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

14-AMRP-0293

SEP 19 2014

Ms. J. A. Hedges, Program Manager
Nuclear Waste Program
State of Washington
Department of Ecology
3100 Port of Benton Blvd.
Richland, Washington 99354

Dear Ms. Hedges:

TRANSMITTAL OF APPROVED WASTE SITE RECLASSIFICATION FORM AND SUPPORTING DOCUMENTATION FOR THE 100-N-82, 100-N DECONTAMINATION PAD WASTE SITE, REVISION 0

Attached for your use is the approved Waste Site Reclassification Form No. 2014-087 and supporting, "Remaining Sites Verification Package for the 100-N-82, 100-N Decontamination Pad Waste Site," Rev. 0. If you have questions, please contact me or your staff may contact Joanne Chance, of my staff, at (509) 376-0811.

Sincerely,

Mark S. French, Director
River Corridor Division

AMRP:JCC

Attachment

cc w/attach:
N. M. Menard, Ecology
Administrative Record, H6-08

cc w/o attach:
R. D. Cantwell, WCH
S. L. Feaster, WCH
D. L. Plung, WCH
J. P. Shearer, CHPRC

WASTE SITE RECLASSIFICATION FORM

Operable Unit: 100-NR-1 **Control No.:** 2014-087

Waste Site Code(s)/Subsite Code(s): 100-N-82

Reclassification Category: Interim ☒ Final ☐

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

Approvals Needed: DOE ☒ Ecology ☒ EPA ☐

Description of current waste site condition:

The 100-N-82, 100-N Decontamination Pad waste site, part of the 100-NR-1 Operable Unit, was included in 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) and 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 remove, treat, and dispose site.

The 100-N-82 waste site was located approximately 245 m (804 ft) northeast of the 1120-N Building. The 100-N-82 decontamination pad was constructed in 2000 and consisted of a reinforced concrete slab with a center drainage trench and sump. The slab sloped toward the center trench where the water was trapped in the sump. It was used exclusively by the 100-N vehicles and equipment performing remediation work associated with sites 116-N-1 and 116-N-3. The pad was covered with a liner upon demobilization to prevent rainwater from entering the trench and sump.

Remediation of the 100-N-82, 100-N Decontamination Pad was performed between March 19 and March 24, 2014. Approximately 194 bank cubic meters (254 bank cubic yards) of excavated materials were removed and direct loaded for disposal at the Environmental Restoration Disposal Facility (ERDF).

Cleanup verification soil samples were collected from the 100-N-82 waste site on May 16, 2014, per the *Work Instruction for Verification Sampling of the 100-N-82, 100-N Decontamination Pad Waste Site*, 0100N-WI-G0078, Rev. 0, Washington Closure Hanford, Richland, Washington (WCH 2014b). Analytical results of those samples indicate the 100-N-82 waste site achieves remedial action objectives (RAOs) and remedial action goals (RAGs) established by the *Remedial Design Report/Remedial Action Work Plan for the 100-N Area*, DOE/RL-2005-93, Rev. 1, (100-N Area RDR/RAWP), U.S. Department of Energy, Richland Operations Office, Richland, Washington (DOE-RL 2013), and 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 in the 200 Area of the Hanford Site, (3) demonstrating through verification sampling that cleanup goals have been achieved, and (4) proposing the site for reclassification as Interim Closed Out.

Basis for reclassification:

The verification sampling results were evaluated in comparison to the RAGs. In accordance with this evaluation, the verification sampling results support a reclassification of the 100-N-82 waste site to Interim Closed Out. The current site conditions achieve the RAOs and RAGs established by the 100-N Area RDR/RAWP (DOE-RL 2013) and the 100-N Area ROD (EPA 1999). The evaluation (which may include fate-and-transport modeling) of all data collected from the waste site resulted in a determination 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-82, 100-N Decontamination Pad Waste Site* (attached).

WASTE SITE RECLASSIFICATION FORM

Operable Unit: 100-NR-1 **Control No.:** 2014-087

Waste Site Code(s)/Subsite Code(s): 100-N-82

Regulator comments:

Waste Site Controls:

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

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

J. P. Neath	J P Neath	9/4/14
DOE Federal Project Director (printed)	Signature	Date
N. Menard	Nina M. Menard	9/9/14
Ecology Project Manager (printed)	Signature	Date
N/A		
EPA Project Manager (printed)	Signature	Date

REMAINING SITES VERIFICATION PACKAGE FOR THE 100-N-82, 100-N DECONTAMINATION PAD WASTE SITE

Attachment to Waste Site Reclassification Form 2014-087

September 2014

REMAINING SITES VERIFICATION PACKAGE FOR THE 100-N-82, 100-N DECONTAMINATION PAD WASTE SITE

EXECUTIVE SUMMARY

The 100-N-82, 100-N Decontamination Pad waste site, part of the 100-NR-1 Operable Unit, was included in 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* (EPA 2011) and 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) (EPA 1999) as a remove, treat, and dispose site.

The 100-N-82 decontamination pad was located approximately 245 m (804 ft) northeast of the 1120-N Building. The decontamination pad was constructed in 2000, consisting of the reinforced concrete slab with a center drainage trench and sump. The decontamination pad was used exclusively by the 100-N vehicles and equipment performing remediation work associated with the 116-N-1 and 116-N-3 waste sites. The pad was covered with a liner upon demobilization to prevent rainwater from entering the trench and sump.

Remedial action at the 100-N-82 waste site to remove the decontamination pad, trench, sump, and underlying soil was performed between March 19 and March 24, 2014. All excavated materials were direct loaded for disposal at the Environmental Restoration Disposal Facility (ERDF). Approximately 194 bank cubic meters (254 bank cubic yards) of excavated materials were removed and direct loaded for disposal at ERDF. There was no staging pile area or overburden soil stockpile associated with the 100-N-82 waste site excavation. The depth of the excavation was approximately 1.5 m (4.9 ft) below ground surface.

Verification sampling was conducted on May 16, 2014, per the *Work Instruction for Verification Sampling of the 100-N-82, 100-N Decontamination Pad Waste Site* (WCH 2014b). A summary of the cleanup evaluation for the soil results against the applicable criteria is presented in Table ES-1. The results of the verification sampling are used to make reclassification decisions for the 100-N-82 waste site 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 site to Interim Closed Out. The current site conditions achieve the remedial action objectives and the corresponding remedial action goals established in the *Remedial Design Report/Remedial Action Work Plan for the 100-N Area* (DOE-RL 2013) and the 100-N Area ROD (EPA 1999).

Table ES-1. Summary of Remedial Action Goals for the 100-N-82 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.	Maximum dose rate for the 100-N-82 waste site shallow zone predicted using sum of fractions evaluations with generic dose equivalence lookup values is 1.73 mrem/yr above background for statistical samples.	Yes
Direct Exposure – Nonradionuclides	Attain individual COPC RAGs.	All individual COPC concentrations are below the direct exposure criteria.	Yes
Risk Requirements – Nonradionuclides	Attain a hazard quotient of <1 for all individual noncarcinogens.	All hazard quotients for individual nonradionuclide COPCs are <1.	Yes
	Attain a cumulative hazard quotient of <1 for noncarcinogens.	The direct exposure cumulative hazard quotient (2.3×10^{-3}) is <1.	
	Attain an excess cancer risk of $<1 \times 10^{-6}$ for individual carcinogens.	The individual cancer risk for hexavalent chromium, the only constituent subject to the cancer risk calculation, is 1.3×10^{-7}, and thus is $<1 \times 10^{-6}$.	
	Attain a cumulative excess cancer risk of $<1 \times 10^{-5}$ for carcinogens.	The cumulative excess cancer risk for hexavalent chromium, the only constituent subject to cancer risk calculation, is 1.3×10^{-7}, and thus is $<1 \times 10^{-5}$.	
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.	
	Meet drinking water standards for alpha emitters: the most stringent of 15 pCi/L MCL or 1/25th of the derived concentration guides from DOE Order 5400.5 [b].	No alpha-emitting radionuclide COPCs were quantified above groundwater/river protection lookup values.	
	Meet total uranium standard of 30 µg/L (21.2 pCi/L) [c].	Uranium was quantified below levels that are protective of 100 Area groundwater.	
Groundwater/River Protection – Nonradionuclides	Attain individual nonradionuclide groundwater and river cleanup requirements.	All individual soil COC and COPC concentrations are below the groundwater and/or Columbia River protection criteria.	Yes

[a] "National Primary Drinking Water Regulations" (40 *Code of Federal Regulations* 141).
[b] *Radiation Protection of the Public and Environment* (DOE Order 5400.5).
[c] Based on the isotopic distribution of uranium in the 100 Area, the 30 µg/L MCL corresponds to 21.2 pCi/L. Concentration-to-activity calculations are documented in *Calculation of Total Uranium Activity Corresponding to a Maximum Contaminant Level for Total Uranium of 30 Micrograms per Liter in Groundwater* (BHI 2001).

