/29/14	9.84		0.154	11.4		0.308	21000		8.20	7.72	D	0.378	4080		8.71	300		0.205	0.463	B	0.205	9.26		0.154	1220		6.56
Split of J1V2H4	J1V2H8	12/29/14	6.2	X	0.095	10.9	X	0.21	19800	X	3.6	7.0		0.29	4380		3.5	301		0.095	0.25	U	0.25	9.1	X	0.12	1360		39.1

Analysis:

		Cobalt	Copper	Iron	Lithium	Magnesium	Manganese	Molybdenum	Nickel	Potassium
TDL		2	1	5	2.5	75	5	2	4	400
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	No-Stop (acceptable)	Yes (calc RPD)	Yes (calc RPD)	No-Stop (acceptable)	Yes (calc RPD)	Yes (calc RPD)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)
	RPD		6.8%	0.5%		3.1%	2.4%			
	Difference > 2 TDL?	No - acceptable	No - acceptable	Yes - assess further	No - acceptable	No - acceptable	No - acceptable	No - acceptable	No - acceptable	No - acceptable
Split Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	No-Stop (acceptable)	Yes (continue)	Yes (continue)
	Both >5xTDL?	No-Stop (acceptable)	Yes (calc RPD)	Yes (calc RPD)	No-Stop (acceptable)	Yes (calc RPD)	Yes (calc RPD)		No-Stop (acceptable)	No-Stop (acceptable)
	RPD		11.3%	6.4%		4.0%	2.7%			
	Difference > 2 TDL?	No - acceptable	No - acceptable	Yes - assess further	No - acceptable	Yes - assess further	No - acceptable	No - acceptable	No - acceptable	No - acceptable

Duplicate/Split Analysis - 300-9 Excavation Samples

Sampling Area	Sample Number	Sample Date	Selenium			Silicon			Sodium			Strontium			Tin			Uranium			Vanadium			Zinc			Zirconium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-11	J1V2H4	12/29/14	2.50	D	0.34	1360	DN	14.2	116		6.61	18.6		0.0944	3.41	BCD	2.83	0.385	*D	0.0135	52.1		0.0944	26.6		0.378	18.4	D	0.102
Duplicate of J1V2H4	J1V2H6	12/29/14	2.50	D	0.31	1440	DN	15.4	145		7.18	17.4		0.103	3.30	BCD	3.08	0.418	*D	0.0125	51.0		0.103	26.4		0.41	18.7	D	0.0945
Split of J1V2H4	J1V2H8	12/29/14	0.82	U	0.82	134	N	5.4	170		56.2	21.7		0.034	0.87	UN	0.87	0.36		0.0015	46.3		0.090	37.0		0.4	16.0		0.34

Analysis:

		Selenium	Silicon	Sodium	Strontium	Tin	Uranium	Vanadium	Zinc	Zirconium
TDL		10	2	50	1	10	1	2.5	1	2.5
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	No-Stop (acceptable)	Yes (calc RPD)	No-Stop (acceptable)	Yes (calc RPD)	No-Stop (acceptable)	No-Stop (acceptable)	Yes (calc RPD)	Yes (calc RPD)	Yes (calc RPD)
	RPD		5.7%		6.7%			2.1%	0.8%	1.6%
	Difference > 2 TDL?	No - acceptable	Yes - assess further	No - acceptable	No - acceptable	No - acceptable	No - acceptable	No - acceptable	No - acceptable	No - acceptable
Split Analysis	Both > PQL?	No-Stop (acceptable)	Yes (continue)	Yes (continue)	Yes (continue)	No-Stop (acceptable)	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?		Yes (calc RPD)	No-Stop (acceptable)	Yes (calc RPD)		No-Stop (acceptable)	Yes (calc RPD)	Yes (calc RPD)	Yes (calc RPD)
	RPD		*164.1%*		15.4%			11.8%	32.7%	14.0%
	Difference > 2 TDL?	No - acceptable	Yes - assess further	No - acceptable	Yes - assess further	No - acceptable	No - acceptable	Yes - assess further	Yes - assess further	No - acceptable

Attachment 1. 300-9 Waste Site Verification Sample Results (Radionuclides).

Location	HEIS Number	Date	Americium-241			Curium-242			Curium-243/244			Uranium-233/234			Uranium-235		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
EXC-11	J1V2H4	12/29/14	0.002	U	0.07				0.023	U	0.07	0.383		0.07	0.039	U	0.07
Duplicate of J1V2H4	J1V2H6	12/29/14	0.004	U	0.07				0.014	U	0.07	0.808		0.08	0.123		0.08
EXC-1	J1V2F4	12/29/14	0.026	U	0.07				0.008	U	0.08	0.641		0.07	0.065	U	0.08
EXC-2	J1V2F5	12/29/14	-0.0005	U	0.09				-0.0002	U	0.07	0.722		0.06	0.081		0.07
EXC-3	J1V2F6	12/29/14	0.056	U	0.13				0.021	U	0.12	0.692		0.07	0.041	U	0.12
EXC-4	J1V2F7	12/29/14	0.057	U	0.07				-0.006	U	0.11	0.885		0.07	0.122		0.10
EXC-5	J1V2F8	12/29/14	0.016	U	0.10				-0.003	U	0.07	0.588		0.11	0.009	U	0.10
EXC-6	J1V2F9	12/29/14	0.013	U	0.08				0.018	U	0.07	0.837		0.06	0.077	U	0.12
EXC-7	J1V2H0	12/29/14	0.101		0.09				0.051	U	0.08	0.746		0.16	-0.024	U	0.13
EXC-8	J1V2H1	12/29/14	0.039	U	0.11				-0.037	U	0.14	0.763		0.08	0.030	U	0.09
EXC-9	J1V2H2	12/29/14	0.042	U	0.10				0.036	U	0.11	0.682		0.09	-0.003	U	0.08
EXC-10	J1V2H3	12/29/14	0.018	U	0.10				-0.005	U	0.10	0.581		0.07	0.042	U	0.13
EXC-12	J1V2H5	12/29/14	-0.021	U	0.12				0.047	U	0.08	0.473		0.08	0.074	U	0.11
Split of J1V2H4	J1V2H8	12/29/14	0.0324	U	0.0858	0.00885	U	0.0581	0.0162	U	0.0697	0.150		0.0287	0.00	U	0.0170

Location	HEIS Number	Date	Uranium-238		
			pCi/g	Q	MDA
EXC-11	J1V2H4	12/29/14	0.440		0.07
Duplicate of J1V2H4	J1V2H6	12/29/14	0.578		0.06
EXC-1	J1V2F4	12/29/14	0.624		0.07
EXC-2	J1V2F5	12/29/14	0.708		0.08
EXC-3	J1V2F6	12/29/14	0.590		0.07
EXC-4	J1V2F7	12/29/14	0.746		0.08
EXC-5	J1V2F8	12/29/14	0.657		0.09
EXC-6	J1V2F9	12/29/14	0.723		0.07
EXC-7	J1V2H0	12/29/14	0.723		0.15
EXC-8	J1V2H1	12/29/14	0.706		0.06
EXC-9	J1V2H2	12/29/14	0.588		0.06
EXC-10	J1V2H3	12/29/14	0.479		0.10
EXC-12	J1V2H5	12/29/14	0.698		0.07
Split of J1V2H4	J1V2H8	12/29/14	0.200		0.0253

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

Gray cells indicate not applicable.

