WASTE SITE RECLASSIFICATION FORM

Operable Unit: 100-NR-1 **Control No.:** 2016-006

Waste Site Code(s)/Subsite Code(s): 100-N-83

Reclassification Category: Interim ☒ Final ☐

Reclassification Status: Closed Out ☒ No Action ☐ Rejected ☐

RCRA Post closure ☐ Consolidated ☐ None ☐

Approvals Needed: DOE ☒ Ecology ☒ EPA ☐

Description of current waste site condition:

The 100-N-83, Two Contamination Areas Found Near 116-N-1 Waste Site, part of the 100-NR-1 Operable Unit, was added to the *Interim Action Record of Decision for the 100-NR-1 and 100-NR-2 Operable Units, Hanford Site, Benton County, Washington* (100-N Area ROD), U.S. Environmental Protection Agency, Region 10, Seattle, Washington (EPA 1999), as a candidate site for confirmatory sampling via the *Explanation of Significant Differences for the 100-NR-1 and 100-NR-2 Operable Units Interim Remedial Action Record of Decision, Hanford Site, Benton County, Washington*, U.S. Environmental Protection Agency, Region 10, Seattle, Washington (EPA 2011).

The 100-N-83 waste site consisted of two radiologically contaminated areas that were identified during remediation of the 116-N-1 Crib and Trench. Site No. 1 was located where an uncontaminated soil stockpile was previously removed. Site No. 2 was a relatively undisturbed area near and around the eastern end of the former 116-N-1 Trench.

Remedial action at the 100-N-83 waste site was performed between February 1 and February 29, 2016. The depth of the remediation was approximately 15 cm (6 in.), with the exception of one area in the southern region of the waste site where the excavation extended to 1.5 m (5 ft) below ground surface. An estimated 3,461 bank cubic meters (4,527 bank cubic yards) of contaminated soil were removed and disposed at the Environmental Restoration Disposal Facility (ERDF).

Cleanup verification sampling was conducted on April 26, 2016, to determine if the waste site met the remedial action objectives (RAOs) and remedial action goals (RAGs) established by the *Remedial Design Report/Remedial Action Work Plan for the 100-N Area* (100-N Area RDR/RAWP), DOE/RL-2005-93, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington (DOE-RL 2013), and the 100-N Area ROD (EPA 1999). The selected remedy involved (1) excavating the site to the extent required to meet specified soil cleanup levels, (2) disposing of contaminated excavation materials at ERDF, (3) demonstrating through verification sampling that cleanup goals have been achieved, and (4) proposing the site for reclassification to Interim Closed Out.

Basis for reclassification:

The verification sampling and modeling results for the 100-N-83 waste site demonstrate that the site meets the RAOs and corresponding RAGs established in the 100-N Area RDR/RAWP (DOE-RL 2013) and the 100-N Area ROD (EPA 1999) to support a reclassification to Interim Closed Out. These sampling results established that residual contaminant concentrations do not preclude any future uses (as bounded by the rural-residential scenario) and allow for unrestricted use of shallow zone soils (i.e., surface to 4.6 m [15 ft] deep). The results also demonstrate that residual contaminant concentrations are protective of groundwater and the Columbia River. Contamination above direct exposure levels was not observed in shallow zone soils and is concluded to not exist in deep zone soils; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone soil are not required. The basis for reclassification is described in detail in the *Remaining Sites Verification Package for the 100-N-83, Two Contamination Areas Found Near 116-N-1 Waste Site* (attached).

WASTE SITE RECLASSIFICATION FORM

Operable Unit: 100-NR-1 **Control No.:** 2016-006

Waste Site Code(s)/Subsite Code(s): 100-N-83

Regulator comments:

Waste Site Controls:

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

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

J. P. Neath		8/15/16
DOE Federal Project Director (printed)	Signature	Date
N. Menard		8/16/16
Ecology Project Manager (printed)	Signature	Date
N/A		
EPA Project Manager (printed)	Signature	Date

REMAINING SITES VERIFICATION PACKAGE FOR THE 100-N-83, TWO CONTAMINATION AREAS FOUND NEAR 116-N-1 WASTE SITE

Attachment to Waste Site Reclassification Form 2016-006

August 2016

REMAINING SITES VERIFICATION PACKAGE FOR THE 100-N-83, TWO CONTAMINATION AREAS FOUND NEAR 116-N-1 WASTE SITE

EXECUTIVE SUMMARY

The 100-N-83, Two Contamination Areas Found Near 116-N-1 Waste Site, part of the 100-NR-1 Operable Unit, consisted of two radiologically contaminated areas that were identified during remediation of the 116-N-1 Crib and Trench. Site No. 1 was located where an uncontaminated soil stockpile was previously removed. Site No. 2 was a relatively undisturbed area near and around the eastern end of the former 116-N-1 Trench. The 100-N-83 waste site was recommended for remediation without confirmatory sampling.

Remedial action at the 100-N-83 waste site was performed between February 1 and February 29, 2016. Approximately 3,461 bank cubic meters (4,527 bank cubic yards) of contaminated soil was removed from the excavation and disposed at the Environmental Restoration Disposal Facility. The depth of the remediation was approximately 15 cm (6 in.), with the exception of one area in the southern region of the waste site where the excavation extended to approximately 1.5 m (5 ft) below ground surface.

Following remediation, verification soil sampling was conducted on April 26, 2016. The verification sampling results indicate that the waste removal action achieved compliance with the remedial action objectives and remedial action goals established in the *Remedial Design Report/Remedial Action Work Plan for the 100-N Area* (100-N Area RDR/RAWP) (DOE-RL 2013) and the *Interim Action Record of Decision for the 100-NR-1 and 100-NR-2 Operable Units, Hanford Site, Benton County, Washington* (100-N Area ROD) (EPA 1999).

A summary of the cleanup evaluation for the results from verification sampling compared to applicable criteria is presented in Table ES-1.

The results of verification sampling are used to make reclassification decisions for the 100-N-83 in accordance with the TPA-MP-14 procedure in the *Tri-Party Agreement Handbook Management Procedures* (DOE-RL 2011). In accordance with this evaluation, the verification sampling results support a reclassification of this waste site to Interim Closed Out. The current site conditions achieve the remedial action objectives and the corresponding remedial action goals of the 100-N Area RDR/RAWP (DOE-RL 2013) and the 100-N Area ROD (EPA 1999). The results also demonstrate that residual contaminant concentrations support unrestricted future use of shallow zone soil (surface to 4.6 m [15 ft] below ground surface), and that contaminant levels remaining in the soil are protective of groundwater and the Columbia River.

Contamination above direct exposure levels was not observed in shallow zone soils and is concluded to not exist in deep zone soils; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone soil are not required.

Table ES-1. Summary of Remedial Action Goals for the 100-N-83 Waste Site.

Regulatory Requirement	Remedial Action Goals	Results	Remedial Action Objectives Attained?
Direct Exposure – Radionuclides	Attain dose rate of <15-mrem/yr above background over 1,000 years.	The maximum predicted cumulative dose for the waste site excavation is 11.6 mrem/yr. The maximum predicted cumulative dose for the focused sample location is 11.7 mrem/yr.	Yes
Direct Exposure – Nonradionuclides	Attain individual COPC direct exposure RAGs.	All individual COPC concentrations are below the direct exposure RAGs.	Yes
Risk Requirements – Nonradionuclides	Attain a hazard quotient of <1 for all individual noncarcinogens.	All hazard quotients for individual nonradionuclide COPCs are <1.	Yes
	Attain a cumulative hazard quotient of <1 for noncarcinogens.	The cumulative hazard quotient for the 100-N-83 waste site excavation is 2.2×10^{-3} and the hazard quotient for the focused sample location is 9.4×10^{-5}, both of which are <1.	Yes
	Attain an excess cancer risk of $<1 \times 10^{-6}$ for individual carcinogens.	The excess cancer risk from hexavalent chromium, the only constituent that met the requirement for this calculation, is 2.4×10^{-7}, which is $<1 \times 10^{-6}$.	Yes
	Attain a cumulative excess cancer risk of $<1 \times 10^{-5}$ for carcinogens.	The total excess cancer risk from hexavalent chromium, the only nonradionuclide carcinogen that met the requirement for this calculation, is 2.4×10^{-7}, which is $<1 \times 10^{-5}$.	Yes
Groundwater/River Protection – Radionuclides	Attain single-COPC groundwater and river protection RAGs.	No radionuclide COPCs were quantified above groundwater/river protection lookup values.	Yes
	Attain national primary drinking water standards [a]: 4 mrem/yr (beta/gamma) dose rate to target receptor/organs.	No radionuclide COPCs were quantified above groundwater/river protection lookup values.	Yes
	Meet drinking water MCL for alpha emitters.	No alpha-emitting radionuclide COPCs were quantified above groundwater/river protection lookup values.	Yes
	Meet total uranium standard of 30 µg/L (21.2 pCi/L) [b].	Uranium was not a COPC for the 100-N-83 waste site.	NA
Groundwater/river protection – nonradionuclides	Attain individual nonradionuclide groundwater and river RAGs.	All individual nonradionuclide COPC concentrations are below the groundwater and river protection RAGs.	Yes

[a] "National Primary Drinking Water Regulations" (40 *Code of Federal Regulations* 141).

[b] Based on the isotopic distribution of uranium in the 100 Area, the 30 µg/L MCL corresponds to 21.2 pCi/L. Concentration-to-activity calculations are documented in *Calculation of Total Uranium Activity Corresponding to a Maximum Contaminant Level for Total Uranium of 30 Micrograms per Liter in Groundwater* (BHI 2001).

COPC = contaminant of potential concern
MCL = maximum contaminant level
NA = not applicable
RAG = remedial action goal

Soil cleanup levels were established in the 100-N Area ROD (EPA 1999) based in part on a limited ecological risk assessment. Although not required by the 100-N Area ROD, a comparison against ecological risk screening levels has been made for the 100-N-83 contaminants of potential concern and other constituents (Appendix A). Ecological screening levels from the WAC 173-340 (2007), "Model Toxics Control Act – Cleanup," were exceeded for boron and vanadium. The U.S. Environmental Protection Agency's ecological soil screening levels were exceeded for antimony, manganese, and vanadium. Exceedance of screening values is intended to trigger additional evaluation and does not necessarily indicate the existence of risk to ecological receptors. Because concentrations of antimony, manganese, and vanadium are below Hanford Site background values, it is believed that the presence of these constituents does not pose a risk to ecological receptors. All exceedances will be evaluated in the context of additional lines of evidence for risk to ecological receptors as part of the final closeout decision for this site.

REMAINING SITES VERIFICATION PACKAGE FOR THE 100-N-83, TWO CONTAMINATION AREAS FOUND NEAR 116-N-1 WASTE SITE

STATEMENT OF PROTECTIVENESS

The 100-N-83, Two Contamination Areas Found Near 116-N-1 waste site verification sampling data, site evaluations, and supporting documentation demonstrate that the site meets the objectives established in the *Remedial Design Report/Remedial Action Work Plan for the 100-N Area* (100-N Area RDR/RAWP) (DOE-RL 2013) and the *Interim Action Record of Decision for the 100-NR-1 and 100-NR-2 Operable Units, Hanford Site, Benton County, Washington* (100-N Area ROD) (EPA 1999). The verification sampling and modeling results show that residual soil concentrations do not preclude any future uses (as bounded by the rural-residential scenario) and allow for unrestricted use of shallow zone soils (i.e., surface to 4.6 m [15 ft] deep). The results also demonstrate that residual contaminant concentrations are protective of groundwater and the Columbia River.

Soil cleanup levels were established in the 100-N Area ROD (EPA 1999) based in part on a limited ecological risk assessment. Although not required by the 100-N Area ROD, a comparison against ecological risk screening levels has been made for the 100-N-83 contaminants of potential concern (COPCs) and other constituents (Appendix A). Ecological screening levels from the WAC 173-340, "Model Toxics Control Act – Cleanup," were exceeded for boron and vanadium. The U.S. Environmental Protection Agency's (EPA) ecological soil screening levels were exceeded for antimony, manganese, and vanadium. Exceedance of screening values is intended to trigger additional evaluation and does not necessarily indicate the existence of risk to ecological receptors. Because concentrations of antimony, manganese, and vanadium are below Hanford Site background values, it is believed that the presence of these constituents does not pose a risk to ecological receptors. All exceedances will be evaluated in the context of additional lines of evidence for risk to ecological receptors as part of the final closeout decision for this site.

GENERAL SITE INFORMATION AND BACKGROUND

The 100-N-83 waste site, part of the 100-NR-1 Operable Unit, consisted of two radiologically contaminated areas that were discovered during remediation of the 116-N-1 Crib and Trench. The two areas, referred to as Site No. 1 and Site No. 2, are located along the northeast and southeast excavation boundary of the 116-N-1 Crib and Trench (Figure 1). Both areas were bound on the northeast and southeast by the 100-N Area security fences that have since been removed as Miscellaneous Restoration scope.

Site No. 1 is located where an uncontaminated soil stockpile, associated with the 116-N-1 waste site, was previously located. Site No. 2 was a relatively undisturbed area near and around the eastern end of the former 116-N-1 Trench. An aerial photograph from 2005 (Figure 2) shows the 116-N-1 excavation as well as Site No. 1 and Site No. 2.

Figure 1. Overall Site Location Map of the 100-N-83 Waste Site.

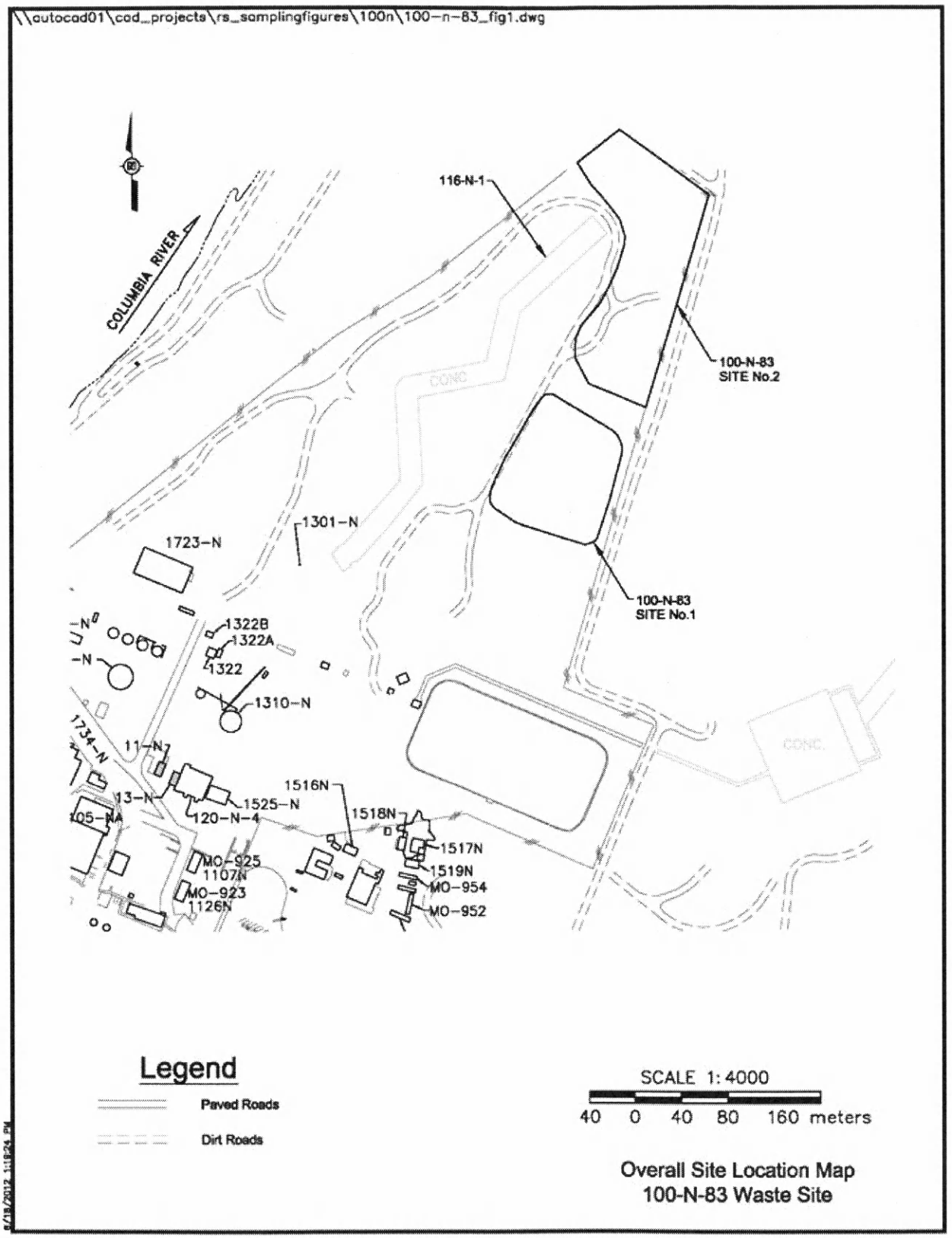


Figure 2. Aerial Photograph of the 100-N-83 Waste Site, Looking South (December 8, 2005).

REMEDIAL ACTION SUMMARY

Remedial action at the 100-N-83 waste site was performed between February 1 and February 29, 2016. The depth of the remediation was approximately 15 cm (6 in.), with the exception of one area in the southern region of the waste site where the excavation extended to 1.5 m (5 ft) below ground surface. A total of 3,461 bank cubic meters (4,527 bank cubic yards) of soil was removed for disposal at the Environmental Restoration Disposal Facility.

All waste material was staged within the excavation area prior to loadout for disposal to the Environmental Restoration Disposal Facility; therefore, no waste staging pile area was created. Additionally, no overburden soil was salvaged for use as clean backfill. No in-process soil samples were collected. Post-excavation Global Positioning Environmental Radiological Surveyor (GPERS) surveys were conducted and are provided in Figures 3 and 4.

A post-excavation civil survey was conducted following remedial action activities and is provided in Figure 5. Photographs taken following remediation are provided in Figures 6 and 7.

Figure 3. The 100-N-83 GPERS Radiological Survey Beta Track Map.

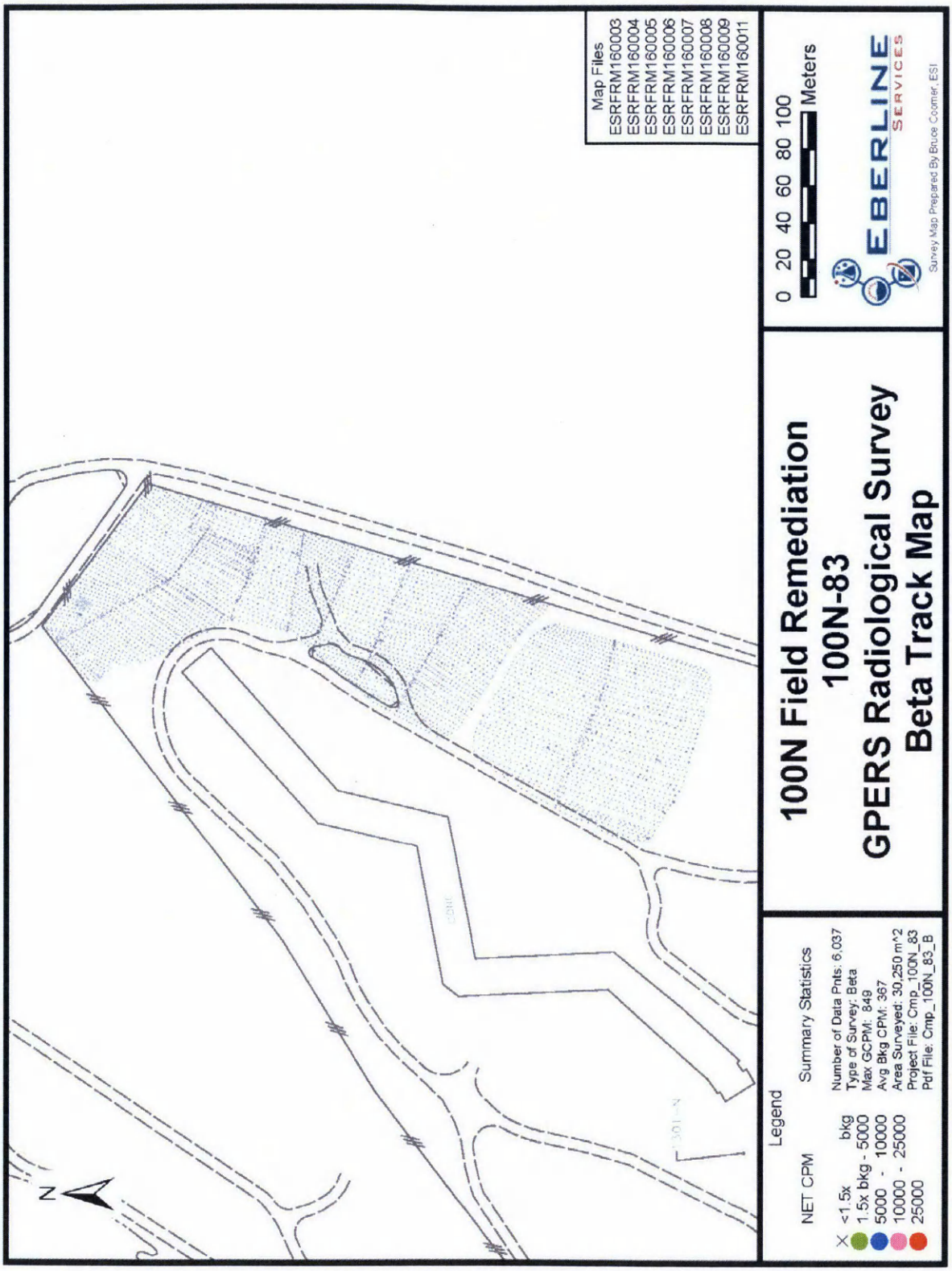


Figure 4. The 100-N-83 GPERS Radiological Survey Gamma Track Map.