COC = contaminant of concern
COPC = contaminant of potential concern
DOE = U.S. Department of Energy
MCL= maximum contaminant level
RAG= remedial action goal

The verification sample results show 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 cleanup levels was not observed in shallow zone soils and is concluded not to be present in deep zone soils; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are not required.

Soil cleanup levels were established in the 100-N Area ROD (EPA 1999) based 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-82 waste site contaminants of potential concern and other constituents (Appendix A). The U.S. Environmental Protection Agency ecological soil screening levels were exceeded for manganese and vanadium. Ecological screening levels from the *Washington Administrative Code* (WAC) 173-340, "Model Toxics Control Act – Cleanup," were exceeded for boron and vanadium. Exceeding screening values is intended to trigger additional evaluation and does not necessarily indicate the existence of risk to ecological receptors. Because concentrations of manganese and vanadium are below Hanford Site or Washington State background values (note that state background values are only used when Hanford Site background values are not available), it is believed that the presence of these constituents do 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 a part of the final closeout decision for this site.

REMAINING SITES VERIFICATION PACKAGE FOR THE 100-N-82, 100-N DECONTAMINATION PAD WASTE SITE

STATEMENT OF PROTECTIVENESS

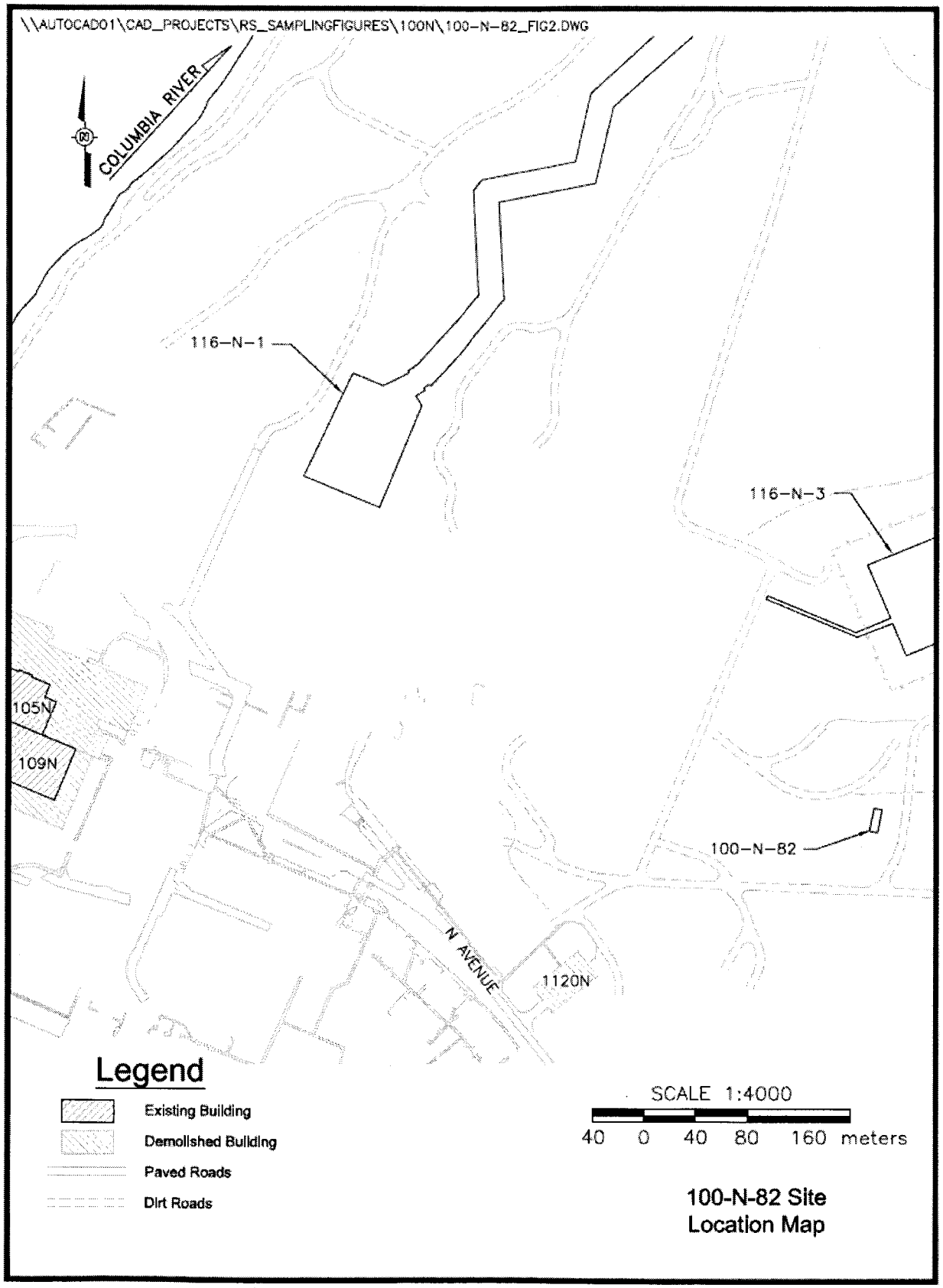
This report demonstrates that the 100-N-82, 100-N Decontamination Pad waste site meets the objectives to support a reclassification of this site to Interim Closed Out as established in the *Remedial Design Report/Remedial Action Work Plan for the 100-N Area* (100-N Area RDR/RAWP) (DOE-RL 2013) and the *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 results of verification sampling and modeling show that residual soil concentrations do not preclude any future uses (as bounded by the rural-residential scenario) and allow for unrestricted use of shallow zone soils (i.e., surface to 4.6 m [15 ft] deep). The results also demonstrate that residual contaminant concentrations are protective of groundwater and the Columbia River. Contamination above direct exposure cleanup levels was not observed in shallow zone soils and is concluded not to be present in deep zone soils; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are not required.

Soil cleanup levels were established in the 100-N Area ROD (EPA 1999) based 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-82 waste site contaminants of potential concern (COPCs) and other constituents (Appendix A). The U.S. Environmental Protection Agency (EPA) ecological soil screening levels were exceeded for manganese and vanadium. Ecological screening levels from the *Washington Administrative Code* (WAC) 173-340, "Model Toxics Control Act – Cleanup," were exceeded for boron and vanadium. Exceeding screening values is intended to trigger additional evaluation and does not necessarily indicate the existence of risk to ecological receptors. Because concentrations of manganese and vanadium are below Hanford Site or Washington State background values (note that state background values are only used when Hanford Site background values are not available), it is believed that the presence of these constituents do 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 a part of the final closeout decision for this site.

GENERAL SITE INFORMATION AND BACKGROUND

The 100-N-82, 100-N Decontamination Pad waste site, part of the 100-NR-1 Operable Unit, is approximately 245 m (804 ft) northeast of the 1120-N Building (Figure 1). The waste site consisted of an 18.3- by 6.1-m (60- by 20-ft) decontamination pad and underlying soil. The decontamination pad was constructed of reinforced concrete with a center drainage trench and sump. The slab sloped toward the center trench where the water was trapped in the sump. The Washington State Plane coordinates for the southwest corner of the pad area are N 149404.1, E 571865.4.

Figure 1. The 100-N-82 Waste Site Location Map.