* Duplicate analysis not within control limits

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

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

C = Target analyte was detected in the sample and the associated blank.

D = dilution

EXC = excavation

HEIS = Hanford Environmental Information System

J = estimate

MDA = minimal detectable activity

MDL = method detection limit

N = recovery is outside the control limits

PCB = polychlorinated biphenyls

PQL = practical quantitation limit

Q = qualifier

U = undetected

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

Attachment	1	Sheet No.	1 of 6
Originator	J. D. Skoglie	Date	4/22/15
Checked	I. B. Berezovskiy	Job No.	Job No.
Calc. No.	0300X-CA-V0212	Rev. No.	0

Attachment 1. 300-9 Waste Site Verification Sample Results (Metals).

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
EXC-11	J1V2H4	12/29/14	6000		6.42	3.11	UD	3.11	3.94		0.472	86.7		0.0944
Duplicate of J1V2H4	J1V2H6	12/29/14	5890		6.97	3.38	UD	3.38	2.58	B	0.513	68.8		0.103
EXC-1	J1V2F4	12/29/14	6450		7.15	3.47	UD	3.47	3.37		0.526	75.9		0.105
EXC-2	J1V2F5	12/29/14	6110		6.87	3.33	UD	3.33	4.13		0.505	81.2		0.101
EXC-3	J1V2F6	12/29/14	5190		6.73	3.26	UD	3.26	3.22		0.495	64.4		0.0989
EXC-4	J1V2F7	12/29/14	6380		6.78	3.29	UD	3.29	3.77		0.499	98.1		0.0997
EXC-5	J1V2F8	12/29/14	6560		6.56	3.18	UD	3.18	3.28		0.482	81.5		0.0965
EXC-6	J1V2F9	12/29/14	5650		7.27	3.53	UD	3.53	4.23		0.535	89.6		0.107
EXC-7	J1V2H0	12/29/14	5710		7.26	3.52	UD	3.52	3.63		0.533	83.4		0.107
EXC-8	J1V2H1	12/29/14	5110		6.93	3.37	UD	3.37	2.43	B	0.510	54.8		0.102
EXC-9	J1V2H2	12/29/14	5770		7.36	3.57	UD	3.57	2.88	B	0.541	67.3		0.108
EXC-10	J1V2H3	12/29/14	6760		6.37	3.09	UD	3.09	3.31		0.469	80.7		0.0937
EXC-12	J1V2H5	12/29/14	5880		6.52	3.17	UD	3.17	3.07		0.480	72.8		0.0959
Split of J1V2H4	J1V2H8	12/29/14	6770	X	1.5	0.36	U	0.36	3.3		0.63	74.2		0.072
Equipment blank	J1V2H7	12/29/14	106		6.25	0.303	U	0.303	0.519	B	0.460	1.95		0.092

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
EXC-11	J1V2H4	12/29/14	0.800		0.0944	0.944	U	0.944	0.107	B	0.0944	3740		7.55
Duplicate of J1V2H4	J1V2H6	12/29/14	0.823		0.103	1.03	U	1.03	0.103	U	0.103	3430		8.20
EXC-1	J1V2F4	12/29/14	0.915		0.105	1.05	U	1.05	0.105	U	0.105	13000		8.42
EXC-2	J1V2F5	12/29/14	0.967		0.101	1.01	U	1.01	0.101	U	0.101	9180		8.08
EXC-3	J1V2F6	12/29/14	0.715		0.0989	0.989	U	0.989	0.0989	U	0.0989	14000		7.92
EXC-4	J1V2F7	12/29/14	0.931		0.0997	0.997	U	0.997	0.0997	U	0.0997	19700		7.98
EXC-5	J1V2F8	12/29/14	0.958		0.0965	0.965	U	0.965	0.0965	U	0.0965	8550		7.72
EXC-6	J1V2F9	12/29/14	0.820		0.107	1.07	U	1.07	0.132	B	0.107	19000		8.56
EXC-7	J1V2H0	12/29/14	0.840		0.107	1.07	U	1.07	0.107	U	0.107	15600		8.54
EXC-8	J1V2H1	12/29/14	0.743		0.102	1.02	U	1.02	0.128	B	0.102	6320		8.16
EXC-9	J1V2H2	12/29/14	0.777		0.108	1.08	U	1.08	0.108	U	0.108	4920		8.65
EXC-10	J1V2H3	12/29/14	0.864		0.0937	0.937	U	0.937	0.0937	U	0.0937	3170		7.50
EXC-12	J1V2H5	12/29/14	0.737		0.0959	0.959	U	0.959	0.0959	U	0.0959	2930		7.67
Split of J1V2H4	J1V2H8	12/29/14	0.031	U	0.031	1.1	BN	0.93	0.071	B	0.039	3640	X	13.4
Equipment blank	J1V2H7	12/29/14	0.092	U	0.092	0.920	U	0.920	0.092	U	0.092	29.1		7.36

Attachment	1	Sheet No.	2 of 6
Originator	J. D. Skoglie	Date	4/22/15
Checked	I. B. Berezovskiy	Job No.	Job No.
Calc. No.	0300X-CA-V0212	Rev. No.	0

Attachment 1. 300-9 Waste Site Verification Sample Results (Metals).