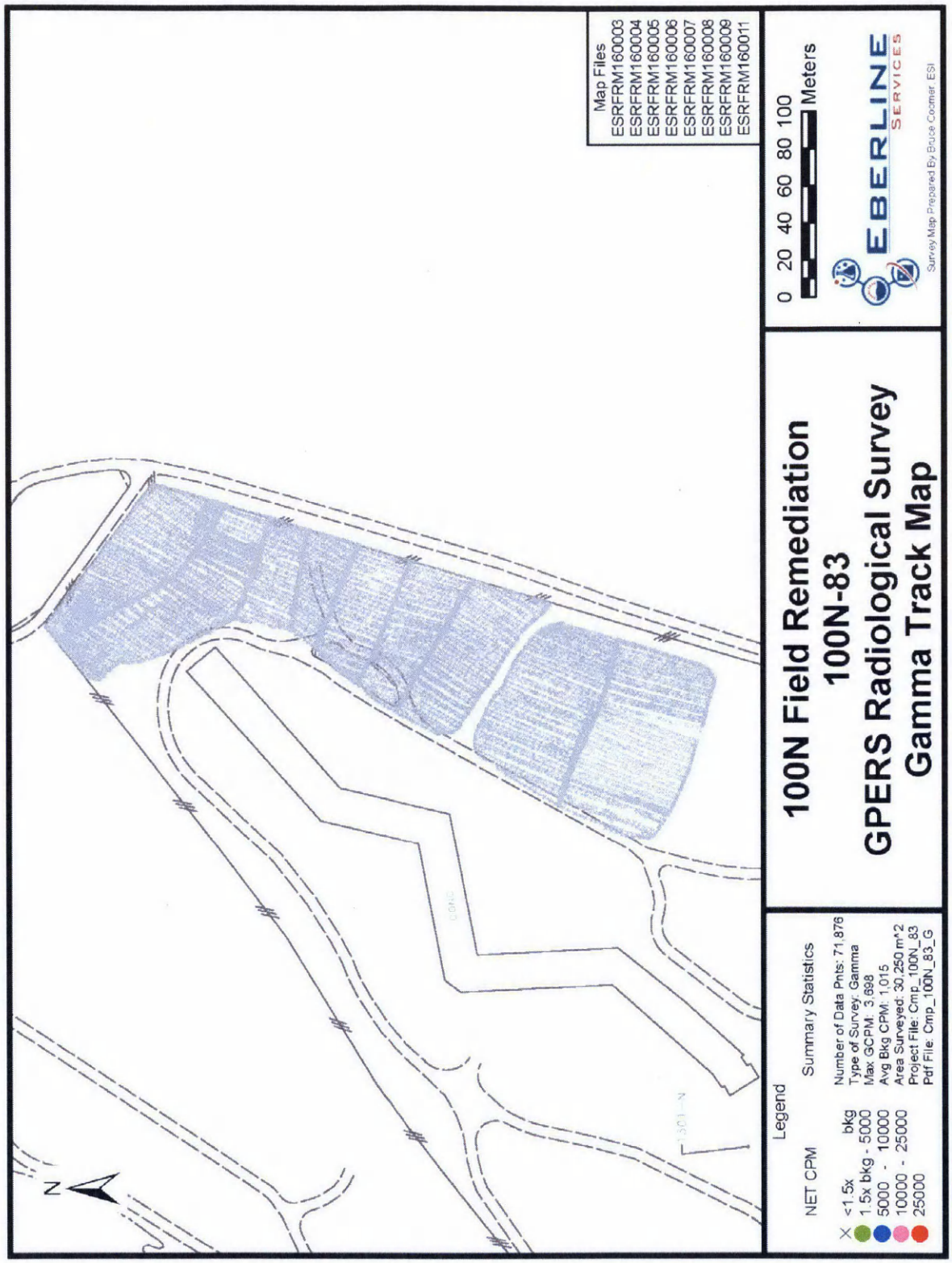


Figure 5. The 100-N-83 Post-Excavation Civil Survey.

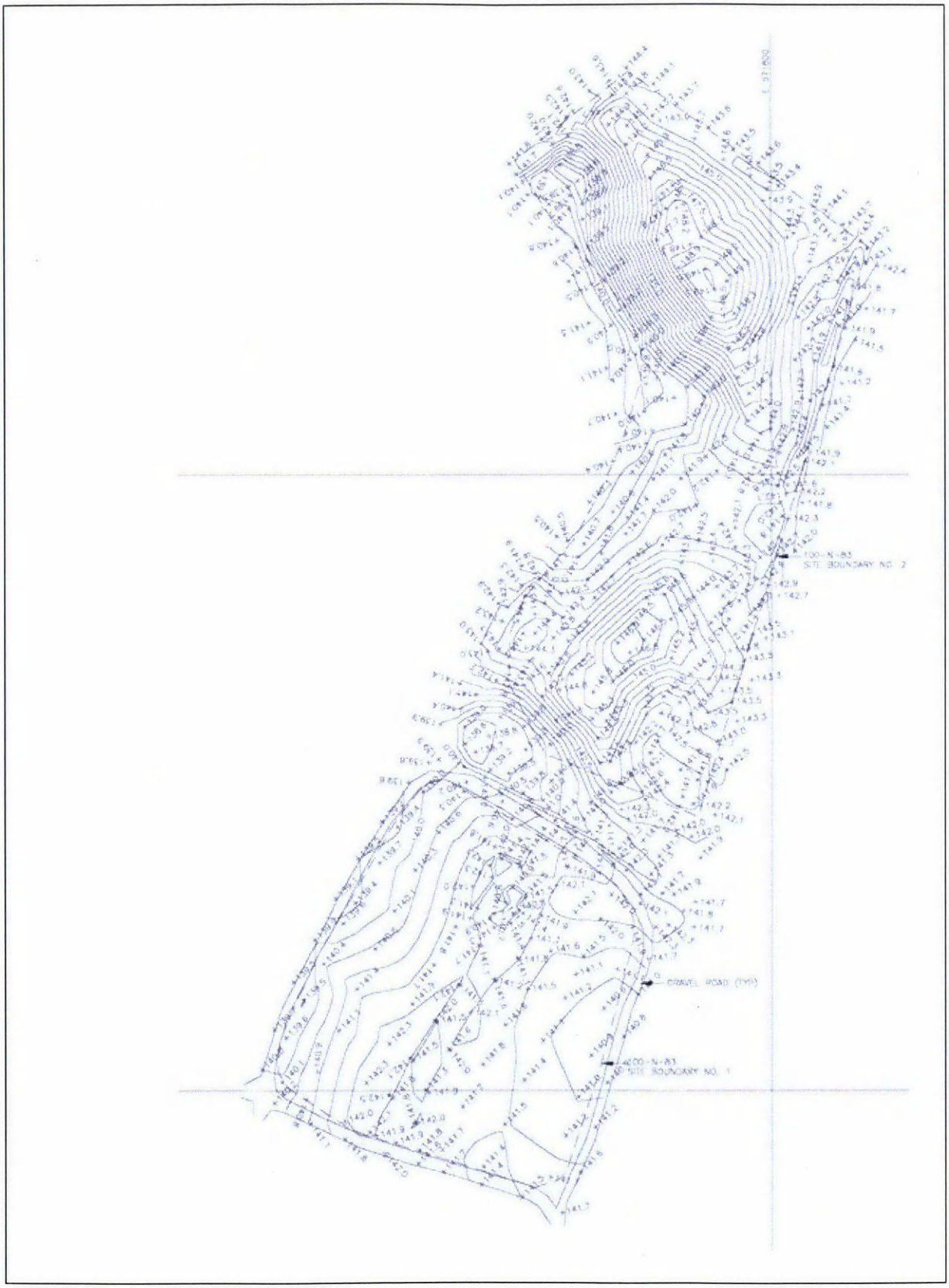


Figure 6. The 100-N-83 Post-Excavation Aerial Photograph Looking South.

Figure 7. The 100-N-83 Post-Excavation Aerial Photograph Looking East.

VERIFICATION SAMPLING ACTIVITIES

Verification soil sampling was conducted on April 26, 2016, per the *Work Instruction for Verification Sampling of the 100-N-83, Two Contamination Areas found Near 116-N-1* (WCH 2016). The verification samples were collected to support a determination that residual contaminant concentrations at this site meet the cleanup criteria specified in the 100-N Area RDR/RAWP (DOE-RL 2013) and the 100-N Area ROD (EPA 1999).

Contaminants of Potential Concern for Verification Sampling

The COPCs for the 100-N-83 waste site were determined based on process knowledge, historical information, and the 116-N-1 cleanup verification package. The COPCs include strontium-90, americium-241, plutonium-239/240, nickel-63, cesium-137, cobalt-60, europium-152, europium-154, europium-155, tritium, total chromium, hexavalent chromium, mercury, and nitrate.

All verification samples were collected and submitted for full protocol laboratory analysis and analyzed using EPA-approved analytical methods. The analytical methods that were performed to evaluate the site COPCs are provided in Table 1.

Table 1. Laboratory Analytical Methods for the 100-N-83 Waste Site.

Analytical Method	COPC
ICP metals [a] – EPA Method 6010	Total chromium
Mercury – EPA Method 7471	Mercury
Hexavalent chromium – EPA Method 7196	Hexavalent chromium
IC anions – EPA Method 300.0	Nitrate
GEA – gamma spectroscopy	Americium-241, cesium-137, cobalt-60, europium-152, europium-154, europium-155
Isotopic plutonium	Plutonium-239/240
Strontium-90 – liquid scintillation	Strontium-90
Nickel-63 – liquid scintillation	Nickel-63
NO_2/NO_3 – EPA Method 353.2 [b]	Nitrate
Tritium – liquid scintillation	Tritium

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

[b] To preclude holding time issues associated with EPA Method 300.0 for nitrate and nitrite, EPA Method 353.2 was also performed.

COPC= contaminant of potential concern
EPA = U.S. Environmental Protection Agency
GEA = gamma energy analysis
IC = ion chromatography
ICP = inductively coupled plasma

Verification Sample Design

One decision unit was identified for the 100-N-83 waste site excavation area. A combination of a statistical and focused sample design was used to evaluate the 100-N-83 waste site. Twelve statistical verification soil samples plus one duplicate and one split were collected from the excavation. Additionally, one focused soil sample (FS-1) was collected from the excavation at the location where the elevated GPERS readings were recorded in 2006 and where the excavation extended to 1.5 m (5 ft) below ground surface during remediation. One equipment blank sample was also collected.

All sampling was performed in accordance with ENV-1, *Environmental Monitoring & Management*, to fulfill the requirements of the *100-N Area Sampling and Analysis Plan for CERCLA Waste Sites* (DOE-RL 2006). All samples were grab samples collected at the predetermined coordinates identified in Table 2. The verification sample locations are shown in Figure 8.

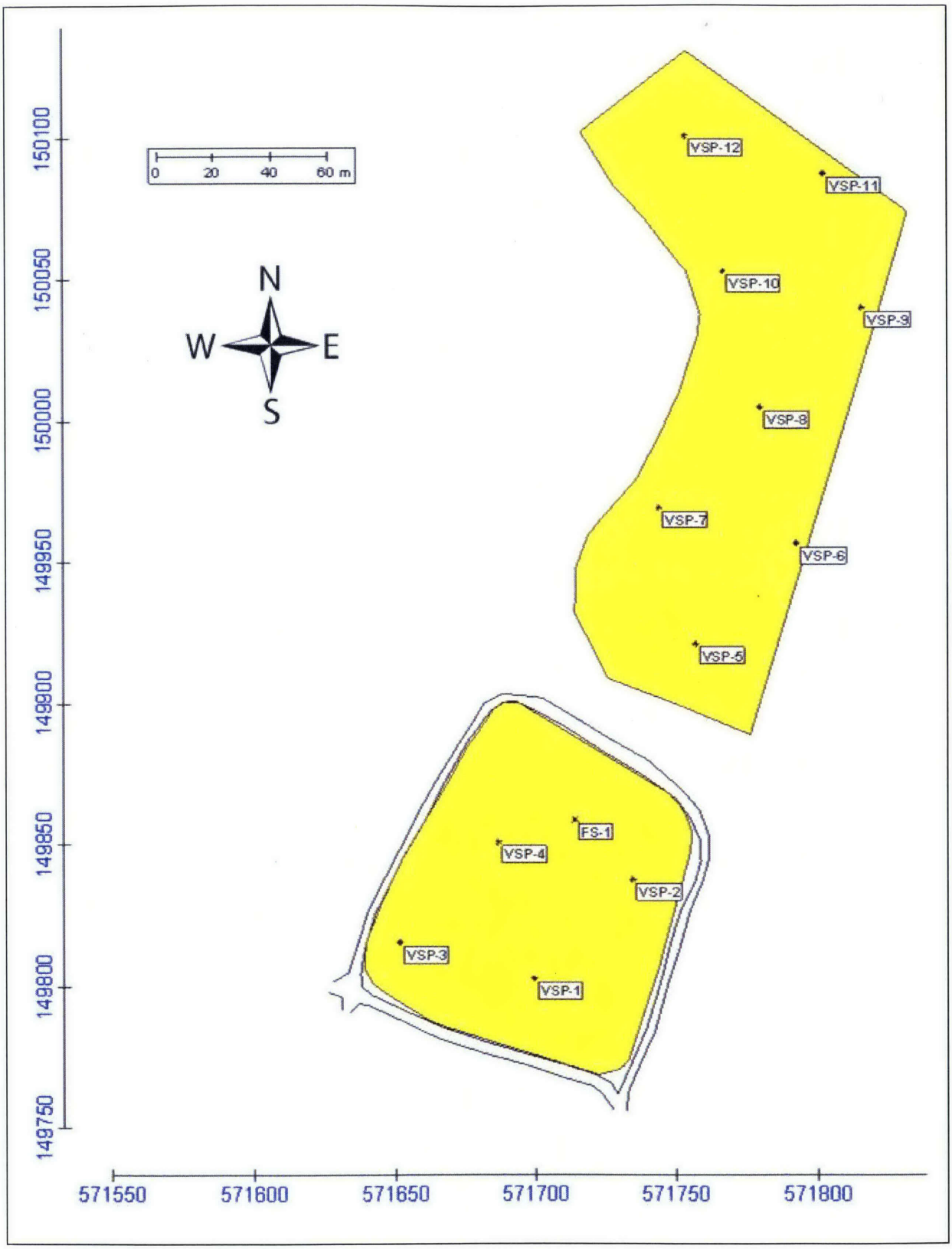
Table 2. The 100-N-83 Waste Site Verification Sample Summary.

Sample Location	HEIS Sample Number	Northing	Easting	Sample Analysis
VSP-1	J1V8V8	149802.7	571699.7	GEA, nickel-63, isotopic plutonium, strontium-90, tritium, ICP metals [a], mercury, hexavalent chromium, nitrate/nitrate, IC anions
VSP-2	J1V8V9	149837.9	571734.9	
VSP-3	J1V8W0	149815.6	571651.6	
VSP-4	J1V8W1	149850.8	571686.8	
VSP-5	J1V8W2	149921.3	571757.3	
VSP-6	J1V8W3	149956.5	571792.5	
VSP-7	J1V8W4	149969.4	571744.4	
VSP-8	J1V8W5	150004.6	571779.6	
VSP-9	J1V8W6	150039.8	571814.9	
VSP-10	J1V8W7	150052.7	571766.7	
VSP-11	J1V8W8	150087.9	571801.9	
VSP-12	J1V8W9	150100.9	571753.8	
Duplicate of J1V8W4	J1V8X1	149969.4	571744.4	
Split of J1V8W4	J1V8X3	149969.4	571744.4	
FS-1	J1V8X0	149858.7	571714.4	
Equipment blank	J1V8X2	NA	NA	GEA, nickel-63, isotopic plutonium, strontium-90, tritium, ICP metals [a], mercury, hexavalent chromium, nitrate/nitrite, IC anions

[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.

GEA = gamma energy analysis
HEIS = Hanford Environmental Information System
IC = ion chromatography
ICP = inductively coupled plasma
NA = not applicable

Figure 8. The 100-N-83 Waste Site Verification Sample Locations.



Verification Sampling Results

The primary statistical calculation to evaluate compliance with cleanup standards is the 95% upper confidence limit (UCL) on the arithmetic mean of the data. The 95% UCL values for each detected COPC are computed for the 100-N-83 excavation decision unit as specified by the 100-N Area RDR/RAWP (DOE-RL 2013). The calculations are provided in Appendix B. When a nonradionuclide COPC was detected in fewer than 50% of the verification samples collected for the decision unit, the maximum detected value was used for comparison to RAGs. If no detections for a given COPC were reported in the data set, then no statistical calculation or evaluation was performed for that COPC. Evaluation of the verification data was performed by direct comparison of the statistical or maximum sample results for each COPC against the cleanup criteria.

Comparisons of the statistical results for COPCs against the site remedial action goals (RAGs) are summarized in Tables 3 and 4. Contaminants that were not detected by laboratory analysis are excluded from these tables. Calculated cleanup levels are not presented in the Cleanup Levels and Risk Calculations Database (Ecology 2016) under WAC 173-340-740(3) for calcium, magnesium, potassium, silicon, and sodium. The EPA's *Risk Assessment Guidance for Superfund: Volume 1, Human Health Evaluation Manual* (EPA 1989) recommends that aluminum and iron not be considered in site risk evaluations. Therefore, aluminum, calcium, iron, magnesium, potassium, silicon, and sodium are not considered site COPCs and are also not included in these tables.

Table 3. Comparison of Contaminant Concentrations to Action Levels for the 100-N-83 Waste Site Statistical Verification Samples. (2 Pages)

COPC	Statistical or Maximum Result [b] (pCi/g)	Soil Lookup Values [a] (pCi/g)			Does the Result Exceed Lookup Values?	Does the Result Pass RESRAD Modeling?
		Direct Exposure Lookup Value	Soil Lookup Value for Groundwater Protection	Soil Lookup Value for River Protection		
Cesium-137	0.217 (<BG)	6.2	1,465	1,465	No	--
Nickel-63 [c]	2.46	4,013 [d]	83	83	No	--
Strontium-90	3.33	4.5	27.6	27.6	No	--
COPC	**Statistical or Maximum Result [b] (mg/kg)**	**Remedial Action Goals [a] (mg/kg)**			**Does the Result Exceed RAGs?**	**Does the Result Pass RESRAD Modeling?**
		Direct Exposure	Soil Cleanup Level for Groundwater Protection	Soil Cleanup Level for River Protection		
Antimony [e]	0.47 (<BG)	32 [f]	5 [g]	5 [g]	No	--
Arsenic	2.9 (<BG)	20 [g]	20 [g]	20 [g]	No	--
Barium	87.1 (<BG)	16,000 [f]	200	400	No	--
Beryllium	0.49 (<BG)	10.4 [h]	1.51 [g]	1.51 [g]	No	--
Boron [c]	2.0	16,000 [f]	320	-- [i]	No	--

Table 3. Comparison of Contaminant Concentrations to Action Levels for the 100-N-83 Waste Site Statistical Verification Samples. (2 Pages)

COPC	Statistical or Maximum Result [b] (mg/kg)	Remedial Action Goals [a] (mg/kg)			Does the Result Exceed RAGs?	Does the Result Pass RESRAD Modeling?
		Direct Exposure	Soil Cleanup Level for Groundwater Protection	Soil Cleanup Level for River Protection		
Cadmium [e]	0.23 (<BG)	13.9 [h]	0.81 [g]	0.81 [g]	No	--
Chromium	13.6 (<BG)	120,000 [f]	18.5 [g]	18.5 [g]	No	--
Cobalt	7.3 (<BG)	1,600 [f]	32	-- [i]	No	--
Copper	14.1 (<BG)	2,960 [f]	59.2	22.0 [g]	No	--
Hexavalent chromium [c]	0.50	2.1 [h]	4.8	2	No	--
Lead	5.6 (<BG)	353	10.2 [g]	10.2 [g]	No	--
Manganese	338 (<BG)	11,200 [f]	512 [g]	-- [i]	No	--
Mercury	0.0094 (<BG)	24 [f]	0.33 [g]	0.33 [g]	No	--
Nickel	12.2 (<BG)	1,600 [f]	19.1 [g]	27.4	No	--
Vanadium	44.8 (<BG)	560 [f]	85.1 [g]	-- [i]	No	--
Zinc	39.4 (<BG)	24,000 [f]	480	67.8 [g]	No	--
Chloride	7.1 (<BG)	--	25,000 [d]	-- [i]	No	--
Fluoride	0.89 (<BG)	4,800 [d]	96 [d]	400 [d]	No	--
Nitrogen in nitrate	7.7 (<BG)	128,000 [d]	1,000 [d]	2,000 [d]	No	--
Sulfate	7.9 (<BG)	--	25,000	-- [i]	No	--

[a] RAGs or lookup value obtained from the 100-N Area RDR/RAWP (DOE-RL 2013) unless otherwise noted.
[b] 95% UCL or maximum results as described in the *100-N-83 Waste Site Cleanup Verification 95% UCL Calculation* (Appendix B).
[c] No Hanford Site-specific or Washington State background value available.
[d] RAG or lookup value obtained from the 100 Area RDR/RAWP (DOE-RL 2009).
[e] Hanford Site-specific background not available. Value is Washington State background from *Natural Background Soil Metals Concentrations in Washing State* (Ecology 1994).
[f] Noncarcinogenic cleanup level calculated from WAC 173-340-740(3), Method B, Ecology 1996.
[g] Where cleanup levels are less than background, cleanup levels default to background per WAC 173-340-700(4)(d) (Ecology 1996). The arsenic cleanup level of 20 mg/kg has been agreed to by the Tri-Party Agreement project managers.
[h] Carcinogenic cleanup level calculated based on the inhalation exposure pathway (WAC 173-340-750[3], Ecology 1996).
[i] No parameters (bioconcentration factors or ambient water quality criteria values) are available from the Washington State Department of Ecology Cleanup Levels and Risk Calculations database or other databases to calculate cleanup levels (WAC 173-340-730[3][a][iii], 1996 [Method B for surface waters]).