The 100-N-82, 100-N Decontamination Pad was constructed in 2000 to support 100-N vehicles and equipment decontamination activities associated with the remediation of the 116-N-1 and 116-N-3 waste sites. When a vehicle drove onto a pad, a self-contained steam cleaner, water tank, and a pump with suction and discharge hoses was used to decontaminate the vehicle. Runoff water would enter the trench and sump, and, as needed, wash water would be pumped to a tank truck for removal and disposal.

Activities at the 100-N-82, 100-N Decontamination Pad ceased in 2006. A high-density polyethylene liner cover was installed on top of the decontamination pad to prevent rainwater from entering the trench and sump area. The area was roped off with signs on the perimeter stating "Caution, Contaminated Soil Area."

Figure 2. Aerial View of the 100-N-82 Decontamination Pad Prior to Remediation (October 14, 2013).

REMEDIAL ACTION SUMMARY

Remediation of the 100-N-82, 100-N Decontamination Pad was performed between March 19 and March 24, 2014. Approximately 194 bank cubic meters (254 bank cubic yards) of excavated materials were removed and direct loaded for disposal at the Environmental Restoration Disposal Facility. The depth of the excavation was approximately 1.5 m (4.9 ft). Excavated materials

included plastic tarp, concrete, railroad ties, steel, rebar, soil, and other miscellaneous debris. The sump located near the center of the decontamination pad was also removed. No soil staining or anomalies were observed during and after the excavation. A post-remediation photograph is shown in Figure 3.

Figure 3. Post-Remediation Photograph of 100-N-82 Waste Site Excavation (March 25, 2014).

No overburden materials were salvaged from the 100-N-82 waste site excavation; therefore, there is no overburden pile associated with the 100-N-82 waste site. Figure 4 compares the post-remediation excavation boundary with the 100-N-82 Waste Information Data System boundary. A 100-N-82 waste site walkaround boundary was used to determine the footprint for the 100-N-82 waste site and develop the verification sampling design.

A Global Positioning Environmental Radiological Surveyor (GPERS) survey was conducted within the 100-N-82 waste site open excavation. No radiological contamination was detected above background. The GPERS survey results are provided in Figures 5 and 6.

Figure 4. Post-Excavation Boundary for the 100-N-82 Waste Site.

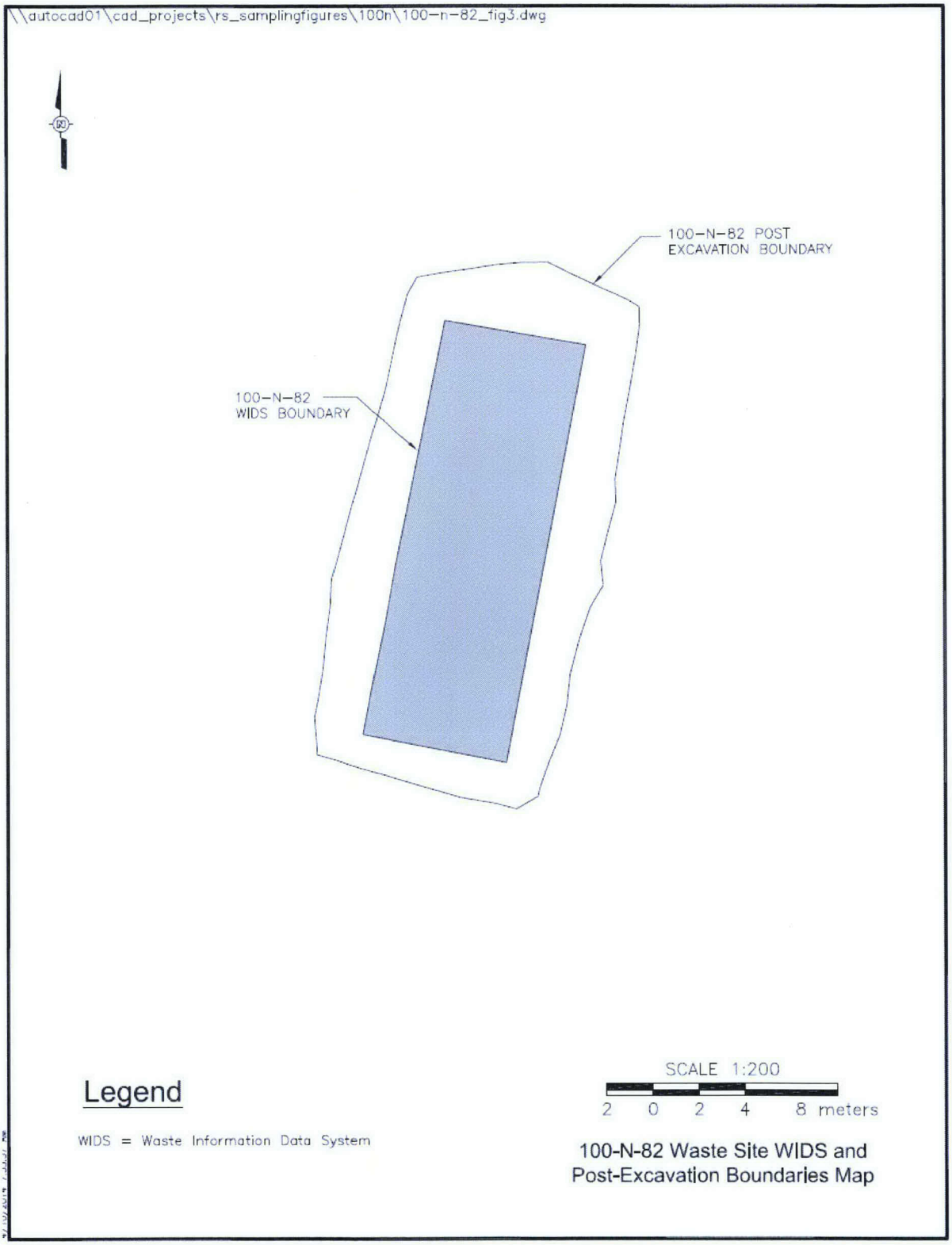


Figure 5. 100-N-82 Waste Site Excavation GPERS – Beta Track Map.