Location	HEIS Number	Sample Date	Mercury			Molybdenum			Nickel			Potassium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-11	J1V2H4	12/29/14	0.00426	U	0.00426	0.373	B	0.189	9.78		0.142	1200		6.04
Duplicate of J1V2H4	J1V2H6	12/29/14	0.00583	B	0.00403	0.463	B	0.205	9.26		0.154	1220		6.56
EXC-1	J1V2F4	12/29/14	0.00435	U	0.00435	0.581	B	0.210	10.9		0.158	1070		6.73
EXC-2	J1V2F5	12/29/14	0.00426	U	0.00426	0.431	B	0.202	10.1		0.152	865		6.47
EXC-3	J1V2F6	12/29/14	0.00422	U	0.00422	0.326	B	0.198	8.09		0.148	997		6.33
EXC-4	J1V2F7	12/29/14	0.00428	U	0.00428	0.439	B	0.199	10.3		0.150	1140		6.38
EXC-5	J1V2F8	12/29/14	0.00419	U	0.00419	0.421	B	0.193	10.9		0.145	1210		6.17
EXC-6	J1V2F9	12/29/14	0.00433	U	0.00433	0.440	B	0.214	10.2		0.160	1000		6.85
EXC-7	J1V2H0	12/29/14	0.00425	U	0.00425	0.471	B	0.213	9.06		0.160	1100		6.83
EXC-8	J1V2H1	12/29/14	0.00402	U	0.00402	0.421	B	0.204	8.85		0.153	932		6.53
EXC-9	J1V2H2	12/29/14	0.00431	U	0.00431	0.423	B	0.216	8.78		0.162	1290		6.92
EXC-10	J1V2H3	12/29/14	0.00422	U	0.00422	0.470	B	0.187	9.72		0.141	1490		6.00
EXC-12	J1V2H5	12/29/14	0.00407	U	0.00407	0.366	B	0.192	10.6		0.144	1170		6.14
Split of J1V2H4	J1V2H8	12/29/14	0.021		0.0059	0.25	U	0.25	9.1	X	0.12	1360		39.1
Equipment blank	J1V2H7	12/29/14	0.00396	U	0.00396	0.184	U	0.184	0.138	U	0.138	40.3		5.89

Location	HEIS Number	Sample Date	Selenium			Silicon			Silver			Sodium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-11	J1V2H4	12/29/14	2.50	D	0.338	1360	DN	14.2	0.0944	U	0.0944	116		6.61
Duplicate of J1V2H4	J1V2H6	12/29/14	2.50	D	0.312	1440	DN	15.4	0.103	U	0.103	145		7.18
EXC-1	J1V2F4	12/29/14	3.00	D	0.353	1450	DN	15.8	0.105	U	0.105	154		7.36
EXC-2	J1V2F5	12/29/14	3.04	D	0.330	1340	DN	15.2	0.101	U	0.101	163		7.07
EXC-3	J1V2F6	12/29/14	2.08	D	0.315	1040	DN	14.8	0.0989	U	0.0989	135		6.93
EXC-4	J1V2F7	12/29/14	2.79	D	0.352	1410	DN	15.0	0.0997	U	0.0997	152		6.98
EXC-5	J1V2F8	12/29/14	2.74	D	0.316	1280	DN	14.5	0.0965	U	0.0965	153		6.75
EXC-6	J1V2F9	12/29/14	2.64	D	0.309	1310	DN	16.0	0.107	U	0.107	144		7.49
EXC-7	J1V2H0	12/29/14	2.66	D	0.335	1220	DN	16.0	0.107	U	0.107	146		7.47
EXC-8	J1V2H1	12/29/14	2.53	D	0.314	1170	DN	15.3	0.102	U	0.102	115		7.14
EXC-9	J1V2H2	12/29/14	2.29	D	0.359	1510	DN	16.2	0.108	U	0.108	113		7.57
EXC-10	J1V2H3	12/29/14	2.63	D	0.317	1490	DN	14.1	0.0937	U	0.0937	119		6.56
EXC-12	J1V2H5	12/29/14	2.20	D	0.332	1370	DN	14.4	0.0959	U	0.0959	112		6.71
Split of J1V2H4	J1V2H8	12/29/14	0.82	U	0.82	134	N	5.4	0.15	U	0.15	170		56.2
Equipment blank	J1V2H7	12/29/14	0.585	BD	0.324	145	N	1.38	0.092	U	0.092	6.44	U	6.44

Attachment	1	Sheet No.	4 of 6
Originator	J. D. Skoglie	Date	4/22/15
Checked	I. B. Berezovskiy	Job No.	Job No.
Calc. No.	0300X-CA-V0212	Rev. No.	0

Attachment 1. 300-9 Waste Site Verification Sample Results (Metals).

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
EXC-11	J1V2H4	12/29/14	9.20		0.142	9.67		0.142	12.2		0.283	21100		7.55
Duplicate of J1V2H4	J1V2H6	12/29/14	8.95		0.154	9.84		0.154	11.4		0.308	21000		8.20
EXC-1	J1V2F4	12/29/14	11.5		0.158	11.5		0.158	13.1		0.316	25100		8.42
EXC-2	J1V2F5	12/29/14	11.1		0.152	12.7		0.152	12.7		0.303	25700		8.08
EXC-3	J1V2F6	12/29/14	8.54		0.148	8.78		0.148	11.0		0.297	19000		7.92
EXC-4	J1V2F7	12/29/14	11.9		0.150	12.3		0.150	14.3		0.299	25200		7.98
EXC-5	J1V2F8	12/29/14	11.2		0.145	11.8		0.145	12.4		0.289	25400		7.72
EXC-6	J1V2F9	12/29/14	9.92		0.160	10.9		0.160	13.8		0.321	21600		8.56
EXC-7	J1V2H0	12/29/14	10.4		0.160	12.8		0.160	12.0		0.320	22900		8.54
EXC-8	J1V2H1	12/29/14	8.91		0.153	9.15		0.153	10.5		0.306	19300		8.16
EXC-9	J1V2H2	12/29/14	9.19		0.162	9.51		0.162	11.0		0.325	20000		8.65
EXC-10	J1V2H3	12/29/14	10.6		0.141	10.2		0.141	12.0		0.281	21800		7.50
EXC-12	J1V2H5	12/29/14	12.2		0.144	9.20		0.144	11.9		0.288	20500		7.67
Split of J1V2H4	J1V2H8	12/29/14	7.8		0.055	6.2	X	0.095	10.9	X	0.21	19800	X	3.6
Equipment blank	J1V2H7	12/29/14	0.138	U	0.138	0.138	U	0.138	0.276	U	0.276	287		7.36