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

Table 4. Comparison of Contaminant Concentrations to Action Levels for the 100-N-83 Waste Site Focused Verification Samples.

COPC	Maximum Result [b] (pCi/g)	Soil Lookup Values [a] (pCi/g)			Does the Result Exceed Lookup Values?	Does the Result Pass RESRAD Modeling?
		Direct Exposure Lookup Value	Soil Lookup Value for Groundwater Protection	Soil Lookup Value for River Protection		
Cesium-137	4.16	6.2	1,465	1,465	No	--
Cobalt-60	0.156	1.4	13,900	13,900	No	--
COPC	**Maximum Result [b] (mg/kg)**	**Remedial Action Goals [a] (mg/kg)**			**Does the Result Exceed RAGs?**	**Does the Result Pass RESRAD Modeling?**
		Direct Exposure	Soil Cleanup Level for Groundwater Protection	Soil Cleanup Level for River Protection		
Antimony	0.75 (<BG)	32 [c]	5 [d]	5 [d]	No	--
Arsenic	2.6 (<BG)	20 [d]	20 [d]	20 [d]	No	--
Barium	79.8 (<BG)	16,000 [c]	200	400	No	--
Beryllium	0.34 (<BG)	10.4 [e]	1.51 [d]	1.51 [d]	No	--
Boron [f]	1.5	16,000 [c]	320	-- [g]	No	--
Cadmium [h]	0.21 (<BG)	13.9 [e]	0.81 [d]	0.81 [d]	No	--
Chromium	15.0 (<BG)	120,000	18.5 [d]	18.5 [d]	No	--
Cobalt	9.3 (<BG)	1,600 [c]	32	-- [g]	No	--
Copper	14.1 (<BG)	2,960 [c]	59.2	22.0 [d]	No	--
Lead	4.9 (<BG)	353 [e]	10.2 [d]	10.2 [d]	No	--
Manganese	353 (<BG)	11,200 [c]	512 [d]	-- [g]	No	--
Nickel	11.5 (<BG)	1,600 [c]	19.1 [d]	27.4	No	--
Vanadium	48.6 (<BG)	560 [c]	85.1 [d]	-- [g]	No	--
Zinc	39.4 (<BG)	24,000 [c]	480	67.8 [d]	No	--
Chloride	7.1 (<BG)	--	25,000 [i]	-- [g]	No	--
Fluoride	1.5 (<BG)	4,800 [i]	96 [i]	400 [i]	No	--
Nitrogen in nitrate	4.2 (<BG)	128,000 [i]	1,000 [i]	2,000 [i]	No	--
Sulfate	13.9 (<BG)	--	25,000	-- [g]	No	--

[a] RAGs or lookup value obtained from the 100-N Area RDR/RAWP (DOE-RL 2013) unless otherwise noted..
[b] Maximum results as described in the *100-N-83 Waste Site Cleanup Verification 95% UCL Calculation* (Appendix B).
[c] Noncarcinogenic cleanup level calculated from WAC 173-340-740(3), Method B (Ecology 1996).
[d] Where cleanup levels are less than background, cleanup levels default to background per WAC 173-340-700(4)(d) (Ecology 1996). The arsenic cleanup level of 20 mg/kg has been agreed to by the Tri-Party Agreement project managers
[e] Carcinogenic cleanup level calculated based on the inhalation exposure pathway (WAC 173-340-750[3] [Ecology 1996]).
[f] No Hanford Site-specific or Washington State background value available.
[g] No parameters (bioconcentration factors or ambient water quality criteria values) are available from the Washington State Department of Ecology Cleanup Levels and Risk Calculations database or other databases to calculate cleanup levels (WAC 173-340-730[3][a][iii] [Ecology 1996] [Method B for surface waters]).
[h] Hanford Site-specific background not available. Value is Washington State background from *Natural Background Soil Metals Concentrations in Washing State* (Ecology 1994).
[i] RAG or lookup value obtained from the 100 Area RDR/RAWP (DOE-RL 2009)

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

The complete laboratory-reported data results for all constituents are stored in a Washington Closure Hanford project-specific database prior to inclusion into the Hanford Environmental Information System and are presented as part of the 95% UCL calculation in Appendix B.

DATA EVALUATION

This section demonstrates that contaminant concentrations at the 100-N-83 waste site achieve the applicable RAGs developed to support unrestricted land use at the 100 Area as documented in the 100-N Area RDR/RAWP (DOE-RL 2013).

Attainment of Remedial Action Goals and Lookup Values

Tables 3 and 4 compare the cleanup verification sample values for the 100-N-83 waste site excavation decision unit to the applicable soil RAGs and lookup values for direct exposure, protection of groundwater, and protection of the Columbia River. All COPCs were quantified below the direct exposure, groundwater, and river protection RAGs. Therefore, residual concentrations of all COPCs are predicted to be protective of groundwater and the Columbia River.

Three-Part Test for Nonradionuclides

When using a statistical sampling approach, a RAG requirement for nonradionuclides is the WAC 173-340-740(7)(e) three-part test and consists of the following criteria: (1) the cleanup verification 95% upper confidence limit value must be less than the cleanup level, (2) no single detection shall exceed two times the cleanup criteria, and (3) the percentage of samples exceeding the cleanup criteria must be less than 10% of the data set.

The application of the three-part test for the 100-N-83 remediation footprint is included in the statistical calculations (Appendix B). The results of this evaluation indicate that residual COPC concentrations pass the three-part test in comparison against the applicable RAGs. An additional application of the three-part test is included for the statistical data sets, which default to the maximum because less than half of the data set was detected. The results of this evaluation indicate that all residual COPC concentrations pass the three-part test in comparison against applicable RAGs. Therefore, residual concentrations of all COPCs within the 100-N-83 waste site are predicted to be protective of groundwater and the Columbia River.

Nonradionuclide Direct Contact Hazard Quotient and Carcinogenic Risk RAGs Attained

Assessment of the risk requirements for the 100-N-83 waste site was determined by calculation of the hazard quotient and excess carcinogenic risk. The requirements include an individual hazard quotient of less than 1.0, a cumulative hazard quotient of less than 1.0, an individual contaminant carcinogenic risk of less than 1×10^{-6}, and a cumulative excess carcinogenic risk of less than 1×10^{-5}. The hazard quotient and excess carcinogenic risk calculations for direct contact were performed for the 100-N-83 waste site excavation and the focused sample location using the statistical and maximum value, respectively. 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 for the excavation and the focused sample location. The cumulative hazard quotient for the excavation is 2.2×10^{-3} and the focused sample location is 9.4×10^{-5}, which are both less than 1.0. The excess carcinogenic risk value for hexavalent chromium, the only constituent subject to the excess carcinogenic risk calculation for the excavation, is 2.4×10^{-7}, satisfying the individual and cumulative criteria of less than 1×10^{-6} and 1×10^{-5}, respectively. There were no constituents that required the excess carcinogenic risk calculation for the focused sample location. Therefore, the nonradionuclide risk requirements for the 100-N-83 waste site are met.

Nonradionuclide Groundwater Hazard Quotient and Carcinogenic Risk RAGs Attained

Assessment of the risk requirements for the 100-N-83 waste site included calculation of the hazard quotient and carcinogenic (excess cancer) risk values for groundwater protection for nonradionuclides. The requirements include an individual and cumulative hazard quotient of less than 1.0, an individual excess carcinogenic risk of less than 1×10^{-6}, and a cumulative excess carcinogenic risk of less than 1×10^{-5}. These risk values were conservatively calculated for the entire waste site using the highest statistical or maximum value for each COPC. Risk values were calculated for constituents that were detected at concentrations above Hanford Site or Washington State background values or for which there is no background value. In addition, the distribution coefficients for these contaminants are less than that necessary to show no migration to groundwater in 1,000 years based on RESidual RADioactivity modeling discussed in Appendix C of the 100-N Area RDR/RAWP (DOE-RL 2013). Based on this model and a vadose zone of approximately 22 m (72 ft) in thickness, a distribution coefficient (K_d) of 3.4 or greater is required to show no predicted migration to groundwater in 1,000 years. All individual hazard quotients for noncarcinogenic constituents are less than 1.0. The cumulative hazard quotient for the 100-N-83 waste site is 1.1×10^{-1}, which is less than 1.0. There were no constituents that required the excess cancer risk calculation; therefore, the individual and cumulative carcinogenic risk of less than 1×10^{-6} and less than 1×10^{-5} are met.

Attainment of Radionuclide Direct Exposure RAGs

Evaluation of RAG attainment for radionuclides was performed using the single-radionuclide dose-equivalence lookup values. The model used to develop the dose-equivalence lookup values is presented in the 100-N Area RDR/RAWP (DOE-RL 2013). A comparison of the radionuclide verification sample results for the statistical and focused sample data sets to the cumulative direct exposure radiological dose limit of 15 mrem/yr was conducted using sum–of-fractions calculations (Appendix B). The sum of fractions was calculated for the 100-N-83 excavation and the focused sample location using the statistical and maximum values, respectively, for each COPC.

The sum of fractions shown in the *100-N-83 Waste Site Direct Contact Hazard Quotient and Carcinogenic Risk Calculations, and Sum of Fractions Calculations* in Appendix B determined that the maximum predicted total radiological dose is 11.6 mrem/yr for the excavation decision unit, and 11.7 mrem/yr for the focused sample location. Comparing these values to the dose limit of <15 mrem/yr, the requirement is met.

DATA QUALITY ASSESSMENT

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

The DQA for the 100-N-83 waste site established 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 cleanup verification sample analytical data are stored in a Washington Closure Hanford project-specific database for data evaluation prior to its archival in the Hanford Environmental Information System and are summarized in Appendix B. The detailed DQA is presented in Appendix C.

SUMMARY FOR INTERIM CLOSURE

The 100-N-83 waste site has been evaluated in accordance with the 100-N Area ROD (EPA 1999) and the 100-N Area RDR/RAWP (DOE-RL 2013). Verification sampling was performed, and the analytical results indicate that the residual concentrations of COPCs at the site meet the RAOs for direct exposure, groundwater protection, and river protection.

In accordance with this evaluation, the confirmatory and verification sampling and modeling results support a reclassification of the 100-N-83 waste site to Interim Closed Out. Contamination above direct exposure levels was not observed in the shallow zone soils and is concluded to not exist in deep zone soils; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone soil are not required.

REFERENCES

40 CFR 141, "National Primary Drinking Water Regulations," *Code of Federal Regulations*, as amended.

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EPA, 2011, *Explanation of Significant Differences for the 100-NR-1 and 100-NR-2 Operable Units Interim Remedial Action Record of Decision, Hanford Site, Benton County, Washington*, U.S. Environmental Protection Agency, Region 10, Seattle, Washington.

WAC 173-340, 2007, "Model Toxics Control Act – Cleanup," *Washington Administrative Code, as amended.*

WCH, 2016, *Work Instruction for Verification Sampling of the 100-N-83, Two Contamination Areas Found Near 116-N-1,* 0100N-WI-G0093, Rev. 0, Washington Closure Hanford, Richland, Washington.

APPENDIX A

EXCEEDANCES OF ECOLOGICAL SCREENING LEVELS FOR THE 100-N-83 WASTE SITE

Table A-1. Maximum Contaminant Concentrations that Exceed Ecological Screening Levels for the 100-N-83 Waste Site [a].

Hazardous Substance	Background	2007 WAC 173-340, Table 749-3			EPA Ecological Soil Screening Levels [b]				Maximum or Statistical Result
		Plants	Soil Biota	Wildlife	Plants	Soil Biota	Avian [c]	Mammalian [c]	
		Metals (mg/kg):							
Antimony	5	5	--	--	--	78	--	0.27	0.75 (<BG)
Boron	--	0.5	--	--	--	--	--	--	2.0
Manganese	512	1,100	--	1,500	220	450	4,300	4,000	353 (<BG)
Vanadium	85.1	2	--	--	--	--	7.8	280	48.6 (<BG)

NOTE: Shaded cells are exceeded by the maximum of the focused or statistical result.

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

[b] Available on the internet at (www.epa.gov/ecotox/ecossl).

[c] Wildlife.

-- = not applicable
BG = Hanford Site Background
EPA = U.S. Environmental Protection Agency
WAC= *Washington Administrative Code*

APPENDIX B

CALCULATIONS

APPENDIX B

CALCULATION BRIEFS

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 file will be stored in a U.S. Department of Energy, Richland Operations Office repository. This calculation has been prepared in accordance with ENG-1, *Engineering Services*, ENG-1-4.5, "Project Calculation," Washington Closure Hanford, Richland, Washington. The following calculations are provided in this appendix.

100-N-83 Waste Site Cleanup Verification, 95% UCL Calculations, 0100N-CA-V0294, Rev. 0, Washington Closure Hanford, Richland, Washington.

100-N-83 Waste Site Direct Contact Hazard Quotient and Carcinogenic Risk Calculations, and Sum of Fractions Calculations, 0100N-CA-V0295, Rev. 0, Washington Closure Hanford, Richland, Washington.

100-N-83 Waste Site Hazard Quotient and Carcinogenic Risk Calculations for Protection of Groundwater, 0100N-CA-V0296, Rev. 0, Washington Closure Hanford, Richland, Washington.

DISCLAIMER FOR CALCULATIONS

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

Acrobat 8.0

CALCULATION COVER SHEET

Project Title: 100-N Field Remediation **Job No. 14655**

Area: 100-N

Discipline: Environmental *Calculation No: 0100N-CA-V0294

Subject: 100-N-83 Waste Site Cleanup Verification 95% UCL Calculations

Computer Program: Excel Program No: Excel 2010

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

Committed Calculation ☒ Preliminary ☐ Superseded ☐ Voided ☐

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover = 1 Sheets = 11 Attm. 1 = 6 Total = 18	R. J. Nielson	J. M. Capron	B. L. Vedder	S. G. Wilkinson	8/4/16

SUMMARY OF REVISION

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

CALCULATION SHEET

Washington Closure Hanford

Originator R. J. Nielson RJN
Project 100-N Field Remediation
Subject 100-N-83 Waste Site Cleanup Verification 95% UCL Calculations

Calc. No. 0100N-CA-V0294 **Rev. No.** 0
Checked J. M. Capron JMC **Date** 06/20/16
Job No. 14655 **Sheet No.** 1 of 11

Summary

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

Table of Contents:

Given/References:
1) Sample Results (Attachment 1).
2) DOE-RL, 2006, 100-N Area Sampling and Analysis Plan for CERCLA Waste Sites, DOE/RL-2005-92, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
3) DOE-RL, 2013, Remedial Design Report/Remedial Action Work Plan for the 100-N Area, DOE/RL-2005-93, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
4) Ecology, 1992, Statistical Guidance for Ecology Site Managers, Publication #92-54, Washington Department of Ecology, Olympia, Washington.
5) Ecology, 1993, Statistical Guidance for Ecology Site Managers, Supplement S-6, Analyzing Site or Background Data with Below-detection Limit or Below-PQL Values (Censored Data Sets), Publication #92-54, Washington Department of Ecology, Olympia, Washington.
6) Ecology, 2011, Cleanup Levels and Risk Calculations (CLARC) Database, Washington State Department of Ecology, Olympia, Washington, <https://fortress.wa.gov/ecy/clarc/CLARCHome.aspx>.
7) EPA, 1989, Risk Assessment Guidance for Superfund: Volume 1, Human Health Evaluation Manual, Part A; Interim Final, EPA/540/1-89/002, U.S. Environmental Protection Agency, Washington, D. C.
8) WAC 173-340, 1996, "Model Toxic Control Act - Cleanup," Washington Administrative Code.

Solution:
Calculation methodology is described in Ecology Pub. #92-54 (Ecology 1992, 1993), below, and in the RDR/RAWP (DOE-RL 2013). Use data from attached worksheets to perform the 95% UCL calculation for each analyte, the WAC 173-340-740(7)(e) 3-part test for nonradionuclides, and the RPD calculations for each COC/COPC. The hazard quotient and carcinogenic risk calculations are located in a separate calculation brief as an appendix to the Remaining Sites Verification Package (RSVP).

Calculation Description:
The subject calculations were performed on statistical data from soil verification samples (Attachment 1) from the 100-N-83 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 2013) is documented by this calculation. Duplicate RPD results are used in evaluation of data quality within the RSVP for this site.

Methodology:
The 100-N-83 waste site underwent statistical sampling at one decision unit; specifically, the excavation.

Analytical results for all sampling locations are summarized in the table provided on sheet 4. Further information of the sample data quality is presented in the data quality assessment section of the associated RSVP.

Washington Closure Hanford **CALCULATION SHEET**

Originator R. J. Nielson RN **Calc. No.** 0100N-CA-V0294 **Rev. No.** 0
Project 100-N Field Remediation **Checked** J. M. Capron JMC **Date** 06/20/16
Subject 100-N-83 Waste Site Cleanup Verification 95% UCL Calculations **Job No.** 14655 **Sheet No.** 2 of 11

Summary (continued)

Methodology, continued:
For nonradioactive analytes with ≤50% of the data below detection limits and all detected radionuclide analytes, 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, the maximum detected value for the data set (which includes primary and duplicate samples) is used instead of the 95% UCL, and no further calculations are performed for those data sets. For convenience, these maximum detected values are included in the summary tables that follow. The 95% UCL was not calculated for data sets with no reported detections. Calculated cleanup levels are not available in (Ecology 2011) under WAC 173-340-740(3) for calcium, magnesium, potassium, silicon, and sodium. The EPA's *Risk Assessment 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 and radium-226 based on natural occurence at the Hanford Site. All sample results are provided in Attachment 1.

All nonradionuclide data reported as being undetected are set to ½ the detection limit value for calculation of the statistics (Ecology 1993). For the statistical evaluation of duplicate sample pairs, the samples are averaged before being included in the data set, after adjustments for censored data as described above. For radionuclide data, calculation of the statistics is done using the reported value. In cases where the laboratory does not report a value below the minimum detectable activity (MDA), half of the MDA is used in the calculation. For the statistical evaluation of duplicate sample pairs, the samples are averaged before being included in the data set, after adjustments for censored data as described above.

For nonradionuclides, the WAC 173-340 statistical guidance suggests that a test for distributional form be performed on the data and the 95% UCL calculated on the appropriate distribution using Ecology software. For nonradionuclide small data sets ($n < 10$), the calculations are performed assuming nonparametric distribution, so no tests for distribution are performed. For nonradionuclide data sets of ten or greater, as for the subject site, distributional testing is done using Ecology's MTCAStat software (Ecology 1993). Due to differences in addressing censored data between the RDR/RAWP (DOE-RL 2013) and MTCAStat coding and due to a limitation in the MTCAStat coding (no direct capability to address variable quantitation limits within a data set), substitutions for censored data are performed before software input and the resulting data set treated as uncensored.

The WAC 173-340-740(7)(e) 3-part test is performed for nonradionuclide analytes only and determines if:
1) the 95% UCL exceeds the most stringent cleanup limit for each COPC/COC,
2) greater than 10% of the raw data exceed the most stringent cleanup limit for each COPC/COC,
3) the maximum value of the raw data set exceeds two times the most stringent cleanup limit for each COPC/COC.

The RPD is calculated when both the primary value and either the duplicate or split value for a given analyte are above detection limits and are greater than 5 times the target detection limit (TDL). The TDL is a laboratory detection limit pre-determined for each analytical method and is listed in Table 2-1 of the SAP (DOE-RL 2006) for certain constituents. All other constituents will have their own pre-determined TDL's based on the laboratory and method used. Where direct evaluation of the attached sample data showed that a given analyte was not detected in the primary and/or duplicate sample, further evaluation of the RPD value was not performed. The RPD calculations use the following formula:

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

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

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

Washington Closure Hanford **CALCULATION SHEET**

Originator R. J. Nielson RJN **Calc. No.** 0100N-CA-V0294 **Rev. No.** 0
Project 100-N Field Remediation **Checked** J. M. Capron JMC **Date** 06/20/16
Subject 100-N-83 Waste Site Cleanup Verification 95% UCL Calculations **Job No.** 14655 **Sheet No.** 3 of 11

Summary (continued)

QUALIFIER LIST

B = Estimated result. Result is less than the RL, but greater than the MDL.
C = The analyte was detected in both the sample and the associated QC blank, and the concentration was </= 5 times the blank.
D = Results are reported from a diluted aliquot of sample.
M = Sample duplicate precision not met.
N (metals) = Recovery exceeds upper or lower control limits.
N (anions) = MS, MSD: Spike recovery is outside acceptance limits.
U = analyzed for but not detected.
X = Serial dilution in the analytical batch indicates that physical and chemical interferences are present.