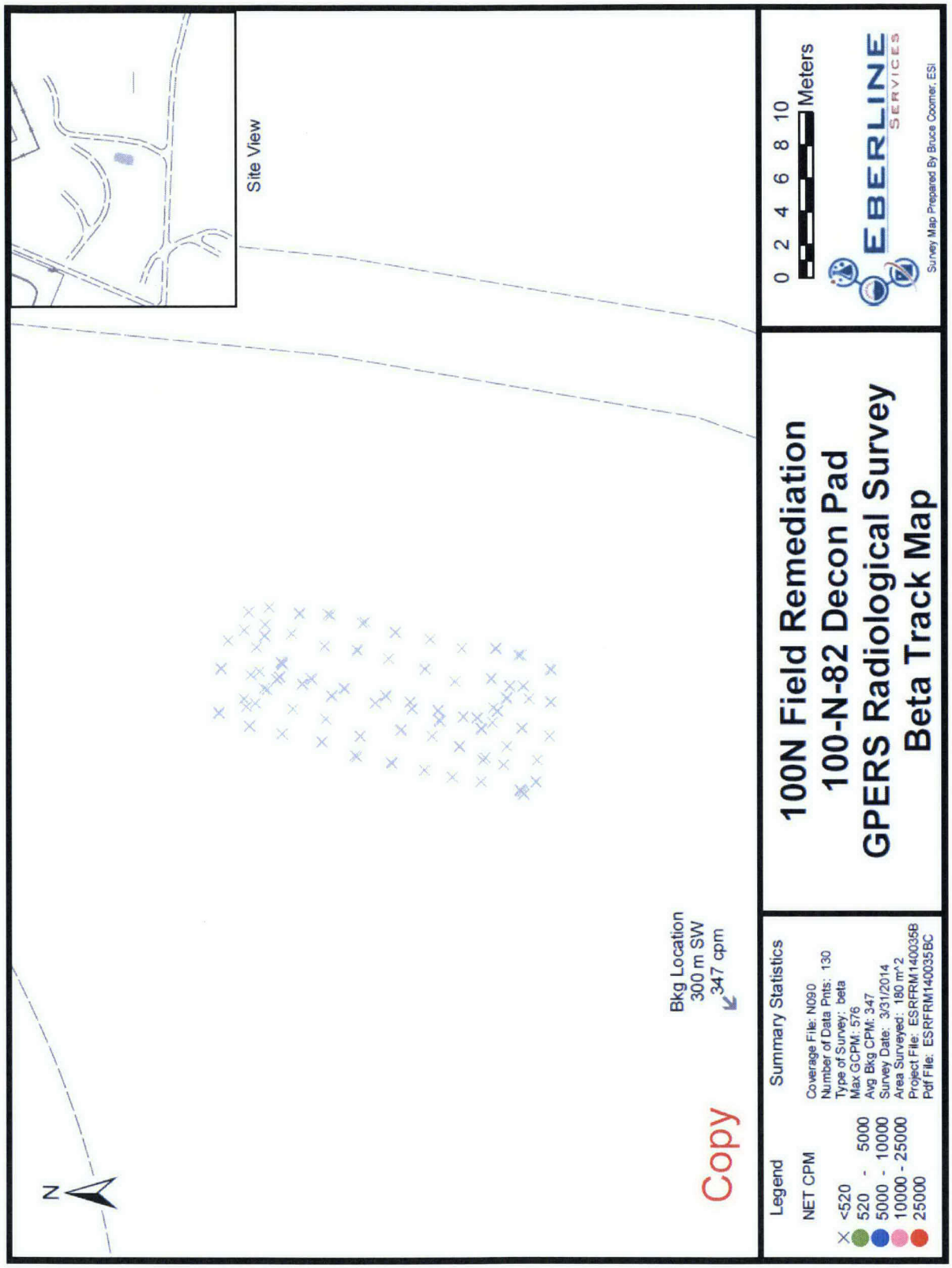
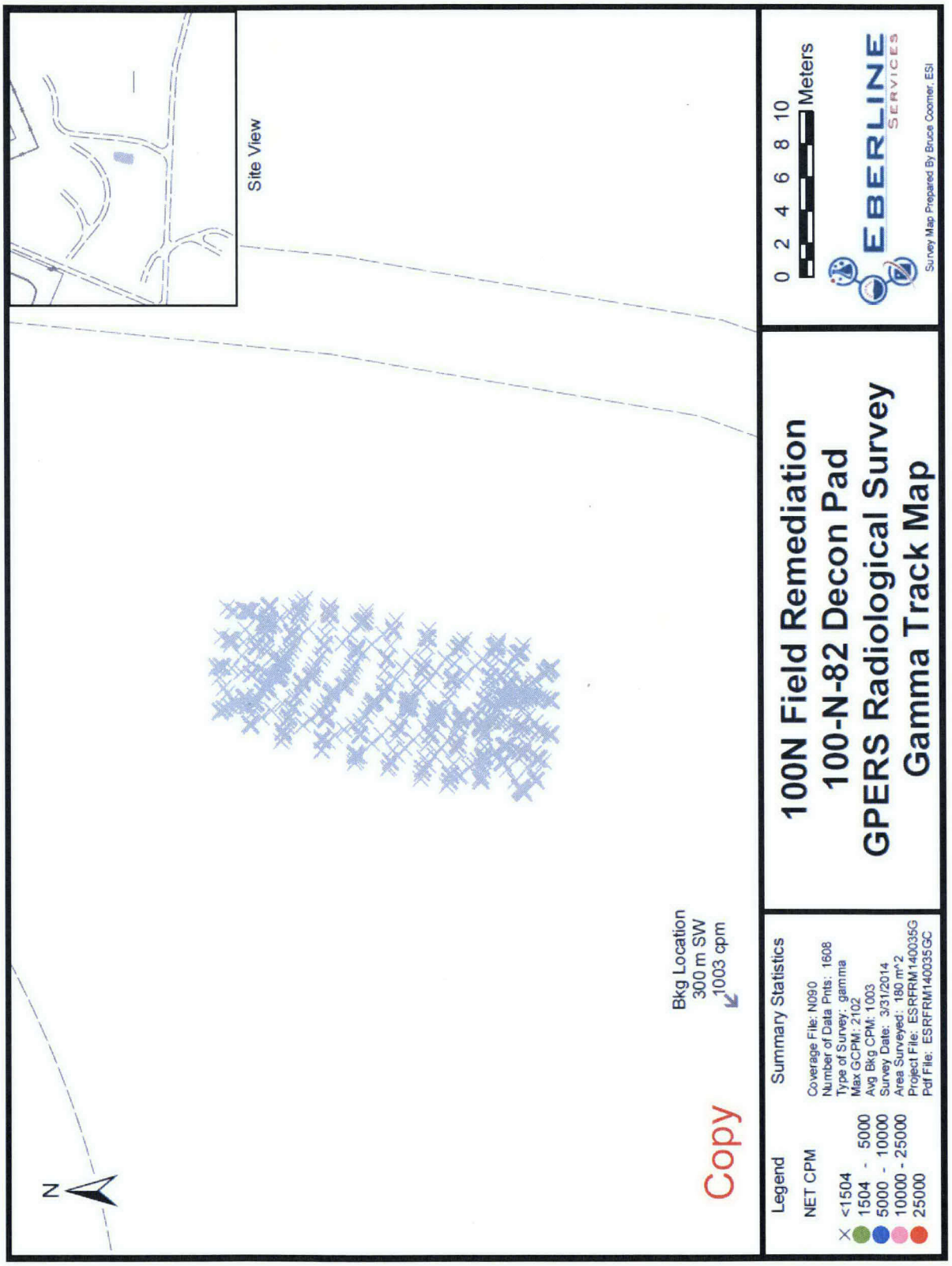


Figure 6. 100-N-82 Waste Site Excavation GPERS – Gamma Track Map.



VERIFICATION SAMPLING ACTIVITIES

Verification sampling for the 100-N-82 waste site was conducted on May 16, 2014. 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). The verification sample results are provided in Appendix B. The following subsections provide additional discussion of the information used to develop the verification sampling design. A more detailed discussion of the verification sample design can be found in the *Work Instruction for Verification Sampling of the 100-N-82, 100-N Decontamination Pad Waste Site* (WCH 2014b).

Contaminants of Potential Concern

The 100-N-82 decontamination pad was used exclusively for the 116-N-1 and 116-N-3 liquid waste disposal facilities remediation equipment decontamination. Therefore, the 100-N-82 waste site COPCs are based on the observed contaminants at the 116-N-1 and 116-N-3 waste sites and include americium-241, cesium-137, cobalt-60, europium-154, europium-155, nickel-63, plutonium-239/240, strontium-90, tritium, nitrate, mercury, total chromium, hexavalent chromium, thorium-228, thorium-232, uranium-233/234, uranium-238, cadmium, and lead.

Although not considered a site COPC, analysis for mercury was also requested. Additionally, analyses for the expanded list of inductively coupled plasma metals were performed to include antimony, arsenic, barium, beryllium, boron, cobalt, copper, manganese, molybdenum, nickel, selenium, silver, vanadium, and zinc.

The analytical methods that were performed to evaluate the site COPCs are provided in Table 1.

Table 1. Laboratory Analytical Methods. (2 Pages)

Analytical Method	Contaminants of Potential Concern
ICP metals [a] – EPA Method 6010	Cadmium, chromium (total), lead
Mercury – EPA Method 7471	Mercury
Hexavalent chromium – EPA Method 7196	Hexavalent chromium
NO_2/NO_3 – EPA method 353.2	Nitrate
GEA – Gamma spectroscopy	Americium-241, cobalt-60, cesium-137, europium-154, europium-155
Nickel-63 – Liquid scintillation	Nickel-63
Total radiostrontium – GPC	Strontium-90
Isotopic plutonium – Pu AEA	Plutonium-293/240
Isotopic thorium – Th AEA	Thorium-228, thorium-232
Isotopic uranium – U AEA	Uranium-233/234, uranium-238

Table 1. Laboratory Analytical Methods. (2 Pages)

Analytical Method	Contaminants of Potential Concern
Tritium [b] – Liquid scintillation	Tritium

[a] Analyses for the expanded list of ICP metals was performed and included antimony, arsenic, barium, beryllium, boron, cadmium, cobalt, copper, lead, manganese, molybdenum, nickel, selenium, silver, vanadium, and zinc.