Location	HEIS Number	Sample Date	Lead			Lithium			Magnesium			Manganese		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-11	J1V2H4	12/29/14	3.11	UD	3.11	7.67	D	0.410	4210		8.02	293		0.189
Duplicate of J1V2H4	J1V2H6	12/29/14	3.38	UD	3.38	7.72	D	0.378	4080		8.71	300		0.205
EXC-1	J1V2F4	12/29/14	3.47	UD	3.47	8.30	D	0.427	4960		8.94	352		0.210
EXC-2	J1V2F5	12/29/14	3.33	UD	3.33	8.33	D	0.400	4960		8.59	347		0.202
EXC-3	J1V2F6	12/29/14	3.26	UD	3.26	7.26	D	0.381	4150		8.41	268		0.198
EXC-4	J1V2F7	12/29/14	3.29	UD	3.29	7.86	D	0.427	5020		8.48	386		0.199
EXC-5	J1V2F8	12/29/14	3.18	UD	3.18	9.30	D	0.383	5030		8.20	346		0.193
EXC-6	J1V2F9	12/29/14	3.53	UD	3.53	8.17	D	0.374	4500		9.09	375		0.214
EXC-7	J1V2H0	12/29/14	3.52	UD	3.52	7.99	D	0.406	4880		9.07	324		0.213
EXC-8	J1V2H1	12/29/14	3.37	UD	3.37	7.24	D	0.381	3990		8.67	255		0.204
EXC-9	J1V2H2	12/29/14	3.57	UD	3.57	8.29	D	0.435	4070		9.19	275		0.216
EXC-10	J1V2H3	12/29/14	3.09	UD	3.09	8.29	D	0.384	4060		7.97	323		0.187
EXC-12	J1V2H5	12/29/14	3.17	UD	3.17	8.02	D	0.403	4100		8.15	315		0.192
Split of J1V2H4	J1V2H8	12/29/14	3.6		0.26	7.0		0.29	4380		3.5	301		0.095
Equipment blank	J1V2H7	12/29/14	0.303	U	0.303	0.392	DU	0.392	14.7	B	7.82	3.97		0.184

Attachment	1	Sheet No.	3 of 6
Originator	J. D. Skoglie	Date	4/22/15
Checked	I. B. Berezovskiy	Job No.	Job No.
Calc. No.	0300X-CA-V0212	Rev. No.	0

Attachment 1. 300-9 Waste Site Verification Sample Results (Metals).

Location	HEIS Number	Sample Date	Strontium			Tin			Uranium			Vanadium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-11	J1V2H4	12/29/14	18.6		0.0944	3.41	BCD	2.83	0.385	*D	0.0135	52.1		0.0944
Duplicate of J1V2H4	J1V2H6	12/29/14	17.4		0.103	3.30	BCD	3.08	0.418	*D	0.0125	51.0		0.103
EXC-1	J1V2F4	12/29/14	29.8		0.105	3.16	UD	3.16	0.625	*D	0.0141	63.7		0.105
EXC-2	J1V2F5	12/29/14	32.0		0.101	3.03	UD	3.03	0.632	*D	0.0132	69.4		0.101
EXC-3	J1V2F6	12/29/14	34.3		0.0989	2.97	UD	2.97	0.400	*D	0.0126	49.1		0.0989
EXC-4	J1V2F7	12/29/14	42.6		0.0997	2.99	UD	2.99	0.776	*D	0.0141	66.8		0.0997
EXC-5	J1V2F8	12/29/14	25.6		0.0965	2.89	UD	2.89	0.671	*D	0.0126	67.3		0.0965
EXC-6	J1V2F9	12/29/14	35.9		0.107	3.21	UD	3.21	0.719	*D	0.0123	57.3		0.107
EXC-7	J1V2H0	12/29/14	41.1		0.107	3.20	UD	3.20	0.509	*D	0.0134	59.3		0.107
EXC-8	J1V2H1	12/29/14	18.9		0.102	3.06	UD	3.06	0.362	*D	0.0126	50.1		0.102
EXC-9	J1V2H2	12/29/14	21.2		0.108	3.25	UD	3.25	0.350	*D	0.0144	50.4		0.108
EXC-10	J1V2H3	12/29/14	19.2		0.0937	3.97	BCD	2.81	0.454	*D	0.0127	53.1		0.0937
EXC-12	J1V2H5	12/29/14	16.6		0.0959	3.71	BCD	2.88	0.362	*D	0.0133	50.5		0.0959
Split of J1V2H4	J1V2H8	12/29/14	21.7		0.034	0.87	UN	0.87	0.36		0.0015	46.3		0.090
Equipment blank	J1V2H7	12/29/14	0.515		0.092	0.276	U	0.276	0.195	*D	0.0129	0.358	B	0.092

Location	HEIS Number	Sample Date	Zinc			Zirconium			Percent moisture (wet sample)		
			mg/kg	Q	PQL	mg/kg	Q	PQL	%	Q	PQL
EXC-11	J1V2H4	12/29/14	26.6		0.378	18.4	D	0.102			
Duplicate of J1V2H4	J1V2H6	12/29/14	26.4		0.410	18.7	D	0.0945			
EXC-1	J1V2F4	12/29/14	30.7		0.421	22.2	D	0.534			
EXC-2	J1V2F5	12/29/14	32.0		0.404	21.4	D	0.500			
EXC-3	J1V2F6	12/29/14	26.2		0.396	15.8	D	0.0953			
EXC-4	J1V2F7	12/29/14	32.6		0.399	20.9	D	0.534			
EXC-5	J1V2F8	12/29/14	30.8		0.386	21.3	D	0.479			
EXC-6	J1V2F9	12/29/14	29.3		0.428	19.7	D	0.468			
EXC-7	J1V2H0	12/29/14	28.4		0.427	19.9	D	0.102			
EXC-8	J1V2H1	12/29/14	25.2		0.408	16.8	D	0.0952			
EXC-9	J1V2H2	12/29/14	27.8		0.433	18.0	D	0.109			
EXC-10	J1V2H3	12/29/14	28.1		0.375	20.7	D	0.480			
EXC-12	J1V2H5	12/29/14	25.3		0.384	18.6	D	0.101			
Split of J1V2H4	J1V2H8	12/29/14	37.0		0.38	16.0		0.34	6.3		0.10
Equipment blank	J1V2H7	12/29/14	0.831	B	0.368	0.649	BD	0.0981			

Attachment	1	Sheet No.	5 of 6
Originator	J. D. Skoglie	Date	4/22/15
Checked	I. B. Berezovskiy	Job No.	Job No.
Calc. No.	0300X-CA-V0212	Rev. No.	0

Attachment 1. 300-9 Waste Site Verification Sample Results (Organics).