ACRONYM LIST

-- = not applicable
CLARC = cleanup levels and risk calculations
COC = contaminant of concern
COPC = contaminant of potential concern
DE = direct exposure
GW = groundwater
HEIS - Hanford Environmental Information System
MDL = method detection limit
MTCA = *Model Toxics Control Act*
PQL = practical quantitation limit
Q = qualifier
QA/QC = quality assurance/quality control
RAG = remedial action goal
RDR/RAWP = remedial design report/remedial action work plan
RESRAD = RESidual RADioactivity (dose model)
RPD = relative percent difference
RSVP = remaining sites verification package
SAP = sampling and analysis plan
TDL = target detection limit
UCL = upper confidence limit
WAC = Washington Administrative Code

Washington Closure Hanford **CALCULATION SHEET**

Originator R. J. Nielson RJN
Project 100-N Field Remediation
Subject 100-N-83 Waste Site Cleanup Verification 95% UCL Calculations

Calc. No. 0100N-CA-V0294 **Rev. No.** 0
Checked J. M. Capron JMC **Date** 06/20/16
Job No. 14655 **Sheet No.** 4 of 11

Summary (continued)

Results:
The results presented in the tables that follow include the summary of the 95% UCL calculations and maximum results 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 RSVP for this subsite.

Results Summary - 100-N-83 Waste Site Verification Samples [a]

Analyte	Excavation 95% UCL Result	Excavation Maximum Result	Focus Maximum Result	Units
Antimony	--	0.47	0.75	mg/kg
Arsenic	2.9	--	2.6	mg/kg
Barium	87.1	--	79.8	mg/kg
Beryllium	0.49	--	0.34	mg/kg
Boron	2.0	--	1.5	mg/kg
Cadmium	0.23	--	0.21	mg/kg
Chromium	13.6	--	15.0	mg/kg
Cobalt	7.3	--	9.3	mg/kg
Copper	14.1	--	14.1	mg/kg
Hexavalent chromium	0.50	--	--	mg/kg
Lead	5.6	--	4.9	mg/kg
Manganese	338	--	353	mg/kg
Mercury	--	0.0094	--	mg/kg
Nickel	12.2	--	11.5	mg/kg
Vanadium	44.8	--	48.6	mg/kg
Zinc	39.4	--	39.4	mg/kg
Chloride	7.1	--	7.1	mg/kg
Fluoride	--	0.89	1.5	mg/kg
Nitrogen in nitrate	5.4	--	3.2	mg/kg
Nitrogen in nitrite and nitrate	7.7	--	4.2	mg/kg
Sulfate	7.9	--	13.9	mg/kg
Cesium-137	0.217	--	4.16	pCi/g
Cobalt-60	--	--	0.156	pCi/g
Nickel-63	2.46	--	--	pCi/g
Total beta radiostrontium	3.33	--	--	pCi/g

3-Part Test Evaluation:	EXC	
95% UCL or maximum [a] >		
Cleanup Limit?	NO	NO
> 10% above Cleanup Limit?	NO	NO
Any sample > 2x Cleanup Limit?	NO	NO

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

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

Analyte	Duplicate	Split
Aluminum	2.7%	10.9%
Barium	5.5%	17.2%
Calcium	2.0%	6.7%
Chromium	2.2%	9.3%
Copper	0.0%	13.3%
Iron	0.5%	2.4%
Magnesium	2.8%	6.8%
Manganese	7.2%	3.1%
Potassium	3.1	--
Silicon	***41.0%***	***46.7%***
Vanadium	0.3%	23.6%
Zinc	1.1%	27.7%
Potassium-40	4.2%	14.5%
Radium-226	8.7%	***39.8%***

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

CALCULATION SHEET

Washington Closure Hanford
Originator R. J. Nielson
Project 100-N Field Remediation
Subject 100-N-83 Waste Site Cleanup Verification 95% UCL Calculations

Calc. No. 0100N-CA-V0294
Checked J. M. Capron
Job No. 14655

Rev. No. 0
Date 06/20/16
Sheet No. 5 of 11

100-N-83 Waste Site Statistical Calculations

Verification Data

Sample Area	Sample Number	Sample Date	Arsenic			Barium			Beryllium			Boron			Cadmium			Chromium			Cobalt			Copper			Hexavalent Chromium		
			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
VSP-7	J1V8W4	4/26/16	2.7		0.63	92.3		0.073	0.45		0.063	1.7	B	0.94	0.18	B	0.039	13.5		0.056	6.1		0.19	12.6	X	0.21	0.16	UJ	0.16
Duplicate of J1V8W4	J1V8X1	4/26/16	2.6		0.50	87.4		0.057	0.44		0.050	1.5		0.74	0.20		0.031	13.2		0.044	6.1		0.15	12.6	X	0.16	0.16	UJ	0.16
VSP-1	J1V8V8	4/26/16	2.9	M	0.50	58.5		0.057	0.47	B	0.12	1.2	BM	0.74	0.16		0.031	9.1		0.044	8.2		0.38	14.9	X	0.16	0.23	BJ	0.16
VSP-2	J1V8V9	4/26/16	2.6		0.56	53.1		0.064	0.42		0.056	1.1	B	0.83	0.15	B	0.035	9.2		0.049	7.5		0.17	13.3	X	0.18	0.16	UJ	0.16
VSP-3	J1V8W0	4/26/16	3.7		0.56	54.6		0.064	0.47		0.056	1.6	B	0.83	0.17		0.035	11.5		0.049	7.0		0.17	15.2	X	0.18	0.43	BJ	0.16
VSP-4	J1V8W1	4/26/16	2.8		0.52	53.1		0.059	0.21		0.026	1.2	B	0.77	0.14	B	0.032	14.6		0.045	5.9		0.078	9.8	X	0.17	0.16	BJ	0.16
VSP-5	J1V8W2	4/26/16	2.3		0.48	84.5		0.055	0.44		0.048	2.1		0.71	0.24		0.030	12.5		0.042	6.0		0.14	12.5	X	0.16	0.27	BJ	0.16
VSP-6	J1V8W3	4/26/16	2.6		0.54	88.5		0.062	0.48		0.054	2.1		0.80	0.21		0.033	14.5		0.047	6.8		0.16	14.0	X	0.18	0.65	BJ	0.16
VSP-8	J1V8W5	4/26/16	2.3		0.52	89.2		0.060	0.52		0.052	2.0		0.77	0.20		0.032	14.6		0.046	7.2		0.16	13.7	X	0.17	0.16	UJ	0.16
VSP-9	J1V8W6	4/26/16	2.9		0.58	88.5		0.066	0.42		0.058	1.9		0.86	0.24		0.036	13.0		0.051	6.4		0.17	13.1	X	0.19	0.29	BJ	0.16
VSP-10	J1V8W7	4/26/16	2.4		0.62	97.7		0.072	0.54		0.062	1.7	B	0.93	0.24		0.039	14.3		0.055	8.0		0.19	14.9	X	0.21	0.46	BJ	0.16
VSP-11	J1V8W8	4/26/16	3.0		0.59	98.7		0.068	0.47		0.059	2.3		0.88	0.26		0.037	12.6		0.052	6.4		0.18	12.2	X	0.19	0.20	BJ	0.17
VSP-12	J1V8W9	4/26/16	2.6		0.58	86.6		0.067	0.47		0.058	1.9		0.86	0.23		0.036	13.3		0.051	6.5		0.18	13.5	X	0.19	0.39	BJ	0.16

Statistical Computation Input Data

Sample Area	Sample Number	Sample Date	Arsenic mg/kg			Barium mg/kg			Beryllium mg/kg			Boron mg/kg			Cadmium mg/kg			Chromium mg/kg			Cobalt mg/kg			Copper mg/kg			Hexavalent Chromium mg/kg		
VSP-7	J1V8W4/ J1V8X1	4/26/16	2.7			89.9			0.45			1.6			0.19			13.4			6.1			12.6			0.080		
VSP-1	J1V8V8	4/26/16	2.9			58.5			0.47			1.2			0.16			9.1			8.2			14.9			0.23		
VSP-2	J1V8V9	4/26/16	2.6			53.1			0.42			1.1			0.15			9.2			7.5			13.3			0.080		
VSP-3	J1V8W0	4/26/16	3.7			54.6			0.47			1.6			0.17			11.5			7.0			15.2			0.43		
VSP-4	J1V8W1	4/26/16	2.8			53.1			0.21			1.2			0.14			14.6			5.9			9.8			0.16		
VSP-5	J1V8W2	4/26/16	2.3			84.5			0.44			2.1			0.24			12.5			6.0			12.5			0.27		
VSP-6	J1V8W3	4/26/16	2.6			88.5			0.48			2.1			0.21			14.5			6.8			14.0			0.65		
VSP-8	J1V8W5	4/26/16	2.3			89.2			0.52			2.0			0.20			14.6			7.2			13.7			0.080		
VSP-9	J1V8W6	4/26/16	2.9			88.5			0.42			1.9			0.24			13.0			6.4			13.1			0.29		
VSP-10	J1V8W7	4/26/16	2.4			97.7			0.54			1.7			0.24			14.3			8.0			14.9			0.46		
VSP-11	J1V8W8	4/26/16	3.0			98.7			0.47			2.3			0.26			12.6			6.4			12.2			0.20		
VSP-12	J1V8W9	4/26/16	2.6			86.6			0.47			1.9			0.23			13.3			6.5			13.5			0.39		

Statistical Computations

	Arsenic			Barium			Beryllium			Boron			Cadmium			Chromium			Cobalt			Copper			Hexavalent Chromium		
95% UCL based on	Large data set (n ≥ 10), use MTCAStat lognormal distribution.			Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.			Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.			Large data set (n ≥ 10), use MTCAStat lognormal distribution.			Large data set (n ≥ 10), use MTCAStat lognormal distribution.			Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.			Large data set (n ≥ 10), use MTCAStat lognormal distribution.			Large data set (n ≥ 10), use MTCAStat normal 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%			25%		
mean	2.7			78.6			0.45			1.73			0.2			12.7			6.8			13.3			0.28		
st. dev.	0.38			18.0			0.082			0.40			0.040			1.9			0.76			1.5			0.18		
95% UCL on mean	2.9			87.1			0.49			2.0			0.23			13.6			7.3			14.1			0.50		
max value	3.7			98.7			0.54			2.3			0.26			14.6			8.2			15.2			0.65		
Most Stringent Cleanup Limit for nonradionuclide and RAG type (mg/kg)	20	DE, GW & River Protection		200	GW Protection		1.51	GW & River Protection		320	GW Protection		0.8	GW & River Protection		18.5	GW & River Protection		32	GW Protection		22.0	River Protection		2.0	River Protection	
WAC 173-340 3-PART TEST																												
95% UCL > Cleanup Limit?	NA			NA			NA			NO			NA			NA			NA			NA			NO		
> 10% above Cleanup Limit?	NA			NA			NA			NO			NA			NA			NA			NA			NO		
Any sample > 2X Cleanup Limit?	NA			NA			NA			NO			NA			NA			NA			NA			NO		
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.			The data set meets the 3-part test criteria when compared to the most stringent RAG.			Because all values are below background (0.81 mg/kg) the WAC 173-340 3-part test is not required.			Because all values are below background (18.5 mg/kg) the WAC 173-340 3-part test is not required.			Because all values are below background (15.7 mg/kg) the WAC 173-340 3-part test is not required.			Because all values are below background (22.0 mg/kg) the WAC 173-340 3-part test is not required.			The data set meets the 3-part test criteria when compared to the most stringent RAG.		

CALCULATION SHEET

Washington Closure Hanford
Originator R. J. Nielson
Project 100-N Field Remediation
Subject 100-N-83 Waste Site Cleanup Verification 95% UCL Calculations

Calc. No. 0100N-CA-V0294
Checked J. M. Capron
Job No. 14655

Rev. No. 0
Date 06/20/16
Sheet No. 6 of 11

100-N-83 Waste Site Statistical Calculations

Verification Data

Sample Area	Sample Number	Sample Date	Lead			Manganese			Nickel			Vanadium			Zinc			Chloride			Nitrogen in Nitrate			Nitrogen in Nitrite and Nitrate			Sulfate		
			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
VSP-7	J1V8W4	4/26/16	4.7		0.26	332	X	0.096	11.7		0.12	39.2		0.090	35.1	X	0.38	6.8	N	2.1	1.4	BJ	0.33	2.1		0.38	4.9	B	1.8
Duplicate of J1V8W4	J1V8X1	4/26/16	4.7		0.20	309	X	0.076	11.2		0.093	39.3		0.071	35.5	X	0.30	6.8		2.0	1.6	BJ	0.32	2.4		0.37	5.4		1.7
VSP-1	J1V8V8	4/26/16	4.1		0.20	288	X	0.075	10.0		0.092	51.0		0.071	39.3	X	0.30	7.2	N	1.9	1.8	BJ	0.30	1.7		0.36	12.7	N	1.6
VSP-2	J1V8V9	4/26/16	4.0		0.23	268	X	0.084	10.1		0.10	42.5		0.079	34.5	X	0.34	6.8		1.9	3.8	J	0.31	3.5		0.36	8.7		1.7
VSP-3	J1V8W0	4/26/16	5.1		0.23	296	X	0.084	11.8		0.10	47.1		0.079	39.0	X	0.34	7.4		2.0	8.5	J	0.31	8.8		0.36	7.4		1.7
VSP-4	J1V8W1	4/26/16	4.1		0.21	210	X	0.078	13.2		0.096	30.8		0.073	30.0	X	0.31	6.1		1.9	2.2	BJ	0.3	2.8		0.36	5.5		1.6
VSP-5	J1V8W2	4/26/16	5.3		0.20	312	X	0.072	11.2		0.089	40.6		0.068	37.1	X	0.29	6.4		2.0	3.6	J	0.32	4.7		0.36	5.7		1.7
VSP-6	J1V8W3	4/26/16	5.6		0.22	342	X	0.081	12.4		0.10	40.8		0.076	40.6	X	0.32	6.9		2.0	5.8	J	0.31	8.4		0.37	7.0		1.7
VSP-8	J1V8W5	4/26/16	5.4		0.21	365	X	0.079	11.7		0.097	44.2		0.074	40.6	X	0.31	7.2		2.0	3.0	J	0.32	4.6		0.36	6.0		1.7
VSP-9	J1V8W6	4/26/16	5.0		0.24	323	X	0.087	11.2		0.11	39.2		0.082	36.8	X	0.35	6.6		2.0	1.4	BJ	0.31	1.4		0.36	6.5		1.7
VSP-10	J1V8W7	4/26/16	6.1		0.26	392	X	0.095	12.8		0.12	45.0		0.089	41.3	X	0.38	7.2		2.1	4.6	J	0.32	5.9		0.36	6.7		1.7
VSP-11	J1V8W8	4/26/16	5.8		0.24	322	X	0.089	11.2		0.11	42.4		0.084	39.5	X	0.36	7.3		2.1	3.1	J	0.33	3.4		0.39	5.9		1.8
VSP-12	J1V8W9	4/26/16	6.4		0.24	331	X	0.088	12.3		0.11	43.9		0.082	39.6	X	0.35	6.8		2.0	4.8	J	0.32	9.9		0.36	5.1		1.7

Statistical Computation Input Data

Sample Area	Sample Number	Sample Date	Lead			Manganese			Nickel			Vanadium			Zinc			Chloride			Nitrogen in Nitrate			Nitrogen in Nitrite and Nitrate			Sulfate		
			mg/kg			mg/kg			mg/kg			mg/kg			mg/kg			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
VSP-7	J1V8W4/ J1V8X1	4/26/16	4.7			321			11.5			39.3			35.3			6.8			1.5			2.3			5.2		
VSP-1	J1V8V8	4/26/16	4.1			288			10.0			51.0			39.3			7.2			1.8			1.7			12.7		
VSP-2	J1V8V9	4/26/16	4.0			268			10.1			42.5			34.5			6.8			3.8			3.5			8.7		
VSP-3	J1V8W0	4/26/16	5.1			296			11.8			47.1			39.0			7.4			8.5			8.8			7.4		
VSP-4	J1V8W1	4/26/16	4.1			210			13.2			30.8			30.0			6.1			2.2			2.8			5.5		
VSP-5	J1V8W2	4/26/16	5.3			312			11.2			40.6			37.1			6.4			3.6			4.7			5.7		
VSP-6	J1V8W3	4/26/16	5.6			342			12.4			40.8			40.6			6.9			5.8			8.4			7.0		
VSP-8	J1V8W5	4/26/16	5.4			365			11.7			44.2			40.6			7.2			3.0			4.6			6.0		
VSP-9	J1V8W6	4/26/16	5.0			323			11.2			39.2			36.8			6.6			1.4			1.4			6.5		
VSP-10	J1V8W7	4/26/16	6.1			392			12.8			45.0			41.3			7.2			4.6			5.9			6.7		
VSP-11	J1V8W8	4/26/16	5.8			322			11.2			42.4			39.5			7.3			3.1			3.4			5.9		
VSP-12	J1V8W9	4/26/16	6.4			331			12.3			43.9			39.6			6.8			4.8			9.9			5.1		

Statistical Computations

	Lead			Manganese			Nickel			Vanadium			Zinc			Chloride			Nitrogen in Nitrate			Nitrogen in Nitrite and Nitrate			Sulfate		
95% UCL based on	Large data set (n ≥ 10), use MTCAStat lognormal distribution.			Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.			Large data set (n ≥ 10), use MTCAStat lognormal distribution.			Large data set (n ≥ 10), use MTCAStat normal distribution.			Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.			Large data set (n ≥ 10), use MTCAStat lognormal distribution.			Large data set (n ≥ 10), use MTCAStat lognormal distribution.			Large data set (n ≥ 10), use MTCAStat lognormal distribution.			Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.		
N	12			12			12			12			12			12			12			12			12		
% < Detection limit	0%			0%			0%			0%			0%			0%			0%			0%			0%		
mean	5.1			314			11.6			42.2			37.8			6.9			3.7			4.8			6.9		
st. dev.	0.79			46.6			1.0			4.9			3.26			0.39			2.1			2.9			2.1		
95% UCL on mean	5.6			338			12.2			44.8			39.4			7.1			5.4			7.7			7.9		
max value	6.4			392			13.2			51.0			41.3			7.4			8.5			9.9			12.7		
Most Stringent Cleanup Limit for nonradionuclide and RAG type (mg/kg) unless stated otherwise	10.2	GW & River Protection		512	GW Protection		19.1	GW Protection		85.1	GW Protection		67.8	River Protection		25,000	GW Protection		1,000	GW Protection		1,000	GW Protection		25,000	GW 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 (10.2 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 (19.1 mg/kg) the WAC 173-340 3-part test is not required.			Because all values are below background (85.1 mg/kg) the WAC 173-340 3-part test is not required.			Because all values are below background (67.8 mg/kg) the WAC 173-340 3-part test is not required.			Because all values are below background (100 mg/kg) the WAC 173-340 3-part test is not required.			Because all values are below background (11.8 mg/kg) the WAC 173-340 3-part test is not required.			Because all values are below background (11.8 mg/kg) the WAC 173-340 3-part test is not required.			Because all values are below background (237 mg/kg) the WAC 173-340 3-part test is not required.		