[b] Tritium samples were collected at a depth of 0.15 m (6 in.) below the excavation surface per Tri-Party Agreement Change Notice TPA-CN-177 (dated August 21, 2007).

AEA = alpha energy analysis
EPA = U.S. Environmental Protection Agency
GEA = gamma energy analysis
GPC = gas proportional counting
ICP = inductively coupled plasma

Verification Sample Design

The statistical sampling design for the 100-N-82 waste site was developed using Visual Sample Plan[1] (VSP). The area identified for the purpose of statistical verification sampling for the 100-N-82 waste site was delineated in VSP and used as the basis for a random-start systematic grid for verification soil sample collection at the site. One decision unit, the decontamination pad excavation area, was identified for the 100-N-82 waste site. A total of 12 statistical verification soil samples were collected from this decision unit. Grab samples were collected at each of the sampling locations.

A triangular grid was used based on studies that indicate triangular grids are superior to square grids (Gilbert 1987). Additional details concerning the use of VSP to develop the statistical sampling designs and derive the number of verification samples to collect are discussed in the *Work Instruction for Verification Sampling of the 100-N-82, 100-N Decontamination Pad Waste Site* (WCH 2014b). The 100-N-82 waste site sample locations are shown in Figure 7.

A summary of the verification samples collected and laboratory analyses performed is provided in Table 2. 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). Table 1 identifies the EPA-approved methods for the analyses performed for verification sampling. Additional information related to verification sampling can be found in the field sampling logbook (WCH 2014a).

Sampling Results

All verification samples were analyzed using EPA-approved analytical methods. A data summary is presented in Appendix B. Evaluation of the verification data from the 100-N-82 waste site was performed by direct comparison of the statistical or maximum sample results for each COPC against cleanup criteria.

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

Figure 7. 100-N-82 Verification Sample Locations.

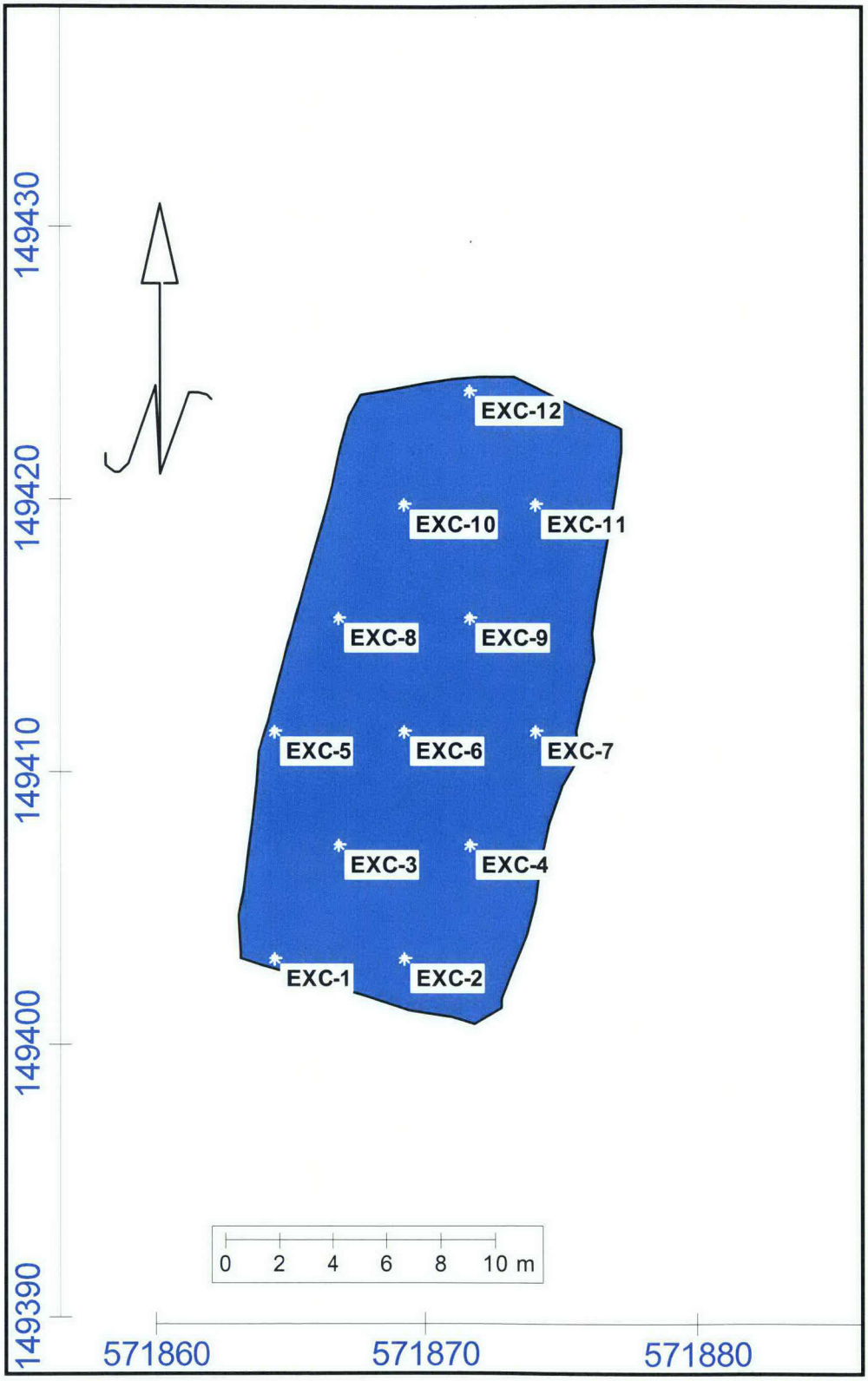


Table 2. 100-N-82 Sample Summary.

Sample Location	HEIS Sample Number	Washington State Plane		Sample Analysis [a]
		Northing (m)	Easting (m)	
EXC-1	J1TL89	149403.1	571864.5	ICP metals [b], mercury, hexavalent chromium, nitrate/nitrite, GEA, nickel-63, strontium-90, isotopic plutonium, isotopic thorium, isotopic uranium, tritium [c]
EXC-2	J1TL90	149403.1	571869.3	
EXC-3	J1TL91	149407.3	571866.9	
EXC-4	J1TL92	149407.3	571871.7	
EXC-5	J1TL93	149411.5	571864.5	
EXC-6	J1TL94	149411.5	571869.3	
EXC-7	J1TL95	149411.5	571874.1	
EXC-8	J1TL96	149415.6	571866.9	
EXC-9	J1TL97	149415.6	571871.7	
EXC-10	J1TL98	149419.8	571869.3	
EXC-11	J1TL99	149419.8	571874.1	
EXC-12	J1TLC0	149423.9	571871.7	
Duplicate of J1TL96	J1TLC1	149415.6	571866.9	
Split of J1TL96	J1TLC3	149415.6	571866.9	
Equipment blank	J1TLC2	NA	NA	ICP metals [a], mercury

[a] Sample analysis was performed as defined in Table 1, Laboratory Analytical Methods. Grab samples were collected at each identified location. All sampling was performed in accordance with ENV-1, Environmental Monitoring and Management consistent with the SAP (DOE-RL 2006) requirements.

[b] The expanded list of ICP metals was performed and included antimony, arsenic, barium, beryllium, boron, cadmium, chromium (total), cobalt, copper, lead, manganese, molybdenum, nickel, selenium, silver, vanadium, and zinc.

[c] The portion of the sample for tritium analysis was collected at a depth of 0.15 m (6 in.) below the excavation surface per Tri-Party Agreement Change Notice TPA-CN-177 (dated August 21, 2007).

GEA = gamma energy analysis
HEIS = Hanford Environmental Information System
ICP = inductively coupled plasma
NA = not applicable
SAP = sampling analysis plan

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-82 excavation 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 a decision unit, the maximum detected value was used for comparison to remedial action goals (RAGs). If no detections for a given COPC were reported in the data set, then no statistical calculation or evaluation was performed for that COPC.