CONSTITUENT	CLASS	J1V2H4, EXC-11			J1V2H6, Duplicate of J1V2H4			J1V2F4, EXC-1			J1V2F5, EXC-2			J1V2F6, EXC-3		
		12/29/14			12/29/14			12/29/14			12/29/14			12/29/14		
		ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
Aroclor-1016	PCB	1.18	U	1.18	1.17	U	1.17	1.23	U	1.23	1.22	U	1.22	1.21	U	1.21
Aroclor-1221	PCB	1.18	U	1.18	1.17	U	1.17	1.23	U	1.23	1.22	U	1.22	1.21	U	1.21
Aroclor-1232	PCB	1.18	U	1.18	1.17	U	1.17	1.23	U	1.23	1.22	U	1.22	1.21	U	1.21
Aroclor-1242	PCB	1.18	U	1.18	1.17	U	1.17	1.23	U	1.23	1.22	U	1.22	1.21	U	1.21
Aroclor-1248	PCB	1.18	U	1.18	1.17	U	1.17	1.23	U	1.23	1.22	U	1.22	1.21	U	1.21
Aroclor-1254	PCB	1.18	U	1.18	1.17	U	1.17	1.23	U	1.23	1.22	U	1.22	1.21	U	1.21
Aroclor-1260	PCB	1.18	U	1.18	1.17	U	1.17	1.23	U	1.23	8.46		1.22	30.1		1.21
Aroclor-1262	PCB	1.18	U	1.18	1.17	U	1.17	1.23	U	1.23	1.22	U	1.22	1.21	U	1.21
Aroclor-1268	PCB	1.18	U	1.18	1.17	U	1.17	1.23	U	1.23	1.22	U	1.22	1.21	U	1.21

CONSTITUENT	CLASS	J1V2F7, EXC-4			J1V2F8, EXC-5			J1V2F9, EXC-6			J1V2H0, EXC-7			J1V2H1, EXC-8		
		12/29/14			12/29/14			12/29/14			12/29/14			12/29/14		
		ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
Aroclor-1016	PCB	2.5	DU	2.5	2.42	DU	2.42	60.4	DU	60.4	242	DU	242	1.17	U	1.17
Aroclor-1221	PCB	2.5	DU	2.5	2.42	DU	2.42	60.4	DU	60.4	242	DU	242	1.17	U	1.17
Aroclor-1232	PCB	2.5	DU	2.5	2.42	DU	2.42	60.4	DU	60.4	242	DU	242	1.17	U	1.17
Aroclor-1242	PCB	2.5	DU	2.5	2.42	DU	2.42	60.4	DU	60.4	242	DU	242	1.17	U	1.17
Aroclor-1248	PCB	2.5	DU	2.5	2.42	DU	2.42	60.4	DU	60.4	242	DU	242	1.17	U	1.17
Aroclor-1254	PCB	2.5	DU	2.5	2.42	DU	2.42	60.4	DU	60.4	242	DU	242	1.17	U	1.17
Aroclor-1260	PCB	56.0	D	2.5	58.6	D	2.42	1070	D	60.4	6980	D	242	2.36	J	1.17
Aroclor-1262	PCB	2.5	DU	2.5	2.42	DU	2.42	60.4	DU	60.4	242	DU	242	1.17	U	1.17
Aroclor-1268	PCB	2.5	DU	2.5	2.42	DU	2.42	60.4	DU	60.4	242	DU	242	1.17	U	1.17

CONSTITUENT	CLASS	J1V2H2, EXC-9			J1V2H3, EXC-10			J1V2H5, EXC-12			J1V2H8, Split of J1V2H4		
		12/29/14			12/29/14			12/29/14			12/29/14		
		ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
Aroclor-1016	PCB	1.22	U	1.22	1.18	U	1.18	1.17	U	1.17	2.8	U	2.8
Aroclor-1221	PCB	1.22	U	1.22	1.18	U	1.18	1.17	U	1.17	8	U	8
Aroclor-1232	PCB	1.22	U	1.22	1.18	U	1.18	1.17	U	1.17	2	U	2
Aroclor-1242	PCB	7.38		1.22	1.18	U	1.18	1.17	U	1.17	4.6	U	4.6
Aroclor-1248	PCB	1.22	U	1.22	1.18	U	1.18	1.17	U	1.17	4.6	U	4.6
Aroclor-1254	PCB	1.22	U	1.22	1.18	U	1.18	1.17	U	1.17	2.6	U	2.6
Aroclor-1260	PCB	35.4		1.22	1.18	U	1.18	1.17	U	1.17	2.6	U	2.6
Aroclor-1262	PCB	1.22	U	1.22	1.18	U	1.18	1.17	U	1.17			
Aroclor-1268	PCB	1.22	U	1.22	1.18	U	1.18	1.17	U	1.17			

Attachment	1	Sheet No.	6 of 6
Originator	J. D. Skoglie	Date	4/22/15
Checked	I. B. Berezovskiy	Job No.	Job No.
Calc. No.	0300X-CA-V0212	Rev. No.	0

Acrobat 8.0

CALCULATION COVER SHEET

Project Title: 300 Area Closure Operations **Job No. 14655**

Area: 300

Discipline: Environmental *Calculation No: 0300X-CA-V0213

Subject: 300-9 Waste Site Direct Contact Hazard Quotient and Carcinogenic Risk Calculations (MTCAStat)

Computer Program: Excel Program No: Excel 2010

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

Committed Calculation ☒ Preliminary ☐ Superseded ☐ Voided ☐

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover = 1 Sheets = 3 Total = 4	J. D. Skoglie	L.B. Berezovskiy	R. J. Nielson	S. G. Wilkinson	5/14/15

SUMMARY OF REVISION

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

Washington Closure Hanford, Inc. CALCULATION SHEET

Originator:	J. D. Skoglie	Date:	05/04/15	Calc. No.:	0300X-CA-V0213	Rev.:	0
Project:	300 Area Closure Operations	Job No:	14655	Checked:	I. B. Berezovskiy	Date:	05/04/15
Subject:	300-9 Waste Site Direct Contact Hazard Quotient and Carcinogenic Risk Calculations (MTCAStat)					Sheet No.	1 of 3

PURPOSE:

Provide documentation to support the calculation of the direct contact hazard quotient (HQ) and excess carcinogenic risk for the 300-9 waste site. In accordance with the cleanup levels (CULs) in the 300 Area Final Action Record of Decision (ROD) (EPA 2013) and the Remedial Investigation/Feasibility Study for the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units (DOE-RL 2014b), the following criteria must be met from the remedial design report/remedial action work plan (RDR/RAWP) (DOE-RL 2009):

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, 2009, *Remedial Design Report/Remedial Action Work Plan for the 300 Area,* DOE/RL-2001-47, Rev. 3, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

2) DOE-RL, 2014a, *300 Area Remedial Action Sampling and Analysis Plan*, DOE/RL-2001-48, Rev. 4, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

3) DOE-RL, 2014b, *Remedial Investigation/Feasibility Study for the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units,* DOE/RL-2010-99, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

4) EPA, 2013, *Record of Decision for the 300-FF-2 Operable Unit and 300-FF-5, and Record of Decision Amendment for 300-FF-1*, Hanford Site, Benton County, Washington, U.S. Environmental Protection Agency, Region 10, Seattle, Washington.