CALCULATION SHEET

Washington Closure Hanford RW
Originator R. J. Nielson
Project 100-N Field Remediation
Subject 100-N-83 Waste Site Cleanup Verification 95% UCL Calculations

Calc. No. 0100N-CA-V0294 **Rev. No.** 0
Checked J. M. Capron JMC **Date** 06/20/16
Job No. 14655 **Sheet No.** 7 of 11

100-N-83 Waste Site Statistical Calculations

Verification Data

Sample Area	Sample Number	Sample Date	Cesium-137 pCi/g	Q	MDA	Nickel-63 pCi/g	Q	MDA	Total Beta Radiostrontium pCi/g	Q	MDA
VSP-7	J1V8W4	4/26/16	0.0405		0.0235	1.61	U	6.68	-0.00686	U	0.436
Duplicate of J1V8W4	J1V8X1	4/26/16	0.0634		0.024	0.732	U	7.52	1.52		0.346
VSP-1	J1V8V8	4/26/16	0.141		0.0236	0.456	U	6.86	8.28		0.399
VSP-2	J1V8V9	4/26/16	0.251		0.0249	0.193	U	6.50	0.123	U	0.392
VSP-3	J1V8W0	4/26/16	0.110		0.0225	0.197	U	7.29	0.643		0.441
VSP-4	J1V8W1	4/26/16	0.00701	U	0.0269	-2.09	U	6.47	0.0769	U	0.445
VSP-5	J1V8W2	4/26/16	0.163		0.0248	-0.452	U	6.70	0.210	U	0.410
VSP-6	J1V8W3	4/26/16	0.394		0.0265	10.6		6.42	0.330	U	0.383
VSP-8	J1V8W5	4/26/16	0.0233	U	0.0251	0.417	U	6.05	8.90		0.403
VSP-9	J1V8W6	4/26/16	0.0433	U	0.0325	1.33	U	6.82	1.20		0.361
VSP-10	J1V8W7	4/26/16	0.150		0.0240	0.478	U	6.02	0.329	U	0.382
VSP-11	J1V8W8	4/26/16	0.430		0.0301	1.06	U	6.46	0.184	U	0.433
VSP-12	J1V8W9	4/26/16	0.0358	U	0.0302	-2.68	U	7.42	0.848		0.382

Statistical Computation Input Data

Sample Area	Sample Number	Sample Date	Cesium-137 pCi/g	Q	MDA	Nickel-63 pCi/g	Q	MDA	Total Beta Radiostrontium pCi/g	Q	MDA
VSP-7	J1V8W4/ J1V8X1	4/26/16	0.0520			1.17			0.757		
VSP-1	J1V8V8	4/26/16	0.141			0.456			8.28		
VSP-2	J1V8V9	4/26/16	0.251			0.193			0.123		
VSP-3	J1V8W0	4/26/16	0.110			0.197			0.643		
VSP-4	J1V8W1	4/26/16	0.00701			-2.09			0.0769		
VSP-5	J1V8W2	4/26/16	0.163			-0.452			0.210		
VSP-6	J1V8W3	4/26/16	0.394			10.6			0.330		
VSP-8	J1V8W5	4/26/16	0.023			0.417			8.90		
VSP-9	J1V8W6	4/26/16	0.0433			1.33			1.20		
VSP-10	J1V8W7	4/26/16	0.150			0.478			0.329		
VSP-11	J1V8W8	4/26/16	0.430			1.06			0.184		
VSP-12	J1V8W9	4/26/16	0.0358			-2.68			0.848		

Statistical Computations

95% UCL based on	Cesium-137	Nickel-63	Total Beta Radiostrontium
	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
% < Detection limit	33%	92%	50%
Mean	0.150	0.89	1.8
Standard deviation	0.142	3.3	3.2
Z-statistic	1.64	1.64	1.64
95% UCL on mean	0.217	2.46	3.33
Maximum value	0.430	10.6	8.90

MAXIMUM VALUE 3-PART TEST CALCULATION SHEET

Washington Closure Hanford
Originator R. J. Nielson RJN
Project 100-N Field Remediation
Subject 100-N-83 Waste Site Cleanup Verification 95% UCL Calculations

Calc. No. 0100N-CA-V0294 **Rev. No.** 0
Checked J. M. Capron JMC **Date** 06/20/16
Job No. 14655 **Sheet No.** 8 of 11

100-N-83 Waste Site Maximum Calculations
Verification Data

Sample Area	Sample Number	Sample Date	Antimony mg/kg	Antimony Q	Antimony PQL	Mercury mg/kg	Mercury Q	Mercury PQL	Fluoride mg/kg	Fluoride Q	Fluoride PQL
VSP-7	J1V8W4	4/26/16	0.36	UJ	0.36	0.0068	U	0.0068	0.86	UN	0.86
Duplicate of J1V8W4	J1V8X1	4/26/16	0.29	UJ	0.29	0.0061	U	0.0061	0.83	U	0.83
VSP-1	J1V8V8	4/26/16	0.29	UJ	0.29	0.0057	U	0.0057	0.79	UN	0.79
VSP-2	J1V8V9	4/26/16	0.32	UJ	0.32	0.0062	U	0.0062	0.80	U	0.80
VSP-3	J1V8W0	4/26/16	0.47	BJ	0.32	0.0066	U	0.0066	0.81	B	0.80
VSP-4	J1V8W1	4/26/16	0.30	UJ	0.30	0.0066	U	0.0066	0.78	U	0.78
VSP-5	J1V8W2	4/26/16	0.27	UJ	0.27	0.0062	U	0.0062	0.83	U	0.83
VSP-6	J1V8W3	4/26/16	0.31	UJ	0.31	0.0068	B	0.0059	0.82	U	0.82
VSP-8	J1V8W5	4/26/16	0.30	UJ	0.30	0.0057	U	0.0057	0.89	B	0.83
VSP-9	J1V8W6	4/26/16	0.33	UJ	0.33	0.0061	U	0.0061	0.80	U	0.80
VSP-10	J1V8W7	4/26/16	0.36	UJ	0.36	0.0094	B	0.0064	0.84	U	0.84
VSP-11	J1V8W8	4/26/16	0.34	UJ	0.34	0.0075	B	0.0068	0.85	U	0.85
VSP-12	J1V8W9	4/26/16	0.33	UJ	0.33	0.0076	B	0.0060	0.83	U	0.83

Statistical Computations

	Antimony			Mercury			Fluoride		
% < Detection limit	92%			67%			83%		
Maximum value	0.47			0.0094			0.89		
Most Stringent Cleanup Limit for nonradionuclide and RAG type (mg/kg) unless stated otherwise	5	GW & River Protection		0.33	GW & River Protection		96	GW Protection	
3-PART TEST									
Maximum > Cleanup Limit?	NA			NA			NA		
> 10% above Cleanup Limit?	NA			NA			NA		
Any sample > 2X Cleanup Limit?	NA			NA			NA		
3-Part Test Compliance?	Because all values are below background (5 mg/kg) the WAC 173-340 3-part test is not required.			Because all values are below background (0.33 mg/kg) the WAC 173-340 3-part test is not required.			Because all values are below background (2.81 mg/kg) the WAC 173-340 3-part test is not required.		

CALCULATION SHEET

Washington Closure Hanford
Originator R. J. Nielson
Project 100-N Field Remediation
Subject 100-N-83 Waste Site Cleanup Verification 95% UCL Calculations

Calc. No. 0100N-CA-V0294
Checked J. M. Capron
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Ecology Software (MTCAStat) Results, 100-N-83 Waste Site

Arsenic 95% UCL Calculation

DATA	ID
2.7	J1V8W4/ J1V8X1
2.9	J1V8V8
2.6	J1V8V9
3.7	J1V8W0
2.8	J1V8W1
2.3	J1V8W2
2.6	J1V8W3
2.3	J1V8W5
2.9	J1V8W6
2.4	J1V8W7
3.0	J1V8W8
2.6	J1V8W9

Number of samples		Uncensored values			
Uncensored	12	Mean	2.7		
Censored		Lognormal mean	2.7		
Detection limit or PQL		Std. devn.	0.38		
Method detection limit		Median	2.6		
TOTAL	12	Min.	2.3		
		Max.	3.7		

Lognormal distribution? Normal distribution?
r-squared is: 0.902 r-squared is: 0.857
Recommendations:
Use lognormal distribution.

UCL (Land's method) 2.9

Barium 95% UCL Calculation

DATA	ID
89.9	J1V8W4/ J1V8X1
58.5	J1V8V8
53.1	J1V8V9
54.6	J1V8W0
53.1	J1V8W1
84.5	J1V8W2
88.5	J1V8W3
89.2	J1V8W5
88.5	J1V8W6
97.7	J1V8W7
98.7	J1V8W8
86.6	J1V8W9

Number of samples		Uncensored values			
Uncensored	12	Mean	78.6		
Censored		Lognormal mean	78.9		
Detection limit or PQL		Std. devn.	18.0		
Method detection limit		Median	87.6		
TOTAL	12	Min.	53.1		
		Max.	98.7		

Lognormal distribution? Normal distribution?
r-squared is: 0.792 r-squared is: 0.817
Recommendations:
Reject BOTH lognormal and normal distributions

UCL (based on Z-statistic) is 87.1

Beryllium 95% UCL Calculation

DATA	ID
0.45	J1V8W4/ J1V8X1
0.47	J1V8V8
0.42	J1V8V9
0.47	J1V8W0
0.21	J1V8W1
0.44	J1V8W2
0.48	J1V8W3
0.52	J1V8W5
0.42	J1V8W6
0.54	J1V8W7
0.47	J1V8W8
0.47	J1V8W9

Number of samples		Uncensored values			
Uncensored	12	Mean	0.45		
Censored		Lognormal mean	0.45		
Detection limit or PQL		Std. devn.	0.082		
Method detection limit		Median	0.47		
TOTAL	12	Min.	0.21		
		Max.	0.54		

Lognormal distribution? Normal distribution?
r-squared is: 0.591 r-squared is: 0.706
Recommendations:
Reject BOTH lognormal and normal distributions

UCL (based on Z-statistic) is 0.49

Boron 95% UCL Calculation

DATA	ID
1.6	J1V8W4/ J1V8X1
1.2	J1V8V8
1.1	J1V8V9
1.6	J1V8W0
1.2	J1V8W1
2.1	J1V8W2
2.1	J1V8W3
2.0	J1V8W5
1.9	J1V8W6
1.7	J1V8W7
2.3	J1V8W8
1.9	J1V8W9

Number of samples		Uncensored values			
Uncensored	12	Mean	1.7		
Censored		Lognormal mean	1.7		
Detection limit or PQL		Std. devn.	0.40		
Method detection limit		Median	1.8		
TOTAL	12	Min.	1.1		
		Max.	2.3		

Lognormal distribution? Normal distribution?
r-squared is: 0.913 r-squared is: 0.944
Recommendations:
Use lognormal distribution.

UCL (Land's method) 2.0

Cadmium 95% UCL Calculation

DATA	ID
0.19	J1V8W4/ J1V8X1
0.16	J1V8V8
0.15	J1V8V9
0.17	J1V8W0
0.14	J1V8W1
0.24	J1V8W2
0.21	J1V8W3
0.20	J1V8W5
0.24	J1V8W6
0.24	J1V8W7
0.26	J1V8W8
0.23	J1V8W9

Number of samples		Uncensored values			
Uncensored	12	Mean	0.20		
Censored		Lognormal mean	0.20		
Detection limit or PQL		Std. devn.	0.040		
Method detection limit		Median	0.21		
TOTAL	12	Min.	0.14		
		Max.	0.26		

Lognormal distribution? Normal distribution?
r-squared is: 0.939 r-squared is: 0.948
Recommendations:
Use lognormal distribution.

UCL (Land's method) 0.23

Chromium 95% UCL Calculation

DATA	ID
13.4	J1V8W4/ J1V8X1
9.1	J1V8V8
9.2	J1V8V9
11.5	J1V8W0
14.6	J1V8W1
12.5	J1V8W2
14.5	J1V8W3
14.6	J1V8W5
13.0	J1V8W6
14.3	J1V8W7
12.6	J1V8W8
13.3	J1V8W9

Number of samples		Uncensored values			
Uncensored	12	Mean	12.7		
Censored		Lognormal mean	12.7		
Detection limit or PQL		Std. devn.	1.92		
Method detection limit		Median	13.2		
TOTAL	12	Min.	9.1		
		Max.	14.6		

Lognormal distribution? Normal distribution?
r-squared is: 0.827 r-squared is: 0.865
Recommendations:
Reject BOTH lognormal and normal distributions

UCL (based on Z-statistic) is 13.6

Cobalt 95% UCL Calculation

DATA	ID
6.1	J1V8W4/ J1V8X1
8.2	J1V8V8
7.5	J1V8V9
7.0	J1V8W0
5.9	J1V8W1
6.0	J1V8W2
6.8	J1V8W3
7.2	J1V8W5
6.4	J1V8W6
8.0	J1V8W7
6.4	J1V8W8
6.5	J1V8W9

Number of samples		Uncensored values			
Uncensored	12	Mean	6.8		
Censored		Lognormal mean	6.8		
Detection limit or PQL		Std. devn.	0.76		
Method detection limit		Median	6.7		
TOTAL	12	Min.	5.9		
		Max.	8.2		

Lognormal distribution? Normal distribution?
r-squared is: 0.958 r-squared is: 0.945
Recommendations:
Use lognormal distribution.

UCL (Land's method) 7.3

Copper 95% UCL Calculation

DATA	ID
12.6	J1V8W4/ J1V8X1
14.9	J1V8V8
13.3	J1V8V9
15.2	J1V8W0
9.8	J1V8W1
12.5	J1V8W2
14.0	J1V8W3
13.7	J1V8W5
13.1	J1V8W6
14.9	J1V8W7
12.2	J1V8W8
13.5	J1V8W9

Number of samples		Uncensored values			
Uncensored	12	Mean	13.3		
Censored		Lognormal mean	13.3		
Detection limit or PQL		Std. devn.	1.48		
Method detection limit		Median	13.4		
TOTAL	12	Min.	9.8		
		Max.	15.2		

Lognormal distribution? Normal distribution?
r-squared is: 0.868 r-squared is: 0.910
Recommendations:
Use normal distribution.

UCL (based on t-statistic) is 14.1

Hexavalent Chromium 95% UCL Calculation

DATA	ID
0.080	J1V8W4/ J1V8X1
0.23	J1V8V8
0.080	J1V8V9
0.43	J1V8W0
0.16	J1V8W1
0.27	J1V8W2
0.65	J1V8W3
0.080	J1V8W5
0.29	J1V8W6
0.46	J1V8W7
0.20	J1V8W8
0.39	J1V8W9

Number of samples		Uncensored values			
Uncensored	12	Mean	0.28		
Censored		Lognormal mean	0.29		
Detection limit or PQL		Std. devn.	0.18		
Method detection limit		Median	0.25		
TOTAL	12	Min.	0.080		
		Max.	0.65		

Lognormal distribution? Normal distribution?
r-squared is: 0.936 r-squared is: 0.932
Recommendations:
Use lognormal distribution.

UCL (Land's method) 0.50

CALCULATION SHEET

Washington Closure Hanford
Originator R. J. Nielson
Project 100-N Field Remediation
Subject 100-N-83 Waste Site Cleanup Verification 95% UCL Calculations

Calc. No. 0100N-CA-V0294
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Ecology Software (MTCAStat) Results, 100-N-83 Waste Site

Lead 95% UCL Calculation

DATA	ID
4.7	J1V8W4/ J1V8X1
4.1	J1V8V8
4.0	J1V8V9
5.1	J1V8W0
4.1	J1V8W1
5.3	J1V8W2
5.6	J1V8W3
5.4	J1V8W5
5.0	J1V8W6
6.1	J1V8W7
5.8	J1V8W8
6.4	J1V8W9

Number of samples		Uncensored values	
Uncensored	12	Mean	5.1
Censored		Lognormal mean	5.1
Detection limit or PQL		Std. devn.	0.79
Method detection limit		Median	5.2
TOTAL	12	Min.	4.0
		Max.	6.4

Lognormal distribution? Normal distribution?
r-squared is: 0.953 r-squared is: 0.966
Recommendations:
Use lognormal distribution.

UCL (Land's method) 5.6

Manganese 95% UCL Calculation

DATA	ID
321	J1V8W4/ J1V8X1
288	J1V8V8
268	J1V8V9
296	J1V8W0
210	J1V8W1
312	J1V8W2
342	J1V8W3
365	J1V8W5
323	J1V8W6
392	J1V8W7
322	J1V8W8
331	J1V8W9

Number of samples		Uncensored values	
Uncensored	12	Mean	314
Censored		Lognormal mean	315
Detection limit or PQL		Std. devn.	46.6
Method detection limit		Median	321
TOTAL	12	Min.	210
		Max.	392

Lognormal distribution? Normal distribution?
r-squared is: 0.893 r-squared is: 0.940
Recommendations:
Use normal distribution.

UCL (based on t-statistic) 338

Nickel 95% UCL Calculation

DATA	ID
11.5	J1V8W4/ J1V8X1
10.0	J1V8V8
10.1	J1V8V9
11.8	J1V8W0
13.2	J1V8W1
11.2	J1V8W2
12.4	J1V8W3
11.7	J1V8W5
11.2	J1V8W6
12.8	J1V8W7
11.2	J1V8W8
12.3	J1V8W9

Number of samples		Uncensored values	
Uncensored	12	Mean	11.6
Censored		Lognormal mean	11.6
Detection limit or PQL		Std. devn.	0.977
Method detection limit		Median	11.6
TOTAL	12	Min.	10.0
		Max.	13.2

Lognormal distribution? Normal distribution?
r-squared is: 0.956 r-squared is: 0.964
Recommendations:
Use lognormal distribution.

UCL (Land's method) 12.2

Vanadium 95% UCL Calculation

DATA	ID
39.3	J1V8W4/ J1V8X1
51.0	J1V8V8
42.5	J1V8V9
47.1	J1V8W0
30.8	J1V8W1
40.6	J1V8W2
40.8	J1V8W3
44.2	J1V8W5
39.2	J1V8W6
45.0	J1V8W7
42.4	J1V8W8
43.9	J1V8W9

Number of samples		Uncensored values	
Uncensored	12	Mean	42.2
Censored		Lognormal mean	42.3
Detection limit or PQL		Std. devn.	4.94
Method detection limit		Median	42.5
TOTAL	12	Min.	30.8
		Max.	51.0

Lognormal distribution? Normal distribution?
r-squared is: 0.877 r-squared is: 0.916
Recommendations:
Use normal distribution.

UCL (based on t-statistic) 44.8

Zinc 95% UCL Calculation

DATA	ID
35.3	J1V8W4/ J1V8X1
39.3	J1V8V8
34.5	J1V8V9
39.0	J1V8W0
30.0	J1V8W1
37.1	J1V8W2
40.6	J1V8W3
40.6	J1V8W5
36.8	J1V8W6
41.3	J1V8W7
39.5	J1V8W8
39.6	J1V8W9

Number of samples		Uncensored values	
Uncensored	12	Mean	37.8
Censored		Lognormal mean	37.8
Detection limit or PQL		Std. devn.	3.26
Method detection limit		Median	39.2
TOTAL	12	Min.	30.0
		Max.	41.3

Lognormal distribution? Normal distribution?
r-squared is: 0.842 r-squared is: 0.871
Recommendations:
Reject BOTH lognormal and normal distributions

UCL (based on Z-statistic) is 39.4

Chloride 95% UCL Calculation

DATA	ID
6.8	J1V8W4/ J1V8X1
7.2	J1V8V8
6.8	J1V8V9
7.4	J1V8W0
6.1	J1V8W1
6.4	J1V8W2
6.9	J1V8W3
7.2	J1V8W5
6.6	J1V8W6
7.2	J1V8W7
7.3	J1V8W8
6.8	J1V8W9

Number of samples		Uncensored values	
Uncensored	12	Mean	6.9
Censored		Lognormal mean	6.9
Detection limit or PQL		Std. devn.	0.39
Method detection limit		Median	6.9
TOTAL	12	Min.	6.1
		Max.	7.4

Lognormal distribution? Normal distribution?
r-squared is: 0.928 r-squared is: 0.937
Recommendations:
Use lognormal distribution.

UCL (Land's method) 7.1

Nitrogen in Nitrate 95% UCL Calculation

DATA	ID
1.5	J1V8W4/ J1V8X1
1.8	J1V8V8
3.8	J1V8V9
8.5	J1V8W0
2.2	J1V8W1
3.6	J1V8W2
5.8	J1V8W3
3.0	J1V8W5
1.4	J1V8W6
4.6	J1V8W7
3.1	J1V8W8
4.8	J1V8W9

Number of samples		Uncensored values	
Uncensored	12	Mean	3.7
Censored		Lognormal mean	3.7
Detection limit or PQL		Std. devn.	2.1
Method detection limit		Median	3.4
TOTAL	12	Min.	1.4
		Max.	8.5

Lognormal distribution? Normal distribution?
r-squared is: 0.979 r-squared is: 0.907
Recommendations:
Use lognormal distribution.

UCL (Land's method) 5.4

Nitrogen in Nitrite and Nitrate 95% UCL Calculation

DATA	ID
2.3	J1V8W4/ J1V8X1
1.7	J1V8V8
3.5	J1V8V9
8.8	J1V8W0
2.8	J1V8W1
4.7	J1V8W2
8.4	J1V8W3
4.6	J1V8W5
1.4	J1V8W6
5.9	J1V8W7
3.4	J1V8W8
9.9	J1V8W9

Number of samples		Uncensored values	
Uncensored	12	Mean	4.8
Censored		Lognormal mean	4.9
Detection limit or PQL		Std. devn.	2.9
Method detection limit		Median	4.1
TOTAL	12	Min.	1.4
		Max.	9.9

Lognormal distribution? Normal distribution?
r-squared is: 0.975 r-squared is: 0.921
Recommendations:
Use lognormal distribution.