Comparisons of the statistical results for COPCs against the site RAGs are summarized in Table 3. Contaminants that were not detected by laboratory analysis are excluded from these tables. Calculated cleanup levels are not presented in the Cleanup Levels and Risk Calculations Database (Ecology 2014) under WAC 173-340-740(3) for calcium, magnesium, potassium, silicon, and sodium. The EPA's *Risk Assessment Guidance for Superfund* (EPA 1989) recommends that aluminum and iron not be considered in site risk evaluations. Therefore, aluminum, calcium, iron, magnesium, potassium, silicon, and sodium are not considered site COPCs and are also not included in the table. The complete laboratory results for all constituents are stored in a Washington Closure Hanford (WCH) project-specific database prior to archival in the Hanford Environmental Information System (HEIS) and are presented in Attachment 1 of the calculations (Appendix B).

Table 3. Comparison of Contaminant Concentrations to Action Levels for the 100-N-82 Waste Site Verification Samples. (2 Pages)

COPC	Statistical or Maximum Result [b] (pCi/g)	Soil Lookup Values (pCi/g) [a]			Does the Result Exceed Lookup Values?	Does the Result Pass RESRAD Modeling?
		Shallow Zone Lookup Value	Soil Lookup Value for Groundwater Protection	Soil Lookup Value for River Protection		
Cesium-137	0.0833 (<BG)	6.2	1,465	1,465	No	--
Thorium-230	0.323	2.95	NV	NV	No	--
Uranium-234	0.323 (<BG)	1.1 [c]	1.1 [c]	1.1 [c]	No	--
Uranium-238	0.0.268 (<BG)	1.1 [c]	1.1 [c]	1.1 [c]	No	--
Nickel-63	1.45	4,013	83	83	No	--
COPC	**Statistical or Maximum Result [b] (mg/kg)**	**Remedial Action Goals (mg/kg) [a]**			**Does the Result Exceed RAGs?**	**Does the Result Pass RESRAD Modeling?**
		Direct Exposure	**Soil Cleanup Level for Groundwater Protection**	**Soil Cleanup Level for River Protection**		
Arsenic	2.6 (<BG)	20 [d]	20 [d]	20 [d]	No	--
Barium	65.4 (<BG)	16,000 [e]	200	400	No	--
Beryllium	0.31 (<BG)	10.4 [f]	1.51 [d]	1.51 [d]	No	--
Boron [g]	1.6	16,000 [e]	320	-- [h]	No	--
Chromium	10.0 (<BG)	120,000 [e]	18.5 [d]	18.5 [d]	No	--
Cobalt	7.1 (<BG)	1,600 [e]	32	-- [h]	No	--
Copper	18.4 (<BG)	2,960 [e]	59.2	22.0 [d]	No	--

Table 3. Comparison of Contaminant Concentrations to Action Levels for the 100-N-82 Waste Site Verification Samples. (2 Pages)

COPC	Statistical or Maximum Result [b] (mg/kg)	Remedial Action Goals (mg/kg) [a]			Does the Result Exceed RAGs?	Does the Result Pass RESRAD Modeling?
		Direct Exposure	Soil Cleanup Level for Groundwater Protection	Soil Cleanup Level for River Protection		
Hexavalent chromium [g]	0.283	2.1	4.8	2	No	--
Lead	4.0 (<BG)	353	10.2 [d]	10.2 [d]	No	--
Manganese	311 (<BG)	11,200 [e]	512 [d]	-- [h]	No	--
Mercury	0.0062 (<BG)	24 [e]	0.33 [d]	0.33 [d]	No	--
Molybdenum [g]	0.28	400 [e]	8	-- [h]	No	--
Nickel	11.4 (<BG)	1,600 [e]	19.1 [d]	27.4	No	--
Vanadium	49.4 (<BG)	560 [e]	85.1 [d]	-- [h]	No	--
Zinc	39.8 (<BG)	24,000 [e]	480	67.8 [d]	No	--
Nitrogen in nitrite and nitrate	41.4	128,000 [e]	1,000	2,000	No	--

[a] Lookup values and RAGs obtained from the 100-N Area RDR/RAWP (DOE-RL 2013), or the 100 Area RDR/RAWP (DOE-RL 2009) where indicated.
[b] Statistical or maximum results as described in the *100-N-82 Waste Site Cleanup Verification 95% UCL Calculations.*
[c] The remedial action goal is below the Hanford-specific soil background concentration. The value presented is the Hanford-specific soil background concentration.
[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 as discussed in Section 2.1.2.1 of the 100-N Area RDR/RAWP (DOE-RL 2013).
[e] Noncarcinogenic cleanup level calculated from WAC 173-340-740(3), Method B, Ecology 1996.
[f] Carcinogenic cleanup level calculated based on the inhalation exposure pathway (WAC 173-340-750[3], Ecology 1996).
[g] No Hanford Site-specific or Washington State background value available.
[h] 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
NV = no value
RAG = remedial action goal
RDR/RAWP = Remedial Design Report/Remedial Action Work Plan
RESRAD = RESidual RADioactivity (dose model)
WAC = *Washington Administrative Code*

Potassium-40, radium-226, thorium-228, and thorium-232 were detected in samples collected at the site, but are not included in the tables, as these isotopes are unrelated to the operational history of the site and were detected below background levels. The thorium and radium detected in environmental samples are associated with background quantities of uranium naturally present in soil and will only occur on the Hanford Site in secular equilibrium with naturally occurring uranium. Radium-228 and thorium-228 are daughter products of thorium-232. Radium-226 and thorium-230 are daughter products of uranium-238. Based on the assumption of secular equilibrium, the background activities for radium-228 and thorium-228 are equal to the statistical background activity of 1.32 pCi/g for thorium-232 and the background for thorium-230 as a daughter product of uranium-238 will be the same as the background for uranium-238, which is 1.06 pCi/g provided in *Hanford Site Background: Part 2, Soil Background for Radionuclides* (DOE-RL 1996).

CLEANUP VERIFICATION DATA EVALUATION

This section demonstrates that remedial action at the 100-N-82 waste site has achieved 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 Radionuclide RAGs

The radionuclide analytical results for the verification samples were all below lookup values, as shown in Table 3. Evaluation of direct exposure RAG attainment for radionuclides was performed using the single-radionuclide dose-equivalence lookup values to do sum-of-fractions evaluations. The model used to develop these dose-equivalence lookup values is presented in the 100-N Area RDR/RAWP (DOE-RL 2013).

A sum-of-fractions calculation presented in the *100-N-82 Waste Site Direct Contact Hazard Quotient, Carcinogenic Risk, and Sum of Fractions Calculation* in Appendix B compares the radionuclide verification sampling results for the statistical data set to 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. The columns on the left side of the tables are the COPCs and the radionuclide activities corrected for background, as appropriate. The third column presents the single radionuclide 15 mrem/yr dose-equivalence activities, and the last column presents the radionuclide activities divided by the dose-equivalence activities. As demonstrated by the summation of these fractions, the cumulative dose contributed by residual radionuclide populations is predicted to be less than the 15 mrem/yr RAG at 1.73 mrem/yr.

Direct Comparison to RAGs

Table 3 compares the cleanup verification sample values statistical results for the excavation area to the applicable soil RAGs for direct exposure, protection of groundwater, and protection of the Columbia River. No contaminants exceed direct exposure RAGs. All cleanup verification data values pass in direct comparison to the applicable RAGs. The only pathway for contaminant migration to the Columbia River is via groundwater; therefore, residual concentrations of these contaminants are also predicted to be protective of 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. The WAC 173-340 three-part test 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 can exceed two times the cleanup criteria, and (3) the percentage of samples exceeding the cleanup criteria must be less than 10% of the data set.

The application of the WAC 173-340 three-part test for the 100-N-82 waste site statistical data is included in the 95% UCL calculation (Appendix B). The results of this evaluation indicate that all residual COPC concentrations pass the three-part test in comparison to applicable RAGs.