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

6) WCH, 2015, 300-9 *Waste Site Cleanup Verification 95% UCL Calculations (MTCAStat),* 0300X-CA-V0212, *Rev. 0*, 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 2009).

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

Washington Closure Hanford Inc. CALCULATION SHEET

Originator:	J. D. Skoglie	Date:	05/04/15	Calc. No.:	0300X-CA-V0213	Rev.:	0
Project:	300 Area Closure Operations	Job No:	14655	Checked:	I. B. Berezovskiy	Date:	05/04/15
Subject:	300-9 Waste Site Direct Contact Hazard Quotient and Carcinogenic Risk Calculations (MTCAStat)					Sheet No.	2 of 3

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 2009).

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

METHODOLOGY:

The 300-9 waste site is comprised of one decision unit for verification sampling: the excavation. The direct contact hazard quotient and carcinogenic risk calculations for the 300-9 waste site were conservatively calculated for the entire waste site using the greater of the statistical or maximum value for each analyte from the excavation decision unit from WCH (2015). Of the contaminants of concern (COC) for this site, strontium, tin, and the detected polychlorinated biphenyls (PCBs) require HQ and risk calculations because these analytes were detected and a Washington State or Hanford Site background value is not available. Selenium requires an HQ and risk calculations because this analyte was detected above a Washington State or Hanford Site background value. All other site nonradionuclide COCs 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 selenium is 2.76 mg/kg, divided by the noncarcinogenic cleanup level (CUL) value of 17,500 mg/kg is 1.6×10^{-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 1.8×10^{-4}. Comparing this value to the requirement of <1.0, this criterion is met.

3) To calculate the excess cancer risk, the statistical value is divided by the carcinogenic CUL value, and then multiplied by 1.0×10^{-6}. For example, the statistical value for aroclor-1242 is 0.00738 mg/kg, divided by 66 mg/kg, and multiplied as indicated, is 1.1×10^{-10}. Comparing this value to the requirement of $<1 \times 10^{-6}$, this criterion is met.

4) After these calculations are completed for the carcinogenic analytes, the cumulative excess cancer risk 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 1.0×10^{-7}. Comparing these values 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

Washington Closure Hanford, Inc. CALCULATION SHEET

Originator:	J. D. Skoglie	Date:	05/04/15	Calc. No.:	0300X-CA-V0213	Rev.:	0
Project:	300 Area Closure Operations	Job No:	14655	Checked:	I. B. Berezovskiy	Date:	05/04/15
Subject:	300-9 Waste Site Direct Contact Hazard Quotient and Carcinogenic Risk Calculations (MTCAStat)					Sheet No.	3 of 3

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

Table 1 shows the results of the calculations.

Table 1. Industrial Direct Contact Hazard Quotient and Excess Cancer Risk Results for the 300-9 Waste Site.

Contaminants of Concern	Statistical Value [a] (mg/kg)	Industrial Noncarcinogen CUL [b] (mg/kg)	Hazard Quotient	Industrial Carcinogen CUL [b] (mg/kg)	Carcinogen Risk
Metals					
Selenium	2.76	17,500	1.6E-04	--	--
Strontium	34.3	2,100,000	1.6E-05	--	--
Tin	3.97	2,100,000	1.9E-06	--	--
Polychlorinated Biphenyls					
Aroclor-1242	0.00738	--	--	66	1.1E-10
Aroclor-1260	6.58	--	--	66	1.0E-07
Totals					
Cumulative Hazard Quotient:			**1.8E-04**		
Cumulative Excess Cancer Risk:					**1.0E-07**

Notes:
[a] = From (WCH 2015).
[b] = Values obtained from (EPA 2013) and (DOE-RL 2014b).
-- = not applicable
CUL = cleanup level

CONCLUSION:

The calculations in Table 1 demonstrate that the 300-9 waste site meet the requirements for the industrial direct contact hazard quotients and carcinogenic (excess cancer) risk, respectively, as identified in the RDR/RAWP (DOE-RL 2009) and SAP (DOE-RL 2014a). The direct contact hazard quotients and carcinogenic (excess cancer) risk calculations are for use in the CVP for this site.

Acrobat 8.0

CALCULATION COVER SHEET

Project Title: 300 Area Closure Operations **Job No. 14655**

Area: 300 Area

Discipline: Environmental *Calculation No: 0300X-CA-V0214

Subject: 300-9 Waste Site Radionuclide Sum of Fractions Calculations (MTCAStat)

Computer Program: Excel Program No: Excel 2010

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

Committed Calculation ☒ Preliminary ☐ Superseded ☐ Voided ☐

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover = 1 Sheets = 3 Total = 4	J. D. Skoglie	I. B. Berezovskiy	R. J. Nielson	S. G. Wilkinson	5/14/15

SUMMARY OF REVISION

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

Washington Closure Hanford CALCULATION SHEET

Originator:	J. D. Skoglie	Date:	04/28/15	Calc. No.:	0300X-CA-V0214	Rev.:	0
Project:	300 Area Closure Operations	Job No:	14655	Checked:	I. B. Berezovskiy	Date:	04/28/15
Subject:	300-9 Waste Site Radionuclide Sum of Fractions Calculations (MTCAStat)					Sheet No.	1 of 3

PURPOSE:

Provide documentation to support the calculation of the sum of fractions evaluation for radionuclide direct exposure excess cancer risk and radiological dose for waste sites identified as requiring remove, treat, and dispose in Table 1 of the 300 Area Final Action Record of Decision (ROD) (EPA 2013). The calculation is prepared for waste site data sets with applicable radiological contaminants of concern (COCs) in accordance with Section 8.0 of the 300 Area Final Action ROD (EPA 2013).