UCL (Land's method) 7.7

Sulfate 95% UCL Calculation

DATA	ID
5.2	J1V8W4/ J1V8X1
12.7	J1V8V8
8.7	J1V8V9
7.4	J1V8W0
5.5	J1V8W1
5.7	J1V8W2
7.0	J1V8W3
6.0	J1V8W5
6.5	J1V8W6
6.7	J1V8W7
5.9	J1V8W8
5.1	J1V8W9

Number of samples		Uncensored values	
Uncensored	12	Mean	6.9
Censored		Lognormal mean	6.9
Detection limit or PQL		Std. devn.	2.1
Method detection limit		Median	6.3
TOTAL	12	Min.	5.1
		Max.	12.7

Lognormal distribution? Normal distribution?
r-squared is: 0.851 r-squared is: 0.740
Recommendations:
Reject BOTH lognormal and normal distributions

UCL (based on Z-statistic) is 7.9

CALCULATION SHEET

Washington Closure Hanford
Originator R. J. Nielson
Project 100-N Field Remediation
Subject 100-N-83 Waste Site Cleanup Verification 95% UCL Calculations

Calc. No. 0100N-CA-V0294 **Rev. No.** 0
Checked J. M. Capron **Date** 06/20/16
Job No. 14655 **Sheet No.** 11 of 11

Duplicate Analysis - 100-N-83 Waste Site

Sampling Area	Sample Number	Sample Date	Aluminum			Arsenic			Barium			Beryllium			Boron			Cadmium			Calcium			Chromium			Cobalt			Copper		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
VSP-7	J1V8W4	4/26/16	9000		1.5	2.7		0.63	92.3		0.073	0.45		0.063	1.7	B	0.94	0.18	B	0.039	3530		13.5	13.5		0.056	6.1		0.19	12.6	X	0.21
Duplicate of J1V8W4	J1V8X1	4/26/16	8760		1.2	2.6		0.50	87.4		0.057	0.44		0.050	1.5		0.74	0.20		0.031	3460		10.7	13.2		0.044	6.1		0.15	12.6	X	0.16
Split of J1V8W4	J1V8X3	4/26/16	8070	M	7.14	3.11	B	0.525	77.7		0.105	0.692		0.105	6.55		1.05	0.525	DU	0.525	3300		8.4	12.3		0.158	6.81	D	0.788	14.4		0.315

Analysis:

	TDL	Aluminum	Arsenic	Barium	Beryllium	Boron	Cadmium	Calcium	Chromium	Cobalt	Copper
		5	10	2	0.2	2	0.2	100	1	2	1
Duplicate Analysis	Both > PQL?	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**
	Both >5xTDL?	**Yes (calc RPD)**	No-Stop (acceptable)	**Yes (calc RPD)**	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	**Yes (calc RPD)**	**Yes (calc RPD)**	No-Stop (acceptable)	**Yes (calc RPD)**
	RPD	2.7%		5.5%				2.0%	2.2%		0.0%
	Difference > 2 TDL?	Not applicable	No - acceptable	Not applicable	No - acceptable	No - acceptable	No - acceptable	Not applicable	Not applicable	No - acceptable	Not applicable
Split Analysis	Both > PQL?	**Yes (continue)**	**Yes (continue)**	**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)	No-Stop (acceptable)		**Yes (calc RPD)**	**Yes (calc RPD)**	No-Stop (acceptable)	**Yes (calc RPD)**
	RPD	10.9%		17.2%				6.7%	9.3%		13.3%
	Difference > 2 TDL?	Not applicable	No - acceptable	Not applicable	No - acceptable	Yes - assess further	No - acceptable	Not applicable	Not applicable	No - acceptable	Not applicable

Duplicate Analysis - 100-N-83 Waste Site

Sampling Area	Sample Number	Sample Date	Iron			Lead			Magnesium			Manganese			Nickel			Potassium			Silicon			Sodium			Vanadium			Zinc		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
VSP-7	J1V8W4	4/26/16	20900		7.3	4.7		0.26	3980		3.5	332	X	0.096	11.7		0.12	2270		39.3	1850	XJ	5.4	166		56.5	39.2		0.090	35.1	X	0.38
Duplicate of J1V8W4	J1V8X1	4/26/16	20800		5.7	4.7		0.20	3870		2.8	309	X	0.076	11.2		0.093	2200		31.0	1220	XJ	4.3	168		44.6	39.3		0.071	35.5	X	0.30
Split of J1V8W4	J1V8X3	4/26/16	20400	M	8.4	3.83		0.347	4260		8.93	322	M	0.21	10.3		0.158	1950		6.72	1150	M	1.58	116		7.35	49.7	D	0.525	46.4	D	2.1

Analysis:

	TDL	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Silicon	Sodium	Vanadium	Zinc
		5	5	75	5	4	400	2	50	2.5	1
Duplicate Analysis	Both > PQL?	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**
	Both >5xTDL?	**Yes (calc RPD)**	No-Stop (acceptable)	**Yes (calc RPD)**	**Yes (calc RPD)**	No-Stop (acceptable)	**Yes (calc RPD)**	**Yes (calc RPD)**	No-Stop (acceptable)	**Yes (calc RPD)**	**Yes (calc RPD)**
	RPD	0.5%		2.8%	7.2%		3.1%	*41.0%*		0.3%	1.1%
	Difference > 2 TDL?	Not applicable	No - acceptable	Not applicable	Not applicable	No - acceptable	Not applicable	Not applicable	No - acceptable	Not applicable	Not applicable
Split Analysis	Both > PQL?	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**
	Both >5xTDL?	**Yes (calc RPD)**	No-Stop (acceptable)	**Yes (calc RPD)**	**Yes (calc RPD)**	No-Stop (acceptable)	No-Stop (acceptable)	**Yes (calc RPD)**	No-Stop (acceptable)	**Yes (calc RPD)**	**Yes (calc RPD)**
	RPD	2.4%		6.8%	3.1%			*46.7%*		23.6%	27.7%
	Difference > 2 TDL?	Not applicable	No - acceptable	Not applicable	Not applicable	No - acceptable	No - acceptable	Not applicable	No - acceptable	Not applicable	Not applicable

Duplicate Analysis - 100-N-83 Waste Site

Sampling Area	Sample Number	Sample Date	Chloride			Nitrogen in Nitrate			Nitrogen in Nitrite and Nitrate			Phosphorous in Phosphate			Sulfate			Cesium-137			Potassium-40			Radium-226		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
VSP-7	J1V8W4	4/26/16	6.8	N	2.1	1.4	BJ	0.33	2.1		0.38	1.8	BMJ	1.3	4.9	B	1.8	0.0405		0.0235	14.7		0.253	0.596		0.0407
Duplicate of J1V8W4	J1V8X1	4/26/16	6.8		2.0	1.6	BJ	0.32	2.4		0.37	2.2	BJ	1.3	5.4		1.7	0.0634		0.024	14.1		0.201	0.65		0.0378
Split of J1V8W4	J1V8X3	4/26/16	1.14	B	0.711	1.92		0.35	1.79		0.178	1.8	B	0.711	2.74	B	1.41	0.031	U	0.10	16.996		1.45	0.892		0.24

Analysis:

	TDL	Chloride	Nitrogen in Nitrate	Nitrogen in Nitrite and Nitrate	Phosphorous in Phosphate	Sulfate	Cesium-137	Potassium-40	Radium-226
		2	0.75	0.75	5	5	0.1	0.5	0.1
Duplicate Analysis	Both > PQL?	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**
	Both >5xTDL?	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	**Yes (calc RPD)**	**Yes (calc RPD)**
	RPD							4.2%	8.7%
	Difference > 2 TDL?	No - acceptable	No - acceptable	No - acceptable	No - acceptable	No - acceptable	No - acceptable	Not applicable	Not applicable
Split Analysis	Both > PQL?	**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)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)		**Yes (calc RPD)**	**Yes (calc RPD)**
	RPD							14.5%	*39.8%*
	Difference > 2 TDL?	Yes - assess further	No - acceptable	No - acceptable	No - acceptable	No - acceptable	No - acceptable	Not applicable	Not applicable

Attachment 1. 100-N-83 Verification Sample Results (Metals).

Sample Location	HEIS Number	Sample Date	Aluminum			Antimony			Arsenic			Barium			Beryllium			Boron		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
VSP-7	J1V8W4	4/26/16	9000		1.5	0.36	UJ	0.36	2.7		0.63	92.3		0.073	0.45		0.063	1.7	B	0.94
Duplicate of J1V8W4	J1V8X1	4/26/16	8760		1.2	0.29	UJ	0.29	2.6		0.50	87.4		0.057	0.44		0.050	1.5		0.74
VSP-1	J1V8V8	4/26/16	6720		1.2	0.29	UJ	0.29	2.9	M	0.50	58.5		0.057	0.47	B	0.12	1.2	BM	0.74
VSP-2	J1V8V9	4/26/16	6580		1.3	0.32	UJ	0.32	2.6		0.56	53.1		0.064	0.42		0.056	1.1	B	0.83
VSP-3	J1V8W0	4/26/16	7560		1.3	0.47	BJ	0.32	3.7		0.56	54.6		0.064	0.47		0.056	1.6	B	0.83
VSP-4	J1V8W1	4/26/16	7040		1.2	0.30	UJ	0.30	2.8		0.52	53.1		0.059	0.21		0.026	1.2	B	0.77
VSP-5	J1V8W2	4/26/16	8470		1.1	0.27	UJ	0.27	2.3		0.48	84.5		0.055	0.44		0.048	2.1		0.71
VSP-6	J1V8W3	4/26/16	9600		1.3	0.31	UJ	0.31	2.6		0.54	88.5		0.062	0.48		0.054	2.1		0.80
VSP-8	J1V8W5	4/26/16	10800		1.2	0.30	UJ	0.30	2.3		0.52	89.2		0.060	0.52		0.052	2.0		0.77
VSP-9	J1V8W6	4/26/16	8960		1.4	0.33	UJ	0.33	2.9		0.58	88.5		0.066	0.42		0.058	1.9		0.86
VSP-10	J1V8W7	4/26/16	10400		1.5	0.36	UJ	0.36	2.4		0.62	97.7		0.072	0.54		0.062	1.7	B	0.93
VSP-11	J1V8W8	4/26/16	9390		1.4	0.34	UJ	0.34	3.0		0.59	98.7		0.068	0.47		0.059	2.3		0.88
VSP-12	J1V8W9	4/26/16	8980		1.4	0.33	UJ	0.33	2.6		0.58	86.6		0.067	0.47		0.058	1.9		0.86
Split of J1V8W4	J1V8X3	4/26/16	8070	M	7.14	1.73	DU	1.73	3.11	B	0.525	77.7		0.105	0.692		0.105	6.55		1.05
Equipment blank	J1V8X2	4/26/16	171		1.1	0.27	UJ	0.27	0.68	B	0.46	1.8		0.053	0.023	B	0.023	0.69	U	0.69
FS-1	J1V8X0	4/26/16	9440		1.1	0.75	J	0.27	2.6		0.47	79.8		0.054	0.34		0.023	1.5		0.69

Acronyms and notes apply to all of the tables in this attachment.
Note: All qualifed data are considered acceptable values.

B = Estimated result. Result is less than the RL, but greater than the MDL.
C = The analyte was detected in both the sample and the associated QC blank, and the concentration was </=5 times the blank.
D = Results are reported from a diluted aliquot of sample.
J = Estimated result
HEIS = Hanford Environmental Information System
M = Sample duplicate precision not met.
MDL = method detection limit
N (metals) = Recovery exceeds upper or lower control limits.
N (anions) = MS, MSD: Spike recovery is outside acceptance limits.
PQL = practical quantitation limit
Q = qualifier
U = analyzed for but not detected
X = Serial dilution in the analytical batch indicates that physical and chemical interferences are present.

Attachment	1	Sheet No.	1 of 6
Originator	R. J. Nielson	Date	06/20/16
Checked	J. M. Capron	Job No.	14655
Calc. No.	0100N-CA-V0294	Rev. No.	0

Attachment 1. 100-N-83 Verification Sample Results (Metals).

Sample Location	HEIS Number	Sample Date	Cadmium			Calcium			Chromium			Cobalt			Copper			Hexavalent Chromium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
VSP-7	J1V8W4	4/26/16	0.18	B	0.039	3530		13.5	13.5		0.056	6.1		0.19	12.6	X	0.21	0.16	UJ	0.16
Duplicate of J1V8W4	J1V8X1	4/26/16	0.20		0.031	3460		10.7	13.2		0.044	6.1		0.15	12.6	X	0.16	0.16	UJ	0.16
VSP-1	J1V8V8	4/26/16	0.16		0.031	7850		10.6	9.1		0.044	8.2		0.38	14.9	X	0.16	0.23	BJ	0.16
VSP-2	J1V8V9	4/26/16	0.15	B	0.035	6620		11.9	9.2		0.049	7.5		0.17	13.3	X	0.18	0.16	UJ	0.16
VSP-3	J1V8W0	4/26/16	0.17		0.035	8930		11.9	11.5		0.049	7.0		0.17	15.2	X	0.18	0.43	BJ	0.16
VSP-4	J1V8W1	4/26/16	0.14	B	0.032	3580		11.0	14.6		0.045	5.9		0.078	9.8	X	0.17	0.16	BJ	0.16
VSP-5	J1V8W2	4/26/16	0.24		0.030	3480		10.2	12.5		0.042	6.0		0.14	12.5	X	0.16	0.27	BJ	0.16
VSP-6	J1V8W3	4/26/16	0.21		0.033	3570		11.5	14.5		0.047	6.8		0.16	14.0	X	0.18	0.65	BJ	0.16
VSP-8	J1V8W5	4/26/16	0.20		0.032	3480		11.1	14.6		0.046	7.2		0.16	13.7	X	0.17	0.16	UJ	0.16
VSP-9	J1V8W6	4/26/16	0.24		0.036	3410		12.3	13.0		0.051	6.4		0.17	13.1	X	0.19	0.29	BJ	0.16
VSP-10	J1V8W7	4/26/16	0.24		0.039	3520		13.3	14.3		0.055	8.0		0.19	14.9	X	0.21	0.46	BJ	0.16
VSP-11	J1V8W8	4/26/16	0.26		0.037	3920		12.6	12.6		0.052	6.4		0.18	12.2	X	0.19	0.20	BJ	0.17
VSP-12	J1V8W9	4/26/16	0.23		0.036	3500		12.4	13.3		0.051	6.5		0.18	13.5	X	0.19	0.39	BJ	0.16
Split of J1V8W4	J1V8X3	4/26/16	0.525	DU	0.525	3300		8.4	12.3		0.158	6.81	D	0.788	14.4		0.315	0.191	B	0.126
Equipment blank	J1V8X2	4/26/16	0.029	U	0.029	28.7	B	9.9	0.17	CUJ	0.041	0.070	U	0.070	0.15	UX	0.15	0.15	UJ	0.15
FS-1	J1V8X0	4/26/16	0.21		0.029	3700		10.0	15.0		0.041	9.3		0.071	14.1	X	0.15	0.16	UJ	0.16

Sample Location	HEIS Number	Sample Date	Iron			Lead			Magnesium			Manganese			Mercury			Molybdenum		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
VSP-7	J1V8W4	4/26/16	20900		7.3	4.7		0.26	3980		3.5	332	X	0.096	0.0068	U	0.0068	0.25	U	0.25
Duplicate of J1V8W4	J1V8X1	4/26/16	20800		5.7	4.7		0.20	3870		2.8	309	X	0.076	0.0061	U	0.0061	0.20	U	0.20
VSP-1	J1V8V8	4/26/16	26000		14.3	4.1		0.20	4650		2.8	288	X	0.075	0.0057	U	0.0057	0.20	U	0.20
VSP-2	J1V8V9	4/26/16	22100		6.4	4.0		0.23	4580		3.1	268	X	0.084	0.0062	U	0.0062	0.22	U	0.22
VSP-3	J1V8W0	4/26/16	22900		6.4	5.1		0.23	5050		3.1	296	X	0.084	0.0066	U	0.0066	0.22	U	0.22
VSP-4	J1V8W1	4/26/16	14600		3.0	4.1		0.21	4050		2.9	210	X	0.078	0.0066	U	0.0066	0.20	U	0.20
VSP-5	J1V8W2	4/26/16	20700		5.5	5.3		0.20	3730		2.7	312	X	0.072	0.0062	U	0.0062	0.19	U	0.19
VSP-6	J1V8W3	4/26/16	22000		6.2	5.6		0.22	3870		3.0	342	X	0.081	0.0068	B	0.0059	0.21	U	0.21
VSP-8	J1V8W5	4/26/16	23700		6.0	5.4		0.21	3940		2.9	365	X	0.079	0.0057	U	0.0057	0.20	U	0.20
VSP-9	J1V8W6	4/26/16	21000		6.6	5.0		0.24	3780		3.2	323	X	0.087	0.0061	U	0.0061	0.23	U	0.23
VSP-10	J1V8W7	4/26/16	24600		7.2	6.1		0.26	4170		3.5	392	X	0.095	0.0094	B	0.0064	0.25	U	0.25
VSP-11	J1V8W8	4/26/16	21500		6.8	5.8		0.24	3870		3.3	322	X	0.089	0.0075	B	0.0068	0.23	U	0.23
VSP-12	J1V8W9	4/26/16	22400		6.7	6.4		0.24	3810		3.2	331	X	0.088	0.0076	B	0.0060	0.23	U	0.23
Split of J1V8W4	J1V8X3	4/26/16	20400	M	8.4	3.83		0.347	4260		8.93	322	M	0.21	0.0042	U	0.0042	0.21	U	0.21
Equipment blank	J1V8X2	4/26/16	247		2.7	0.28	B	0.19	19.9		2.6	5.1	X	0.070	0.0060	U	0.0060	0.18	U	0.18
FS-1	J1V8X0	4/26/16	22500		2.7	4.9		0.19	3740		2.6	353	X	0.071	0.0062	U	0.0062	0.18	U	0.18

Attachment	1	Sheet No.	2 of 6
Originator	R. J. Nielson	Date	06/20/16
Checked	J. M. Capron	Job No.	14655
Calc. No.	0100N-CA-V0294	Rev. No.	0

Attachment 1. 100-N-83 Verification Sample Results (Metals).

Sample Location	HEIS Number	Sample Date	Nickel			Potassium			Selenium			Silicon			Silver			Sodium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
VSP-7	J1V8W4	4/26/16	11.7		0.12	2270		39.3	0.82	U	0.82	1850	XJ	5.4	0.15	U	0.15	166		56.5
Duplicate of J1V8W4	J1V8X1	4/26/16	11.2		0.093	2200		31.0	0.65	U	0.65	1220	XJ	4.3	0.12	U	0.12	168		44.6
VSP-1	J1V8V8	4/26/16	10.0		0.092	1350		30.8	0.65	U	0.65	1760	XNJ	4.3	0.12	U	0.12	366		44.3
VSP-2	J1V8V9	4/26/16	10.1		0.10	1280		34.6	0.73	U	0.73	1520	XJ	4.8	0.13	U	0.13	332		49.8
VSP-3	J1V8W0	4/26/16	11.8		0.10	1750		34.5	0.72	U	0.72	2170	XJ	4.8	0.13	U	0.13	324		49.7
VSP-4	J1V8W1	4/26/16	13.2		0.096	1570		32.0	0.67	U	0.67	951	XJ	4.4	0.13	U	0.13	167		46.1
VSP-5	J1V8W2	4/26/16	11.2		0.089	2440		29.7	0.62	U	0.62	1360	XJ	4.1	0.12	U	0.12	219		42.7
VSP-6	J1V8W3	4/26/16	12.4		0.10	2430		33.4	0.70	U	0.70	1470	XJ	4.6	0.13	U	0.13	191		48.0
VSP-8	J1V8W5	4/26/16	11.7		0.097	2470		32.2	0.68	U	0.68	1830	XJ	4.4	0.13	U	0.13	188		46.4
VSP-9	J1V8W6	4/26/16	11.2		0.11	2450		35.8	0.75	U	0.75	1890	XJ	4.9	0.14	U	0.14	171		51.6
VSP-10	J1V8W7	4/26/16	12.8		0.12	2480		38.8	0.81	U	0.81	1930	XJ	5.4	0.15	U	0.15	169		55.8
VSP-11	J1V8W8	4/26/16	11.2		0.11	2430		36.6	0.77	U	0.77	1520	XJ	5.1	0.14	U	0.14	250		52.7
VSP-12	J1V8W9	4/26/16	12.3		0.11	2480		36.0	0.75	U	0.75	1400	XJ	5.0	0.14	U	0.14	186		51.7
Split of J1V8W4	J1V8X3	4/26/16	10.3		0.158	1950		6.72	0.347	DU	0.347	1150	M	1.58	1.14		0.105	116		7.35
Equipment blank	J1V8X2	4/26/16	0.086	U	0.086	49.0	B	28.7	0.60	U	0.60	134	XJ	4.0	0.11	U	0.11	41.3	U	41.3
FS-1	J1V8X0	4/26/16	11.5		0.087	2280		29.0	0.61	U	0.61	1440	XJ	4.0	0.11	U	0.11	286		41.7

Sample Location	HEIS Number	Sample Date	Vanadium			Zinc		
			mg/kg	Q	PQL	mg/kg	Q	PQL
VSP-7	J1V8W4	4/26/16	39.2		0.09	35.1	X	0.38
Duplicate of J1V8W4	J1V8X1	4/26/16	39.3		0.071	35.5	X	0.30
VSP-1	J1V8V8	4/26/16	51.0		0.071	39.3	X	0.30
VSP-2	J1V8V9	4/26/16	42.5		0.079	34.5	X	0.34
VSP-3	J1V8W0	4/26/16	47.1		0.079	39.0	X	0.34
VSP-4	J1V8W1	4/26/16	30.8		0.073	30.0	X	0.31
VSP-5	J1V8W2	4/26/16	40.6		0.068	37.1	X	0.29
VSP-6	J1V8W3	4/26/16	40.8		0.076	40.6	X	0.32
VSP-8	J1V8W5	4/26/16	44.2		0.074	40.6	X	0.31
VSP-9	J1V8W6	4/26/16	39.2		0.082	36.8	X	0.35
VSP-10	J1V8W7	4/26/16	45.0		0.089	41.3	X	0.38
VSP-11	J1V8W8	4/26/16	42.4		0.084	39.5	X	0.36
VSP-12	J1V8W9	4/26/16	43.9		0.082	39.6	X	0.35
Split of J1V8W4	J1V8X3	4/26/16	49.7	D	0.525	46.4	D	2.1
Equipment blank	J1V8X2	4/26/16	0.25	B	0.066	0.69	BX	0.28
FS-1	J1V8X0	4/26/16	48.6		0.067	39.4	X	0.28

Attachment	1	Sheet No.	3 of 6
Originator	R. J. Nielson	Date	06/20/16
Checked	J. M. Capron	Job No.	14655
Calc. No.	0100N-CA-V0294	Rev. No.	0

Attachment 1. 100-N-83 Verification Sample Results (Anions).