Nonradionuclide Direct Contact Hazard Quotient and Carcinogenic Risk RAGs Attained

Assessment of the risk requirements for the 100-N-82 waste site was determined by calculation of the hazard quotient and excess carcinogenic risk. The requirements include an individual hazard quotient of less than 1.0, a cumulative hazard quotient of less than 1.0, an individual contaminant carcinogenic risk of less than 1×10^{-6}, and a cumulative excess carcinogenic risk of less than 1×10^{-5}. Hazard quotient and excess carcinogenic risk calculations for direct contact were conservatively performed for the 100-N-82 waste site using the highest of the statistical values from the excavation area. Risk values were not calculated for constituents that were not detected or were detected at concentrations below Hanford Site or Washington State background values. All individual hazard quotients are below 1.0, and all individual excess carcinogenic risk values are below 1×10^{-6}. The direct contact cumulative hazard quotient for the 100-N-82 waste site is 2.3×10^{-3}. The carcinogenic risk value for hexavalent chromium, the only carcinogenic constituent detected above background levels, is 1.3×10^{-7}, which is below the individual and cumulative cancer risk standards of 1×10^{-6} and 1×10^{-5}, respectively. Therefore, the 100-N-82 waste site meets the requirements for the direct contact hazard quotient and excess carcinogenic risk as identified in the 100-N Area RDR/RAWP (DOE-RL 2013).

Nonradionuclide Groundwater Hazard Quotient and Carcinogenic Risk RAGs Attained

Assessment of the risk requirements for the 100-N-82 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 value for each COPC from each of the decision units. 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 coefficient (K_d) values 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 21 m (69 ft) in thickness at the excavation, a K_d of 3.6 or greater is required to show no predicted migration to groundwater within 1,000 years. All individual hazard quotients for noncarcinogenic constituents are less than 1.0. The cumulative hazard quotient for the 100-N-82 waste site is 8.0×10^{-2}, which is less than 1.0. The 100-N-82 waste site does not have any carcinogenic constituents subject to the groundwater cancer risk calculation; therefore, the criterion for excess cancer risk is met. Nonradionuclide risk requirements related to groundwater are met.

DATA QUALITY ASSESSMENT

A data quality assessment (DQA) was performed to compare the verification sampling approach (WCH 2014b), the field logbook (WCH 2014a), and resulting analytical data with the sampling and data quality requirements specified by the project objectives and performance specifications. The DQA for the 100-N-82 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 WCH project-specific database for data evaluation prior to its archival in the HEIS and are summarized in Appendix B. The detailed DQA is presented in Appendix C.

SUMMARY FOR INTERIM CLOSURE

The 100-N-82 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 results indicate that the residual concentrations of COPCs at this site meet the RAGs and corresponding remedial action objectives for direct exposure, groundwater protection, and river protection. In accordance with this evaluation, the verification sampling and modeling results support a reclassification of the 100-N-82 waste site to Interim Closed Out. Site contamination did not extend into the deep zone soils; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are not required.

REFERENCES

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Gilbert, R. O., 1987, *Statistical Methods for Environmental Pollution Monitoring*, Wiley & Sons, Inc., New York, New York.

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WCH, 2014a, *100N Field Remediation Sampling*, Logbook EL-1652-12, pp. 9-14, Washington Closure Hanford, Richland, Washington.

WCH, 2014b, *Work Instruction for Verification Sampling of the 100-N-82, 100-N Decontamination Pad Waste Site,* Work Instruction No. 0100N-WI-G0078, Rev. 0, Washington Closure Hanford, Richland, Washington.

APPENDIX A

EXCEEDANCES OF ECOLOGICAL SCREENING LEVELS FOR THE 100-N-82 WASTE SITE

Table A-1. Maximum Contaminant Concentrations that Exceed Ecological Screening Levels for the 100-N-82 Waste Site [a].

Hazardous Substance		2007 WAC 173-340, Table 749-3			EPA Ecological Soil Screening Levels [b]				Maximum of Focused or Statistical Result
		Plants	Soil Biota	Wildlife	Plants	Soil Biota	Avian [c]	Mammalian [c]	
	Background	Metals (mg/kg)							
Boron	--	0.5	--	--	--	--	--	--	1.6
Manganese	512	1,100	--	1,500	220	450	4,300	4,000	311 (<BG)
Vanadium	85.1	2	--	--	--	--	7.8	280	49.4 (<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.

-- = values not available

BG = Hanford Site Background

EPA = U.S. Environmental Protection Agency

WAC= *Washington Administrative Code*

APPENDIX B

CALCULATIONS

APPENDIX B

CALCULATION BRIEF

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-82 Waste Site Cleanup Verification, 95% UCL Calculation, 0100N-CA-V0279, Rev. 0, Washington Closure Hanford, Richland, Washington.

100-N-82 Waste Site Direct Contact Hazard Quotient, Carcinogenic Risk, and Sum of Fractions Calculation, 0100N-CA-V0282, Rev. 0, Washington Closure Hanford, Richland, Washington.

100-N-82 Waste Site Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater, 0100N-CA-V0283, Rev. 0, Washington Closure Hanford, Richland, Washington.

DISCLAIMER FOR CALCULATIONS

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

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CALCULATION COVER SHEET

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

Area: 100-N

Discipline: Environmental *Calculation No: 0100N-CA-V0279

Subject: 100-N-82 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 = 5 Total = 17	I. B. Berezovskiy	J. D. Skoglie	H. M. Sulloway	D. F. Obenauer	6/19/14

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 I. B. Berezovskiy	**Date** 06/16/14	**Calc. No.** 0100N-CA-V0279	**Rev. No.** 0
Project 100-N Field Remediation	**Job No.** 14655	**Checked** J. D. Skoglie	**Date** 06/16/14
Subject 100-N-82 Waste Site Cleanup Verification 95% UCL Calculations			**Sheet No.** 1 of 11

Summary

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

Table of Contents:
Sheets 1 to 4 - Calculation Sheet Summary
Sheets 5 to 8 - Calculation Sheet Verification Data - Excavation Statistical and Maximum Calculations
Sheets 9 to 10 - Ecology Software (MTCAStat) Results
Sheet 11- Calculation Sheet Duplicate-Split Analysis
Attachment 1 - 100-N-82 Waste Site Verification Sampling Results (5 sheets)

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-82 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-82 waste site excavation area decision unit underwent statistical sampling.

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

Washington Closure Hanford

CALCULATION SHEET

Originator I. B. Berezovskiy	**Date** 06/16/14	**Calc. No.** 0100N-CA-V0279		**Rev. No.** 0
Project 100-N Field Remediation	**Job No.** 14655	**Checked** J. D. Skoglie		**Date** 06/16/14
Subject 100-N-82 Waste Site Cleanup Verification 95% UCL Calculations				**Sheet No.** 2 of 11

Summary (continued)

Methodology, continued:

For nonradioactive analytes with ≤50% of the data below detection limits, the statistical value calculated to evaluate the effectiveness of cleanup is the 95% UCL. For nonradioactive analytes with >50% of the data below detection limits, as determined by direct inspection of the sample results (Attachment 1), the maximum detected value for the data set (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, radium-226, radium-228, thorium-228, and thorium-232 based on natural occurrence at the Hanford Site.

All nonradionuclide data reported as being undetected are set to ½ the detection limit value for calculation of the statistics (Ecology 1993). 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 necessary is provided in the data quality assessment section of the applicable RSVP.

Washington Closure Hanford **CALCULATION SHEET**

Originator I. B. Berezovskiy	**Date** 06/16/14	**Calc. No.** 0100N-CA-V0279	**Rev. No.** 0
Project 100-N Field Remediation	**Job No.** 14655	**Checked** J. D. Skoglie	**Date** 06/16/14
Subject 100-N-82 Waste Site Cleanup Verification 95% UCL Calculations			**Sheet No.** 3 of 11

Summary (continued)

QUALIFIER LIST

B = estimated result. Result is less than the RL, but greater than MDL.
J = estimate
N = recovery exceeds upper or lower control limits.
U = undetected
X = serial dilution in the analytical batch indicates that physical and chemical interferences are present (metals).