GIVEN/REFERENCES:

1) DOE-RL, 1996, *Hanford Site Background: Part 2, Soil Background for Radioactive Analytes,* DOE/RL-96-12, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
2) DOE-RL, 2009, *Remedial Design Report/Remedial Action Work Plan for the 300 Area,* DOE/RL-2001-47, Rev. 3, U.S. Department of Energy, Richland Operations Office, Richland, Washington
3) DOE-RL, 2013, *Remedial Investigation/Feasibility Study for the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units,* DOE/RL-2010-99, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
4) EPA, 2013, *Record of Decision for the 300-FF-2 Operable Unit and 300-FF-5, and Record of Decision Amendment for 300-FF-1,* Hanford Site, Benton County, Washington, U.S. Environmental Protection Agency, Region 10, Seattle, Washington.
5) WCH, 2015, *300-9 Waste Site 95% UCL Calculations*, 0300X-CA-V0197, Rev. 0, Washington Closure Hanford, Richland, Washington.

SOLUTION:

As shown in Table 4 of the 300 Area Final Action ROD (EPA 2013), the cleanup levels (CULs) for soil radionuclide COCs were set at a 1×10^{-4} risk limit or 15 mrem/yr dose limit for isotopes where the latter is more conservative. Soil radionuclide CULs must also meet the multi-contaminant total cancer risk limit of 1×10^{-4}. These soil risk limits are applied to both the industrial and residential scenarios.

For waste sites with few radionuclide COCs at concentrations well below the individual radionuclide cleanup levels (CULs) provided in the 300 Area Final Action ROD (EPA 2013), a sum of fractions evaluation is performed for direct exposure single radionuclide 1×10^{-4} cancer risk and 15 mrem/yr dose values as shown in Table 1. The first column of Table 1 presents the COCs and the second column presents statistical or maximum value (depending on the data set). Where applicable, background values (DOE-RL 1996) are presented in the third column. Uranium background is subtracted from the analyses for all soil samples; however, background for other radionuclides is only subtracted from the overburden soil analysis. This accounts for anthropogenic and naturally occurring radionuclide background in surface soils. Only uranium background concentrations are accounted for in shallow and deep zone soils by subtracting uranium isotope concentrations from the statistical or maximum values. The fourth column presents the background subtracted value. The fifth column presents the single radionuclide 1×10^{-4} cancer risk equivalence activity, and the sixth column presents the statistical or maximum value divided by the cancer risk equivalence activity.

The values in the sixth column are summed and presented as the sum of fractions. This value is multiplied by 0.0001 to determine the 1×10^{-4} cancer risk. A cancer risk value of more than 1×10^{-4} indicates additional evaluation is required.

The seventh column presents the single radionuclide 15 mrem/yr dose equivalence activity, and the last column presents the statistical or maximum value divided by the dose equivalence activity. The values in the last column are summed and presented as the sum of fractions. This value is multiplied by 15 mrem/yr to determine the total radiological dose of 0.0032 mrem/yr. A total dose of more than 15 mrem/yr indicates additional evaluation is required.

METHODOLOGY:

The 300-9 waste site excavation area underwent statistical verification sampling. One duplicate sample was also collected. The sum of fractions were conservatively calculated for the 300-9 waste site data set using the greater of the statistical or maximum value (depending on the data set) for each COC detected above background from amongst all applicable decision units, as described in the referenced 95% upper confidence limit (UCL) calculation (WCH 2015).

Calculations for the 300-9 waste site were performed using CULs for industrial land use. The sum of fractions calculation of COCs for industrial land use using data from the 300-9 waste site is presented below.

1) To calculate the fraction for americium-241, the background value of 0 pCi/g is subtracted from the maximum value from the data set of 0.045 pCi/g, resulting in a corrected maximum value of 0.045 pCi/g for americium-241. The background corrected value is divided by the activity equivalent to 1×10^{-4} cancer risk of 942 pCi/g, resulting in a fraction of 0.000048 for americium-241.

2) The fractions for the remaining COCs are determined and summed. The sum of these fractions equals 0.000048. The sum of fractions is then multiplied by 1×10^{-4} to determine the final cancer risk value of 4.8×10^{-9} for the 300-9 waste site. Comparing this value to the cancer risk limit of $<1 \times 10^{-4}$, the requirement is met.

3) To calculate the radiological dose fraction for americium-241, the background corrected maximum value of 0.045 pCi/g is divided by the activity equivalent to a 15 mrem/yr dose of 210 pCi/g, resulting in a fraction of 0.00021 for americium-241.

4) The radiological dose fractions for the remaining COCs are determined and summed. The sum of these fractions equals 0.00021. The sum of fractions is then multiplied by 15 mrem/yr to determine the total radiological dose of 0.0032 mrem/yr for the waste site. Comparing this value to the radiological dose limit of 15 mrem/yr, the requirement is met.

Washington Closure Hanford CALCULATION SHEET

Originator:	J. D. Skoglie	Date:	04/28/15	Calc. No.:	0300X-CA-V0214	Rev.:	0
Project:	300 Area Closure Operations	Job No:	14655	Checked:	I. B. Berezovskiy	Date:	04/28/15
Subject:	300-9 Waste Site Radionuclide Sum of Fractions Calculations (MTCAStat)					Sheet No.	3 of 3

RESULTS:

Table 1 presents the results of the direct contact sum of fractions calculations for 300-9 for industrial land use.

Table 4. 300-9 Waste Site Industrial Sum of Fractions Evaluation of Radionuclide Direct Exposure Excess Cancer Risk and Dose.

COC	Statistical Activity [a] (pCi/g)	Background (pCi/g)	Background Corrected Activity [b] (pCi/g)	Activity Equivalent to Industrial 10^{-4} Cancer Risk [c] (pCi/g)	Fraction for 10^{-4} Cancer Risk [b]	Activity Equivalent to Industrial 15 mrem/yr Dose [d] (pCi/g)	Fraction for 15 mrem/yr Dose [b]
Americium-241	0.045	0	0.045	942	0.000048	210	0.00021
Uranium-233/234	0.739	1.1	0	1757	0	167	0
Uranium-235	0.069	0.11	0	61	0	16	0
Uranium-238	0.688	1.1	0	283	0	167	0
				Sum of Fractions	**0.000048**	**Sum of Fractions**	**0.00021**
				Industrial Excess Cancer Risk	**4.8E-09**	**Dose, mrem/yr**	**0.0032**

[a] From WCH (2015).
[b] Correct decimal places and correct all negative values to be zero.
[c] From Table 8-4 of the 300 Area RI/FS, DOE/RL-2010-99, Rev. 0 (DOE-RL 2013).
[d] From Table 2-2 of the RDR/RAWP for the 300 Area, DOE/RL-2001-047, Rev. 3 (DOE-RL 2009).
COC = Contaminant of Concern.