Sample Location	HEIS Number	Sample Date	Bromide			Chloride			Fluoride			Nitrogen in Nitrate			Nitrogen in Nitrite and Nitrate			Nitrogen in Nitrite		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
VSP-7	J1V8W4	4/26/16	0.41	U	0.41	6.8	N	2.1	0.86	UN	0.86	1.4	BJ	0.33	2.1		0.38	0.35	UJ	0.35
Duplicate of J1V8W4	J1V8X1	4/26/16	0.39	U	0.39	6.8		2.0	0.83	U	0.83	1.6	BJ	0.32	2.4		0.37	0.34	UJ	0.34
VSP-1	J1V8V8	4/26/16	0.38	U	0.38	7.2	N	1.9	0.79	UN	0.79	1.8	BJ	0.30	1.7		0.36	0.33	UJ	0.33
VSP-2	J1V8V9	4/26/16	0.38	U	0.38	6.8		1.9	0.80	U	0.80	3.8	J	0.31	3.5		0.36	0.33	UJ	0.33
VSP-3	J1V8W0	4/26/16	0.38	U	0.38	7.4		2.0	0.81	B	0.80	8.5	J	0.31	8.8		0.36	0.33	UJ	0.33
VSP-4	J1V8W1	4/26/16	0.37	U	0.37	6.1		1.9	0.78	U	0.78	2.2	BJ	0.30	2.8		0.36	0.32	UJ	0.32
VSP-5	J1V8W2	4/26/16	0.39	U	0.39	6.4		2.0	0.83	U	0.83	3.6	J	0.32	4.7		0.36	0.34	UJ	0.34
VSP-6	J1V8W3	4/26/16	0.39	U	0.39	6.9		2.0	0.82	U	0.82	5.8	J	0.31	8.4		0.37	0.33	UJ	0.33
VSP-8	J1V8W5	4/26/16	0.39	U	0.39	7.2		2.0	0.89	B	0.83	3.0	J	0.32	4.6		0.36	0.34	UJ	0.34
VSP-9	J1V8W6	4/26/16	0.38	U	0.38	6.6		2.0	0.80	U	0.80	1.4	BJ	0.31	1.4		0.36	0.33	UJ	0.33
VSP-10	J1V8W7	4/26/16	0.40	U	0.40	7.2		2.1	0.84	U	0.84	4.6	J	0.32	5.9		0.36	0.35	UJ	0.35
VSP-11	J1V8W8	4/26/16	0.40	U	0.40	7.3		2.1	0.85	U	0.85	3.1	J	0.33	3.4		0.39	0.35	UJ	0.35
VSP-12	J1V8W9	4/26/16	0.40	U	0.40	6.8		2.0	0.83	U	0.83	4.8	J	0.32	9.9		0.36	0.34	UJ	0.34
Split of J1V8W4	J1V8X3	4/26/16	0.711	U	0.711	1.14	B	0.711	0.635	B	0.35	1.92		0.35	1.79		0.178	0.35	U	0.35
Equipment blank	J1V8X2	4/26/16	0.38	U	0.38	7.4		2.0	0.80	U	0.80	0.31	UJ	0.31	0.36	U	0.36	0.33	UJ	0.33
FS-1	J1V8X0	4/26/16	0.39	U	0.39	7.1		2.0	1.5	B	0.82	3.2	J	0.31	4.2		0.36	0.34	UJ	0.34

Sample Location	HEIS Number	Sample Date	Phosphorous in Phosphate			Sulfate			% Moisture (wet sample)			pH Measurement		
			mg/kg	Q	PQL	mg/kg	Q	PQL	%	Q	PQL	pH	Q	PQL
VSP-7	J1V8W4	4/26/16	1.8	BMJ	1.3	4.9	B	1.8	5.8		0	7.54	J	0.10
Duplicate of J1V8W4	J1V8X1	4/26/16	2.2	BJ	1.3	5.4		1.7	5.6		0	7.34	J	0.10
VSP-1	J1V8V8	4/26/16	1.4	BJ	1.2	12.7	N	1.6	1.5		0	8.72	J	0.10
VSP-2	J1V8V9	4/26/16	1.9	BJ	1.2	8.7		1.7	2.1		0	8.67	J	0.10
VSP-3	J1V8W0	4/26/16	2.4	BJ	1.2	7.4		1.7	2.4		0	8.24	J	0.10
VSP-4	J1V8W1	4/26/16	1.8	BJ	1.2	5.5		1.6	1.2		0	8.34	J	0.10
VSP-5	J1V8W2	4/26/16	2.8	BJ	1.2	5.7		1.7	2.0		0	7.35	J	0.10
VSP-6	J1V8W3	4/26/16	3.2	BJ	1.2	7.0		1.7	2.1		0	7.35	J	0.10
VSP-8	J1V8W5	4/26/16	1.6	BJ	1.2	6.0		1.7	1.3		0	7.19	J	0.10
VSP-9	J1V8W6	4/26/16	2.6	BJ	1.2	6.5		1.7	1.8		0	7.43	J	0.10
VSP-10	J1V8W7	4/26/16	1.4	BJ	1.3	6.7		1.7	4.0		0	7.10	J	0.10
VSP-11	J1V8W8	4/26/16	2.7	BJ	1.3	5.9		1.8	8.8		0	7.90	J	0.10
VSP-12	J1V8W9	4/26/16	3.1	BJ	1.3	5.1		1.7	2.9		0	7.09	J	0.10
Split of J1V8W4	J1V8X3	4/26/16	1.8	B	0.711	2.74	B	1.41				8.0	X	0.010
Equipment blank	J1V8X2	4/26/16	1.2	UJ	1.2	4.4	B	1.7	0.10	U	0	6.79	J	0.10
FS-1	J1V8X0	4/26/16	2.9	BJ	1.2	13.9		1.7	2.9		0	8.68	J	0.10

Attachment	1	Sheet No.	4 of 6
Originator	R. J. Nielson	Date	06/20/16
Checked	J. M. Capron	Job No.	14655
Calc. No.	0100N-CA-V0294	Rev. No.	0

Attachment 1. 100-N-83 Verification Sample Results (Radionuclides).

Sample Location	HEIS Number	Sample Date	Americium-241			Bismuth-214			Cesium-137			Cobalt-60			Europium-152			Europium-154		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
VSP-7	J1V8W4	4/26/16	-0.00378	U	0.0278				0.0405		0.0235	-0.00854	U	0.0261	0.0184	U	0.0488	-0.0219	U	0.0774
Duplicate of J1V8W4	J1V8X1	4/26/16	0.00644	U	0.0337				0.0634		0.0240	0.00699	U	0.0263	-0.00880	U	0.0478	0.0389	U	0.0826
VSP-1	J1V8V8	4/26/16	0.0308	U	0.176				0.141		0.0236	0.0143	U	0.0271	0.0220	U	0.0579	-0.0350	U	0.0741
VSP-2	J1V8V9	4/26/16	0.00339	U	0.0300				0.251		0.0249	0.0174	U	0.0311	-0.00463	U	0.0489	0.00310	U	0.0881
VSP-3	J1V8W0	4/26/16	0.00016	U	0.0256				0.110		0.0225	0.0116	U	0.0285	0.00330	U	0.0494	0.00800	U	0.0839
VSP-4	J1V8W1	4/26/16	-0.00817	U	0.0350				0.00701	U	0.0269	0.00404	U	0.0303	-0.0444	U	0.0461	0.00424	U	0.0905
VSP-5	J1V8W2	4/26/16	0.00950	U	0.191				0.163		0.0248	0.00303	U	0.0267	-0.0210	U	0.0588	-0.00678	U	0.0824
VSP-6	J1V8W3	4/26/16	0.00877	U	0.0341				0.394		0.0265	0.0181	U	0.0337	-0.0265	U	0.0518	-0.0334	U	0.0876
VSP-8	J1V8W5	4/26/16	0.00516	U	0.0342				0.0233	U	0.0251	0.00378	U	0.0248	-0.00983	U	0.0515	0.00947	U	0.0820
VSP-9	J1V8W6	4/26/16	0.00885	U	0.0373				0.0433	U	0.0325	-0.00570	U	0.0258	-0.00055	U	0.0528	0.0265	U	0.0949
VSP-10	J1V8W7	4/26/16	-0.0829	U	0.181				0.150		0.0240	0.00390	U	0.0274	-0.0316	U	0.0607	0.0155	U	0.0806
VSP-11	J1V8W8	4/26/16	-0.00523	U	0.0377				0.430		0.0301	0.0964	U	0.0488	-0.00729	U	0.0619	0.00857	U	0.105
VSP-12	J1V8W9	4/26/16	0.00307	U	0.0282				0.0358	U	0.0302	0.00765	U	0.0284	-0.00384	U	0.0478	0.0137	U	0.0844
Split of J1V8W4	J1V8X3	4/26/16	0.073	U	0.11	0.892		0.24	0.031	U	0.10	0.028	U	0.10	-1.659	U	0.23	-0.051	U	0.12
Equipment blank	J1V8X2	4/26/16	0.0102	U	0.116				-0.00724	U	0.0138	-0.00055	U	0.0159	-0.00349	U	0.0383	-0.0218	U	0.0464
FS-1	J1V8X0	4/26/16	0.00379	U	0.0394				4.16		0.0265	0.156		0.0263	0.00729	U	0.0704	-0.0388	U	0.0849

Sample Location	HEIS Number	Sample Date	Europium-155			Lead-212			Lead-214			Nickel-63			Plutonium-238			Plutonium-239/240		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
VSP-7	J1V8W4	4/26/16	0.0253	U	0.0440							1.61	U	6.68	-0.00330	U	0.0587	-0.000550	U	0.0456
Duplicate of J1V8W4	J1V8X1	4/26/16	0.0385	U	0.0502							0.732	U	7.52	-0.000570	U	0.0482	0.0137	U	0.0482
VSP-1	J1V8V8	4/26/16	0.0645	U	0.0739							0.456	U	6.86	-0.00280	U	0.0708	-0.0007	U	0.0591
VSP-2	J1V8V9	4/26/16	0.0597	U	0.0461							0.193	U	6.50	0.00966	U	0.0683	0.0284	U	0.0560
VSP-3	J1V8W0	4/26/16	0.0235	U	0.0427							0.197	U	7.29	-0.00343	U	0.0589	0.0542	U	0.0570
VSP-4	J1V8W1	4/26/16	0.0412	U	0.0514							-2.09	U	6.47	0.0114	U	0.0654	0.0300	U	0.0508
VSP-5	J1V8W2	4/26/16	0.0806	U	0.0788							-0.452	U	6.70	-0.00290	U	0.0611	-0.00174	U	0.0562
VSP-6	J1V8W3	4/26/16	0.0338	U	0.0484							10.6		6.42	-0.00576	U	0.0695	-0.00058	U	0.0486
VSP-8	J1V8W5	4/26/16	0.0452	U	0.0494							0.417	U	6.05	0.0132	U	0.0639	-0.00189	U	0.0610
VSP-9	J1V8W6	4/26/16	0.0479	U	0.0542							1.33	U	6.82	0.0115	U	0.0661	0.0431	U	0.0615
VSP-10	J1V8W7	4/26/16	0.0656	U	0.0797							0.478	U	6.02	0.0146	U	0.0476	0.0437	U	0.0545
VSP-11	J1V8W8	4/26/16	0.0510	U	0.0554							1.06	U	6.46	0.00	U	0.0514	0.0292	U	0.0556
VSP-12	J1V8W9	4/26/16	0.0110	U	0.0431							-2.68	U	7.42	0.0150	U	0.0528	-0.00125	U	0.0571
Split of J1V8W4	J1V8X3	4/26/16	0.39		0.22	1.093		0.25	0.762		0.25	-0.77	U	2.33	0.101	U	0.10	0.011	U	0.090
Equipment blank	J1V8X2	4/26/16	0.0441	U	0.0472							0.694	U	6.66	-0.00114	U	0.0520	1.34		0.0481
FS-1	J1V8X0	4/26/16	0.0476	U	0.0596							1.02	U	6.31	-0.00131	U	0.0599	0.0151	U	0.0599

Attachment	1	Sheet No.	5 of 6
Originator	R. J. Nielson	Date	06/20/16
Checked	J. M. Capron	Job No.	14655
Calc. No.	0100N-CA-V0294	Rev. No.	0

Attachment 1. 100-N-83 Verification Sample Results (Radionuclides).

Sample Location	HEIS Number	Sample Date	Potassium-40			Protactinium-234m			Radium-226			Thallium-208			Thorium-234			Total Beta Radiostrontium		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
VSP-7	J1V8W4	4/26/16	14.7		0.253				0.596		0.0407							-0.00686	U	0.436
Duplicate of J1V8W4	J1V8X1	4/26/16	14.1		0.201				0.650		0.0378							1.52		0.346
VSP-1	J1V8V8	4/26/16	14.1		0.202				0.504		0.0384							8.28		0.399
VSP-2	J1V8V9	4/26/16	13.8		0.242				0.494		0.0415							0.123	U	0.392
VSP-3	J1V8W0	4/26/16	14.1		0.236				0.502		0.0366							0.643		0.441
VSP-4	J1V8W1	4/26/16	17.6		0.204				0.629		0.0400							0.0769	U	0.445
VSP-5	J1V8W2	4/26/16	16.2		0.239				0.659		0.0414							0.210	U	0.410
VSP-6	J1V8W3	4/26/16	14.6		0.268				0.627		0.0457							0.330	U	0.383
VSP-8	J1V8W5	4/26/16	14.4		0.216				0.599		0.0407							8.90		0.403
VSP-9	J1V8W6	4/26/16	15.1		0.210				0.695		0.0431							1.20		0.361
VSP-10	J1V8W7	4/26/16	14.8		0.210				0.593		0.0482							0.329	U	0.382
VSP-11	J1V8W8	4/26/16	14.4		0.242				0.734		0.0479							0.184	U	0.433
VSP-12	J1V8W9	4/26/16	15.0		0.197				0.673		0.0401							0.848		0.382
Split of J1V8W4	J1V8X3	4/26/16	16.996		1.45	5.348	U	10.96	0.892		0.24	1.05		0.36	0.651	U	1.13	0.432	U	0.71
Equipment blank	J1V8X2	4/26/16	3.61		0.111				0.191		0.0288							0.515		0.426
FS-1	J1V8X0	4/26/16	15.2		0.199				0.721		0.0480							0.221	U	0.378

Sample Location	HEIS Number	Sample Date	Tritium			Uranium-235		
			pCi/g	Q	MDA	pCi/g	Q	MDA
VSP-7	J1V8W4	4/26/16	0.105	UJ	0.368			
Duplicate of J1V8W4	J1V8X1	4/26/16	0.141	UJ	0.353			
VSP-1	J1V8V8	4/26/16	0.00660	UJ	0.295			
VSP-2	J1V8V9	4/26/16	0.151	UJ	0.304			
VSP-3	J1V8W0	4/26/16	-0.0537	UJ	0.321			
VSP-4	J1V8W1	4/26/16	0.0881	UJ	0.325			
VSP-5	J1V8W2	4/26/16	0.171	UJ	0.323			
VSP-6	J1V8W3	4/26/16	0.0661	UJ	0.321			
VSP-8	J1V8W5	4/26/16	-0.105	UJ	0.339			
VSP-9	J1V8W6	4/26/16	0.0401	UJ	0.331			
VSP-10	J1V8W7	4/26/16	-0.0388	UJ	0.353			
VSP-11	J1V8W8	4/26/16	0.224	UJ	0.381			
VSP-12	J1V8W9	4/26/16	0.177	UJ	0.333			
Split of J1V8W4	J1V8X3	4/26/16	0.188	U	3.89	0.084	U	0.51
Equipment blank	J1V8X2	4/26/16	0.0534	UJ	0.282			
FS-1	J1V8X0	4/26/16	0.0774	UJ	0.344			

Attachment	1	Sheet No.	6 of 6
Originator	R. J. Nielson	Date	06/20/16
Checked	J. M. Capron	Job No.	14655
Calc. No.	0100N-CA-V0294	Rev. No.	0

Acrobat 8.0

CALCULATION COVER SHEET

Project Title: 100-N Field Remediation **Job No. 14655**

Area: 100-N

Discipline: Environmental *Calculation No: 0100N-CA-V0295

waste Re 08/08/16

Subject: 100-N-83 Direct Contact Hazard Quotient and Carcinogenic Risk Calculations, and Sum of Fractions Calc

1

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 = ~~4~~ 5 Total = ~~5~~ 6	R. J. Nielson	J. M. Capron	B. L. Vedder	S. G. Wilkinson	8/4/16
	RJN	6/30/2016				

SUMMARY OF REVISION

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

Washington Closure Hanford CALCULATION SHEET

Originator:	R. J. Nielson	Date:	6/20/2016	Calc. No.:	0100N-CA-V0295	Rev.:	0
Project:	100-N Field Remediation	Job No:	14655	Checked:	J. M. Capron	Date:	6/20/2016
Subject:	100-N-83 Waste Site Direct Contact Hazard Quotient and Carcinogenic Risk Calculations, and Sum of Fractions Calculations					Sheet No.	1 of 5

PURPOSE:

Provide documentation to support the calculation of the direct contact hazard quotient (HQ) and excess carcinogenic risk for the 100-N-83 waste site. In accordance with the remedial action goals (RAGs) in the remedial design report/remedial action work plan (RDR/RAWP) (DOE-RL 2013), the following criteria must be met:

1) An HQ of <1.0 for all individual noncarcinogens
2) A cumulative HQ of <1.0 for noncarcinogens
3) An excess cancer risk of $<1 \times 10^{-6}$ for individual carcinogens
4) A cumulative excess cancer risk of $<1 \times 10^{-5}$ for carcinogens.

GIVEN/REFERENCES:

1) DOE-RL, 2006, *100-N Area Sampling and Analysis Plan for CERCLA Waste Sites*, DOE/RL-2005-92, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

2) DOE-RL, 2013, *Remedial Design Report/Remedial Action Work Plan for the 100-N Area*, DOE/RL-2005-93, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

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

4) WCH, 2016, 100-N-83 *Waste Site Cleanup Verification 95% UCL Calculations, Calculation Number 0100N-CA-V0294*, Washington Closure Hanford, Richland, Washington.

SOLUTION:

1) Generate an HQ for each noncarcinogenic constituent detected above background or required detection limit/practical quantitation limit and compare it to the individual HQ of <1.0 (DOE-RL 2013).

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

3) Generate an excess cancer risk value for each carcinogenic constituent detected above background or required detection limit/practical quantitation limit and compare it to the excess cancer risk of $<1 \times 10^{-6}$ (DOE-RL 2013).

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

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Originator:	R. J. Nielson RJN	Date:	6/20/2016	Calc. No.:	0100N-CA-V0295	Rev.:	0
Project:	100-N Field Remediation	Job No:	14655	Checked:	J. M. Capron JMC	Date:	6/20/2016
Subject:	100-N-83 Waste Site Direct Contact Hazard Quotient and Carcinogenic Risk Calculations, and Sum of Fractions Calculations					Sheet No. 2 of 5	

Summation of Fractions

The sum-of-fractions compares the radionuclide cleanup verification results from the 100-N-83 waste site excavation to the direct exposure single radionuclide 15 mrem/yr dose-equivalence values and shows the sum-of-fractions evaluation for comparison of the total radionuclide dose to the RAG of 15 mrem/yr above background. The first three columns of the table present the COPCs and the statistical and maximum radionuclide activities for the excavation statistical samples and focused sample, respectively. The fourth column presents the single radionuclide 15 mrem/yr dose-equivalence value. The fifth and sixth columns present the radionuclide activities divided by the dose-equivalence value, followed by the sum of the fractions and determination of the total dose for comparison to the 15 mrem/yr RAG for the excavation and the focused sample, respectively.

METHODOLOGY:

The 100-N-86 waste site underwent statistical and focused sampling within the excavation decision unit. The direct contact hazard quotient and carcinogenic risk calculations for the 100-N-83 waste site were conservatively calculated for the entire waste site using the greater of the maximum focused sample result and the statistical verification soil sample results (WCH 2016). Of the contaminants of potential concern (COPCs) for this site, boron and hexavalent chromium require HQ and risk calculations because these analytes were detected and a Washington State or Hanford Site background value is not available. All other site nonradionuclide COPCs were not detected or were quantified below background levels. An example of the HQ and risk calculations is presented below:

1) For example, the statistical value for boron is 2.0 mg/kg, divided by the noncarcinogenic RAG value of 16,000 mg/kg (calculated in accordance with the noncarcinogenic toxics effects formula in WAC 173-340-740[3]), produces a value of 1.3×10^{-4}. Comparing this value, and all other individual values, to the requirement of <1.0, this criterion is met.

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

3) To calculate the excess cancer risk, the maximum or statistical value is divided by the carcinogenic RAG value, and then multiplied by 1.0×10^{-6}. For example, the statistical value for hexavalent chromium is 0.50 mg/kg, divided by 2.1 mg/kg, and multiplied as indicated, is 2.4×10^{-7}. Comparing this value to the requirement of $<1 \times 10^{-6}$, this requirement 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. Hexavalent chromium is the only constituent that required this calculation. Therefore, the sum of the excess cancer risk values is 2.4×10^{-7}. Comparing this value to the requirement of $<1 \times 10^{-5}$, this requirement is met.

Washington Closure Hanford CALCULATION SHEET

Originator:	R. J. Nielson	Date:	6/20/2016	Calc. No.:	0100N-CA-V0295	Rev.:	0
Project:	100-N Field Remediation	Job No:	14655	Checked:	J. M. Capron	Date:	6/20/2016
Subject:	100-N-83 Waste Site Direct Contact Hazard Quotient and Carcinogenic Risk Calculations, and Sum of Fractions Calculations					Sheet No. 3 of 5	

Summation of Fractions

The sum-of-fractions were calculated for the statistical data set using the greater of the statistical or maximum value and for the focused sample using the maximum value for each radionuclide COPC from the 95% upper confidence limit (UCL) calculation (WCH 2016).

The sum of fractions calculation for the 100-N-83 waste site was performed using RAGs from the 100-N Area RDR/RAWP (DOE/RL 2013). An example of the calculation is presented below:

1) To calculate the fraction, the statistical value for cesium-137 (0.215 pCi/g) is divided by the soil activity equivalent of 6.2 pCi/g equivalent to a 15 mrem/yr dose, resulting in a fraction of 0.0347.

2) The fractions for the remaining COPCs are determined and summed. The sum of these fractions equals 0.778. The sum of fractions is then multiplied by 15 mrem/yr to determine the total equivalent dose of 11.7 mrem/yr for the 100-N-83 waste site. Comparing this value to the dose limit of <15 mrem/yr, the requirement is met.

RESULTS:

Hazard Quotient and Excess Cancer Risk Calculations

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

Tables 1 and 2 show the results of the hazard quotient and excess cancer risk calculations for the excavation statistical samples and the focused sample, respectively.

Summation of Fractions

As demonstrated by the summation of the fractions, the maximum cumulative dose values contributed by the residual radionuclide populations is predicted to be less than the RAG of 15 mrem/yr above background.

Table 3 shows the results of the sum of fraction evaluation for radionuclide direct exposure risk.

Washington Closure Hanford CALCULATION SHEET

Originator:	R. J. Nielson	Date:	6/21/2016	Calc. No.:	0100N-CA-V0295	Rev.:	0
Project:	100-N Field Remediation	Job No:	14655	Checked:	J. M. Capron	Date:	6/21/2016
Subject:	100-N-83 Waste Site Direct Contact Hazard Quotient and Carcinogenic Risk Calculations, and Sum of Fractions Calculations					Sheet No.	4 of 5

Table 1. Direct Contact Hazard Quotient and Excess Cancer Risk Results for the 100-N-83 Waste Site Excavation.

Contaminants of Potential Concern	Statistical Value [a] (mg/kg)	Noncarcinogen RAG [b] (mg/kg)	Hazard Quotient	Carcinogen RAG [b] (mg/kg)	Carcinogen Risk
Metals					
Boron	2.0	16,000	1.3E-04	--	--
Chromium, hexavalent [c]	0.50	240	2.1E-03	2.1	2.4E-07
Totals					
Cumulative Hazard Quotient:			**2.2E-03**		
Cumulative Excess Cancer Risk:					**2.4E-07**

Notes:

[a] = From (WCH 2016).

[b] = Value obtained from the 100-N Area RDR/RAWP (DOE-RL 2013) or *Washington Administrative Code* (WAC) 173-340-740(3), Method B, 1996, unless otherwise noted.

[c] = Value for the carcinogen RAG calculated based on the inhalation exposure pathway (WAC) 173-340-750(3), 1996.

-- = not applicable

RAG = remedial action goal

Table 2. Direct Contact Hazard Quotient and Excess Cancer Risk Results for the 100-N-83 Waste Site Focused Sample.

Contaminants of Potential Concern	Maximum Value [a] (mg/kg)	Noncarcinogen RAG [b] (mg/kg)	Hazard Quotient	Carcinogen RAG [b] (mg/kg)	Carcinogen Risk
Metals					
Boron	1.5	16,000	9.4E-05	--	--
Totals					
Cumulative Hazard Quotient:			**9.4E-05**		
Cumulative Excess Cancer Risk:					**0.0E+00**

Notes:

[a] = From (WCH 2016).

[b] = Value obtained from the 100-N Area RDR/RAWP (DOE-RL 2013) or *Washington Administrative Code* (WAC) 173-340-740(3), Method B, 1996, unless otherwise noted.

-- = not applicable

RAG = remedial action goal

Washington Closure Hanford		CALCULATION SHEET					
Originator:	R. J. Nielson	Date:	6/20/2016	Calc. No.:	0100N-CA-V0295	Rev.:	0
Project:	100-N Field Remediation	Job No:	14655	Checked:	J. M. Capron	Date:	6/20/2016
Subject:	100-N-83 Waste Site Direct Contact Hazard Quotient and Carcinogenic Risk Calculations, and Sum of Fractions Calculations					Sheet No. 5 of 5	

Table 3. Attainment of Radionuclide Direct Exposure Remedial Action Goals for the 100-N-83 Waste Site.

COPC	95% UCL Statistical and Maximum Values (pCi/g)		Soil Activity for 15 mrem/yr	Fraction	
	Excavation	Focused Sample	Dose (pCi/g) [a]	Excavation	Focused Sample
Cesium-137	0.217	4.16	6.2	0.0350	0.671
Cobalt-60	--	0.156	1.4	--	0.111
Nickel-63	2.46	--	4,013	0.00061	--
Strontium-90	3.33	--	4.5	0.740	--
			Sum of Fractions	0.776	0.782
			Equivalent Dose (mrem/yr)	11.6	11.7

[a] Single radionuclide 15 mrem/yr dose-equivalence values and methodology are presented in the *100-N Area RDR/RAWP* (DOE-RL 2013).

COPC = contaminant of potential concern

CONCLUSION:

The calculations in Tables 1 and 2 demonstrate that the 100-N-83 waste site meets the requirements for the direct contact hazard quotients and carcinogenic (excess cancer) risk, respectively, as identified in the 100-N Area RDR/RAWP (DOE-RL 2013) and SAP (DOE-RL 2006). The direct contact hazard quotients and carcinogenic (excess cancer) risk calculations are for use in the RSVP for this site.

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CALCULATION COVER SHEET

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

Area: 100-N

Discipline: Environmental *Calculation No: 0100N-CA-V0296

Subject: 100-N-83 Waste Site Hazard Quotient and Carcinogenic Risk Calculations for Protection of Groundwater

Computer Program: Excel Program No: Excel 2010

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

Committed Calculation ☒ Preliminary ☐ Superseded ☐ Voided ☐

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover = 1 Sheets = 3 Total = 4	R. J. Nielson	J. M. Capron	B. L. Vedder	S. G. Wilkinson	8/4/15

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:	R. J. Nielson RJN	Date:	06/21/16	Calc. No.:	0100N-CA-V0296	Rev.:	0
Project:	100-N Closure Operations	Job No:	14655	Checked:	J. M Capron JMC	Date:	06/21/16
Subject:	100-N-83 Waste Site Hazard Quotient and Carcinogenic Risk Calculations for Protection of Groundwater					Sheet No.	1 of 3

PURPOSE:

Provide documentation to support the calculation of the hazard quotient (HQ) and excess carcinogenic risk associated with soil contaminant levels compared to soil cleanup levels for protection of groundwater for the 100-N-83 waste site. In accordance with the remedial action goals (RAGs) in the remedial design report/remedial action work plan (RDR/RAWP) for the 100-N Area (DOE-RL 2013), the following criteria must be met:

1) An HQ of <1.0 for all individual noncarcinogens
2) A cumulative HQ of <1.0 for noncarcinogens
3) An excess cancer risk of $<1 \times 10^{-6}$ for individual carcinogens
4) A cumulative excess cancer risk of $<1 \times 10^{-5}$ for carcinogens.

GIVEN/REFERENCES:

1) DOE-RL, 2013, *Remedial Design Report/Remedial Action Work Plan for the 100-N Area,* DOE/RL-2005-93, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

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

3) WCH, 2016, 100-N-83 *Waste Site Cleanup Verification 95% UCL Calculations, Calculation Number 0100N-CA-V0294*, Washington Closure Hanford, Richland, Washington.

SOLUTION:

1) Generate a HQ for each noncarcinogenic constituent detected above background in soil and with a K_d less than that required to show no migration to groundwater in 1,000 years using the RESRAD generic site model (DOE-RL 2013).

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

3) Generate an excess cancer risk value for each carcinogenic constituent detected above background in soil and with a K_d less than that required to show no migration to groundwater in 1,000 years using the RESRAD generic site model (DOE-RL 2013).

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

Washington Closure Hanford, Inc. CALCULATION SHEET

Originator:	R. J. Nielson	Date:	06/21/16	Calc. No.:	0100N-CA-V0296	Rev.:	0
Project:	100-N Closure Operations	Job No:	14655	Checked:	J. M Capron	Date:	06/21/16
Subject:	100-N-83 Waste Site Hazard Quotient and Carcinogenic Risk Calculations for Protection of Groundwater					Sheet No.	2 of 3

METHODOLOGY:

The 100-N-83 waste site underwent statistical sampling at the excavation decision units. The protection of groundwater hazard quotient and carcinogenic risk calculations for the 100-N-83 waste site were conservatively calculated for the entire waste site using the statistical or maximum value from focused sample for each analyte (WCH 2016). Based on the generic site RESRAD model (DOE-RL 2013) and a vadose zone of approximately 22 m (72 ft) thickness, a K_d of 3.4 or greater is required to show no predicted migration to groundwater in 1,000 years. Boron and hexavalent chromium are included because they have a K_d of less than 3.4, and no Hanford background value has been established. All other site nonradionuclide COPCs were undetected, quantified below background levels, or have a K_d greater than or equal to 3.4. An example of the HQ and risk calculations for soil constituents with a potential impact to groundwater is presented below.

1) The hazard quotient is defined as the ratio of the dose of a substance obtained over a specified time (mg/kg/day) to a reference dose for the same substance derived over the same specified time (mg/kg/day). The hazard quotient can also be calculated as the ratio of the concentration in soil (maximum or statistical value) (mg/kg) to the soil RAG (mg/kg) for protection of groundwater, where the RAG is the groundwater cleanup level (µg/L) (calculated with, and related to the hazard quotient through, WAC 173-340-720 (3)(a)(ii)(A), (1996) x 100 x 1 mg/1000 µg (conversion factor). This is based on the "100 times rule" of WAC 173-340-740(3)(a)(ii) (A) (1996). For example, the statistical value for boron is 2.0 mg/kg, divided by the noncarcinogenic RAG value of 320 mg/kg is 6.3×10^{-3}. Comparing this value to the requirement of <1.0, this criterion is met.

2) After the HQ calculation is completed for the appropriate analytes, the cumulative HQ can be obtained by summing the individual values. (To avoid errors due to intermediate rounding, the individual HQ values prior to rounding are used for this calculation.) The cumulative HQ for the 100-N-83 waste site is 1.1×10^{-1}. Comparing this value to the requirement of <1.0, this criterion is met.

3) To calculate the excess cancer risk, the maximum or statistical value is divided by the carcinogenic RAG value, and then multiplied by 1×10^{-6}. There were no constituents that required this calculation. Therefore, the requirement of $<1 \times 10^{-6}$ is met.

4) After the individual carcinogenic risk calculations have been completed for the appropriate analytes, the cumulative excess cancer risk can be obtained by summing the individual values. (To avoid errors due to intermediate rounding, the individual carcinogenic risk values prior to rounding are used for this calculation). As stated above, there were no constituents that required this calculation; therefore, the requirement of $<1 \times 10^{-5}$ is met.

5) The soil cleanup RAGs for protection of groundwater are based on the "100 times" provision in WAC 173-340-740(3)(a)(ii)(A). WAC 173-340-740(3)(a)(ii)(A) (1996) provides the "100 times rule" but also states "unless it can be demonstrated that a higher soil concentration is protective of ground water at the site." When the "100 times rule" values are exceeded, RESRAD was used to demonstrate that higher soil concentrations may be protective of groundwater.

Washington Closure Hanford, Inc. CALCULATION SHEET

Originator:	R. J. Nielson RJN	Date:	06/21/16	Calc. No.:	0100N-CA-V0296	Rev.:	0
Project:	100-N Closure Operations	Job No:	14655	Checked:	J. M Capron JMC	Date:	06/21/16
Subject:	100-N-83 Waste Site Hazard Quotient and Carcinogenic Risk Calculations for Protection of Groundwater					Sheet No.	3 of 3

RESULTS:

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

Table 1 shows the results of the calculations.

Table 1. Hazard Quotient and Excess Cancer Risk Results for the 100-N-83 Waste Site.

Contaminants of Potential Concern	Maximum or Statistical Value[a] (mg/kg)	Noncarcinogen RAG[b] (mg/kg)	Hazard Quotient	Carcinogen RAG[b] (mg/kg)	Carcinogen Risk
Metals					
Boron	2.0	320	6.3E-03	--	--
Chromium, hexavalent	0.50	4.8	1.0E-01	--	--
Totals					
Cumulative Hazard Quotient:			**1.1E-01**		
Cumulative Excess Cancer Risk:					**0.0E+00**

Notes:

[a] = From (WCH 2016).

[b] = Value obtained from the Cleanup Levels and Risk Calculations (CLARC) database using Groundwater, Method B, results and the "100 times" model.

-- = not applicable

RAG = remedial action goal

CONCLUSION:

This calculation demonstrates that the 100-N-83 waste site meets the requirements for the hazard quotients and excess carcinogenic risk as identified in the RDR/RAWP (DOE-RL 2013). The hazard quotient and carcinogenic risk calculations for protection of groundwater are for use in the RSVP for this site.

APPENDIX C

100-N-83 DATA QUALITY ASSESSMENT

APPENDIX C

100-N-83 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 *100-N Area Sampling and Analysis Plan for CERCLA Waste Sites* (100-N Area SAP) (DOE-RL 2006).

A review of the sample design (WCH 2015), field logbook (WCH 2016), and the applicable analytical data package has been performed as part of this DQA. All samples were collected and analyzed per the sample design. To ensure quality data, the 100-N Area SAP (DOE-RL 2006) data assurance requirements and the data validation procedures for chemical analysis (BHI 2000) are used as appropriate. This review involves evaluation of the data to determine if they are of the right type, quality, and quantity to support the intended use (i.e., closeout decisions). The DQA completes the data life cycle (i.e., planning, implementation, and assessment) that was initiated by the data quality objectives process (EPA 2006).

Verification sample data collected at the 100-N-83 waste site were provided by the laboratories in two sample delivery groups (SDGs): JP1043 and XP0228. SDG JP1043 was submitted for third-party validation.

No major deficiencies were identified in this data set. Minor deficiencies identified in the analytical data sets are discussed in the minor deficiencies section. If no comments are made about a specific analysis, no deficiencies affecting the quality of the data for that analysis were identified.

MINOR DEFICIENCIES

SDG JP1043

This SDG is comprised of 14 verification soil samples (J1V8V8, J1V8V9, J1V8W0 through J1V8W9, J1V8X0, and J1V8X1) and one field equipment blank (J1V8X2). Samples J1V8W4 and J1V8X1 comprise a field duplicate pair. These samples were collected on April 26, 2016. All samples were analyzed for gamma-emitting radionuclides, plutonium-238 and plutonium-239/240, strontium-90, tritium, nickel-63, hexavalent chromium, metals, mercury, nitrate/nitrite, and anions. SDG JP1043 was submitted for third-party validation. Minor deficiencies are as follows.

In the metals analysis, trace total chromium contamination was detected in the method blank. Comparable chromium results in the field equipment blank (J1V8X2) were, therefore, qualified

as undetected and estimated with "UJ" flags by third-party validation. Total chromium results in other samples were significantly greater than the result for the method blank, so no further qualification was applied. Also in the metals analysis, the matrix spike recoveries for antimony (57%) and silicon (-12%) were outside the quality control (QC) limits. The laboratory control sample recovery for silicon (15%) was also outside the QC limits. Third-party validation, therefore, qualified all associated field sample results as estimated with "J" flags. Estimated data are usable for decision-making purposes.

In the anion analysis, holding times for nitrate, nitrite, and phosphate were exceeded by less than twice the limit. Third-party validation therefore qualified all associated field sample results as estimated with "J" flags. Estimated data are usable for decision-making purposes.

In the hexavalent chromium analysis, samples were received at the laboratory slightly above specified preservation temperature. Third-party validation, therefore, qualified all associated field sample results as estimated with "J" flags. Estimated data are usable for decision-making purposes.

In the tritium analysis, no matrix spike was performed and third-party validation qualified all associated field sample results as estimated with "J" flags. Estimated data are usable for decision-making purposes.

In the plutonium analysis, plutonium-239/240 was detected in the field equipment blank. This result was confirmed by a second analysis at the laboratory. This result is unexpected but there are no indications of analytical deficiencies. Plutonium-239/240 was not detected in any of the field soil samples, and no further qualification was applied to any of the associated results.

SDG XP0228

This SDG is comprised of one soil sample (J1V8X3) collected as a split of sample J1V8W4. This sample was analyzed for gamma-emitting radionuclides, plutonium-238 and plutonium-239/240, strontium-90, tritium, nickel-63, hexavalent chromium, metals, mercury, nitrate/nitrite, and anions. Minor deficiencies are as follows.

In the metals analysis, laboratory duplicate relative percent difference (RPD) calculations were above QC limits for boron (35.3%). Although not qualified for the laboratory duplicate results outside of QC limits, the boron result for the field sample may be considered estimated. Estimated data are usable for decision-making purposes.

In the anion analysis, holding times for nitrate, nitrite, and phosphate were exceeded by less than twice the limit. Field sample results for these anions may be considered estimated but are usable for decision-making purposes.

FIELD QUALITY ASSURANCE/QUALITY CONTROL

Relative percent difference evaluations of primary samples versus laboratory duplicates are routinely performed and reported by the laboratory. Any deficiencies in those calculations are reported by SDG in the previous sections.

Field quality assurance (QA)/QC measures are used to assess potential sources of error and cross contamination of samples that could bias results. Field QA/QC samples listed in the field logbook (WCH 2016) are shown in Table C-1. The complete primary and QA/QC sample results are presented with the calculations in Appendix B.

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

Sample Area	Primary Sample	Duplicate Sample	Split Sample
VSP-7	J1V8W4	J1V8X1	J1V8X3

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. Split samples are collected to provide a relative measure of the variability in the sampling, sample handling, and analytical techniques used by commercial laboratories. Field duplicates and splits are evaluated by calculating the RPD of the primary/duplicate or primary/split pair for each analyte. Relative percent differences are not calculated for analytes that are not detected in both the main and duplicate sample at more than five times the target detection limit. Relative percent differences of analytes detected at low concentrations (less than five times the detection limit) are not considered to be indicative of the analytical system performance. The calculation brief in Appendix B provides details on duplicate pair RPD calculation.

The RPD calculations for the field duplicate sample are all below the acceptance criterion (30%), except for silicon (41.0%). The RPD calculations for the field split sample are below the acceptance criterion (35%), except for silicon (46.7%) and radium-228 (39.8%). Elevated RPDs in environmental samples are generally attributed to natural heterogeneities in the sample matrix. Neither silicon nor radium-228 is considered a contaminant of potential concern for the 100-N-83 site.

A secondary check of the data variability is used when one or both of the samples being evaluated (primary and duplicate/split) is less than five times the target detection limit, including undetected analytes. In these cases, a control limit on the difference between the sample results of ±2 times the target detection limit is used (Appendix B) to indicate that a visual check of the data is required by the reviewer. This check was not required for either the primary-duplicate or primary-split pair.

Summary

Limited, random, or sample matrix-specific influenced batch QC issues, such as those discussed above, are a potential for any analysis. The number and types seen in these data sets are within expectations for the matrix types and analyses performed. The DQA review of the 100-N-83 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 the 100-N-83 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 a Washington Closure Hanford project-specific database prior to being submitted for inclusion in the Hanford Environmental Information System database. The verification sample analytical data are also summarized in Appendix B.

REFERENCES

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

DOE-RL, 2006, *100-N Area Sampling and Analysis Plan for CERCLA Waste Sites,* DOE/RL-2005-92, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

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

WCH, 2015, *Work Instruction for Verification Sampling of the 100-N-83, Two Contamination Areas Found Near 116-N-1,* 0100N-WI-G0093, Rev. 0, Washington Closure Hanford, Richland, Washington.

WCH, 2016, *100N Field Remediation Sampling*, Logbook EL-1652-12, pp. 51-54, Washington Closure Hanford, Richland, Washington.