CONCLUSION:

The calculations summarized in Table 1 provide the sum of fraction calculations for the 300-9 waste site with industrial land use radionuclide COCs that were identified as requiring remove, treat, and dispose in Table 1 of the 300 Area Final ROD (EPA 2013). The direct contact sum of fractions calculations are for use in the CVP for this waste site.

APPENDIX B

DATA QUALITY ASSESSMENT

APPENDIX B

DATA QUALITY ASSESSMENT

VERIFICATION SAMPLING

A data quality assessment (DQA) was performed to compare the verification sampling approach and resulting analytical data with the sampling and data requirements specified in the site-specific sample design (WCH 2015). This DQA was performed in accordance with site-specific data quality objectives found in the *300 Area Remedial Action Sampling and Analysis Plan* (300 Area SAP) (DOE-RL 2014).

A review of the sample design (WCH 2015), the field logbook (WCH 2014), and applicable analytical data packages has been performed as part of this DQA. All samples were collected and analyzed per the sample design. To ensure quality data, the 300 Area SAP (DOE-RL 2014) 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 300-9 waste site were provided by the laboratories in two sample delivery groups (SDGs) SDG XP0179 and SDG JP0886. SDG XP0179 was submitted for third-party validation. No major deficiencies were noted in the data results. Minor deficiencies are discussed for 300-9 data set, as follows below. If no comments are made about a specific analysis, it should be assumed that no deficiencies affecting the quality of the data were found.

MINOR DEFICIENCIES

SDG XP0179

This SDG comprises 13 statistical soil samples (J1V2F4 through J1V2F9, J1V2H0 through J1V2H6) collected from the excavation area. This SDG includes one field duplicate pair (J1V2H4/J1V2H6). All samples were analyzed for inductively coupled plasma (ICP) metals, mercury, polychlorinated biphenyls (PCBs), isotopic uranium, americium-241, curium-242, and curium-243/244. In addition, one field equipment blank sample (J1V2H8) was collected and analyzed for ICP metals and mercury. SDG XP0179 was submitted for third-party validation. Minor deficiencies are as follows.

In the alpha spectroscopy analysis, a tracer yield for sample J1V2H0 is outside the quality control (QC) limits. Third-party validation qualified the americium-241 result in

sample J1V2H0 as estimated with a "J" flag. Estimated data are usable for decision-making purposes.

In the alpha spectroscopy analysis, tracer yields in samples J1V2F5, J1V2F7, and J1V2H6 are outside QC limits. Third-party validation qualified the uranium-235 results in these samples as estimated with "J" flags. Estimated data are usable for decision-making purposes.

In the alpha spectroscopy analysis, tracer yields in samples J1V2F5, J1V2F7, J1V2F8, J1V2F9, J1V2H1, J1V2H2, J1V2H4, J1V2H5, and J1V2H6 are outside QC limits. Third-party validation qualified the uranium-233/234 and uranium-238 results for these samples as estimated with "J" flags. Estimated data are usable for decision-making purposes.

In the alpha spectroscopy analysis, no laboratory control sample (LCS) was prepared or analyzed for uranium-235. Third-party validation qualified all uranium-235 results in SDG XP0179 as estimated with "J" flags. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, the matrix spike recovery for silicon (25.3%) is outside the QC limits. Third-party validation qualified all silicon results in SDG XP0179 as estimated with "J" flags. Estimated data are usable for decision-making purposes.

SDG XP0886

This SDG comprises one field split sample (J1V2H8) collected from the 300-9 excavation. This sample is a split of sample J1V2H4 that is included in SDG XP0179. Sample J1V2H8 was analyzed for ICP metals, mercury, PCBs, isotopic uranium, americium-241, curium-242, and curium-233/234. Minor deficiencies are as follows.

In the alpha spectroscopy analysis, the relative percent differences (RPDs) calculated for americium-241 (72.4%), curium-242 (291.9%), curium-233/234 (114.7%), and uranium-235 (200.0%) are above the QC limit. Results for these analytes in SDG XP0886 may be considered estimated. Estimated data are usable for decision-making purposes.

In the alpha spectroscopy analysis, no LCS was prepared or analyzed for uranium-235. Uranium-235 results in SDG XP0886 may be considered estimated. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, serial dilutions indicated physical and chemical interferences for aluminum, calcium, cobalt, copper, iron, and nickel. The laboratory qualified results for these analytes in SDG XP0886 with "X" flags. These data may be considered estimated. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, low levels of calcium and magnesium were detected in the method blank. These detections are less than half of the reporting limit and will not significantly impact the field sample data. The data are usable for decision-making purposes.

In the ICP metals analysis, the matrix spike recoveries for boron, silicon, and tin are outside the QC limits. Acceptable LCS results indicated that the analytical system was operating within control. The laboratory has qualified associated data with "N" flags. These data may be considered estimated. Estimated data are usable for decision-making purposes.

FIELD QUALITY ASSURANCE/QUALITY CONTROL

Relative percent difference 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) measurements are used to assess potential sources of error and cross contamination of samples that could bias results. Field QA/QC samples, listed in the field logbook (WCH 2014), are shown in Table B-1. The main and QA/QC sample results are presented in Appendix A.

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

Sample Area	Main Sample	Duplicate Sample	Split Sample
Excavation area	J1V2H4	J1V2H6	J1V2H8

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

Field split samples are used to determine systematic differences (bias) between laboratories. A statistical determination of systematic differences would require larger data sets than are presented here. Such a determination is complicated by variability introduced by the natural heterogeneities inherent in field soil samples, and the analytical variability that each individual laboratory experiences. Therefore, when

evaluating limited field split data relatively large RPDs are expected. No major deficiencies in the RPD calculations were found for the duplicate or split samples. Minor deficiencies for the field duplicates and split samples are as follows.

In the duplicate evaluation, none of the RPDs calculated are above the duplicate acceptance criteria of 30%. In the split evaluation, the RPD calculated for silicon (164.1%) is above the field split acceptance criteria (less than 35%). Elevated RPDs in environmental samples are generally attributed to natural heterogeneity in the sample matrix. The data are usable for decision-making purposes.

A secondary check of the data variability is used when one or both of the samples being evaluated (main and duplicate) is less than five times the target detection limit. In these cases, a control limit of ±2 times the target detection limit is used (Appendix A) to indicate that a visual check of the data is required by the reviewer. In the duplicate analysis, aluminum, barium, calcium, iron, and silicon required this check. In the split analysis, aluminum, barium, iron, magnesium, silicon, strontium, vanadium, and zinc 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 300-9 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 300-9 waste site concludes that the reviewed data are of the right type, quality, and quantity to support the intended use. The analytical data were found acceptable for decision-making purposes.

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

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