ACRONYM LIST

-- = not applicable
DE = direct exposure
EXC = excavation
GW = groundwater
MTCA = *Model Toxics Control Act*
PQL = practical quantitation limit
Q = qualifier
QA/QC = quality assurance/quality control
RAG = remedial action goal
RDR/RAWP = remedial design report/remedial action work plan
RESRAD = RESidual RADioactivity (dose model)
RPD = relative percent difference
RSVP = remaining sites verification package
SAP = sampling and analysis plan
TDL = target detection limit
UCL = upper confidence limit
WAC = Washington Administrative Code

Washington Closure Hanford **CALCULATION SHEET**

Originator I. B. Berezovskiy **Date** 06/23/14 **Calc. No.** 0100N-CA-V0279 **Rev. No.** 0
Project 100-N Field Remediation **Job No.** 14655 **Checked** J. D. Skoglie **Date** 06/23/14
Subject 100-N-82 Waste Site Cleanup Verification 95% UCL Calculations **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 100-N-82 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 these sites.

Results Summary - 100-N-82 Excavation [a]

Analyte	100-N-82 Excavation		Units
	95% UCL Result	Maximum Result	
Cesium-137	0.0833	--	pCi/g
Thorium-230	0.323	--	pCi/g
Uranium-234	0.203	--	pCi/g
Uranium-238	0.268	--	pCi/g
Nickel-63	1.45	--	pCi/g
Arsenic	2.6	--	mg/kg
Barium	65.4	--	mg/kg
Beryllium	0.31	--	mg/kg
Boron	--	1.6	mg/kg
Chromium	10.0	--	mg/kg
Cobalt	7.1	--	mg/kg
Copper	18.4	--	mg/kg
Hexavalent chromium	--	0.283	mg/kg
Lead	4.0	--	mg/kg
Manganese	311	--	mg/kg
Mercury	--	0.0062	mg/kg
Molybdenum	--	0.28	mg/kg
Nickel	11.4	--	mg/kg
Vanadium	49.4	--	mg/kg
Zinc	39.8	--	mg/kg
Nitrogen in nitrite and nitrate	41.4	--	mg/kg

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 in the methodology section.

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

Analyte	100-N-82 Excavation	
	Duplicate	Split
Potassium-40	7.1%	9.7%
Aluminum	4.1%	14.8%
Barium	0.2%	1.7%
Calcium	12.8%	3.1%
Chromium	16..6%	15.5%
Copper	13.0%	6.6%
Iron	7.4%	10.3%
Magnesium	3.9%	7.2%
Manganese	1.3%	0.3%
Silicon	16.8%	***64.2%***
Sodium	12.6%	--
Vanadium	11.0%	17.2%
Zinc	4.5%	16.2%

[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%, and values greater than 35% for splits, is addressed in the data quality assessment section of the RSVP.

CALCULATION SHEET

Washington Closure Hanford

Originator I. B. Berezovskiy
Project 100-N Field Remediation
Subject 100-N-82 Waste Site Cleanup Verification 95% UCL Calculations

Date 06/16/14
Job No. 14655

Calc. No. 0100N-CA-V0279
Checked J. D. Skoglie

Rev. No. 0
Date 06/16/14
Sheet No. 5 of 11

1 **100-N-82 Statistical Calculations**

2 **Verification Data - Excavation**

3	Sample	Sample	Sample	Cesium-137			Thorium-230			Uranium-234			Uranium-238			Nickel-63		
4	Area	Number	Date	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
5	EXC-8	J1TL96	5/16/14	0.0921		0.0203	0.139		0.0507	0.0924		0.0507	0.161		0.0585	2.43	U	4.78
6	Duplicate of J1TL96	J1TLC1	5/16/14	0.0851		0.0278	0.397		0.0572	0.144		0.0845	0.175		0.0774	5.54		5.04
7	EXC-1	J1TL89	5/16/14	0.256		0.0408	0.274		0.0794	0.138		0.0665	0.166		0.0556	-0.364	U	5.26
8	EXC-2	J1TL90	5/16/14	0.0413	U	0.0348	0.280		0.0708	0.181		0.0937	0.117		0.0736	-0.509	U	5.25
9	EXC-3	J1TL91	5/16/14	0.00274	U	0.0255	0.394		0.0625	0.294		0.128	0.402		0.0881	0.665	U	5.02
10	EXC-4	J1TL92	5/16/14	0.000226	U	0.0246	0.245		0.0621	0.222		0.0614	0.198		0.0634	-0.385	U	5.22
11	EXC-5	J1TL93	5/16/14	0.0501		0.0244	0.336		0.0533	0.178		0.0554	0.161		0.0744	0.969	U	5.01
12	EXC-6	J1TL94	5/16/14	-0.00925	U	0.0168	0.312		0.0524	0.134		0.0542	0.227		0.0615	0.179	U	5.25
13	EXC-7	J1TL95	5/16/14	0.0181	U	0.0283	0.179		0.0653	0.218		0.0735	0.290		0.0787	1.55	U	5.06
14	EXC-9	J1TL97	5/16/14	0.000341	U	0.0245	0.236		0.0686	0.147		0.0717	0.224		0.0545	-0.892	U	5.45
15	EXC-10	J1TL98	5/16/14	-0.00110	U	0.0217	0.259		0.0629	0.201		0.0565	0.0912		0.0670	2.48	U	5.25
16	EXC-11	J1TL99	5/16/14	0.00908	U	0.0254	0.283		0.0572	0.192		0.0773	0.249		0.0727	0.680	U	5.17
17	EXC-12	J1TLC0	5/16/14	0.0259	U	0.0259	0.272		0.0590	0.158		0.0773	0.192		0.0650	1.92	U	4.89

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19 **Statistical Computation Input Data**

20	Sample	Sample	Sample	Cesium-137			Thorium-230			Uranium-234			Uranium-238			Nickel-63		
21	Area	Number	Date	pCi/g			pCi/g			pCi/g			pCi/g			pCi/g		
22	EXC-8	J1TL96/ J1TLC1	5/16/14	0.0886			0.268			0.118			0.168			3.99		
23	EXC-1	J1TL89	5/16/14	0.256			0.274			0.138			0.166			-0.364		
24	EXC-2	J1TL90	5/16/14	0.0413			0.280			0.181			0.117			-0.509		
25	EXC-3	J1TL91	5/16/14	0.00274			0.394			0.294			0.402			0.665		
26	EXC-4	J1TL92	5/16/14	0.000226			0.245			0.222			0.198			-0.385		
27	EXC-5	J1TL93	5/16/14	0.0501			0.336			0.178			0.161			0.969		
28	EXC-6	J1TL94	5/16/14	-0.00925			0.312			0.134			0.227			0.179		
29	EXC-7	J1TL95	5/16/14	0.0181			0.179			0.218			0.290			1.55		
30	EXC-9	J1TL97	5/16/14	0.000341			0.236			0.147			0.224			-0.892		
31	EXC-10	J1TL98	5/16/14	-0.00110			0.259			0.201			0.0912			2.48		
32	EXC-11	J1TL99	5/16/14	0.00908			0.283			0.192			0.249			0.680		
33	EXC-12	J1TLC0	5/16/14	0.0130			0.272			0.158			0.192			1.92		

34 **Statistical Computations**

35		Cesium-137			Thorium-230			Uranium-234			Uranium-238			Nickel-63		
36	95% UCL based on	Radionuclide data set. Use nonparametric z-statistic.			Radionuclide data set. Use nonparametric z-statistic.			Radionuclide data set. Use nonparametric z-statistic.			Radionuclide data set. Use nonparametric z-statistic.			Radionuclide data set. Use nonparametric z-statistic.		
37	N	12			12			12			12			12		
38	% < Detection limit	75%			0%			0%			0%			92%		
39	Mean	0.0391			0.278			0.182			0.207			0.857		
40	Standard deviation	0.0738			0.0532			0.0486			0.0823			1.43		
41	Z-statistic	1.64			1.64			1.64			1.64			1.64		
42	95% UCL on mean	0.0741			0.303			0.205			0.246			1.54		
43	Maximum value	0.256			0.397			0.294			0.402			5.54		

44 Qualifiers are defined on page 3.

CALCULATION SHEET

Washington Closure Hanford

Originator J. B. Berezovskiy
Project 100-N Field Remediation
Subject 100-N-82 Waste Site Cleanup Verification 95% UCL Calculations

Date 06/16/14
Job No. 14655

Calc. No. 0100N-CA-V0279 0
Checked J. D. Skoglie

Rev. No. 0
Date 06/16/14
Sheet No. 6 of 11

1 **100-N-82 Statistical Calculations**

2 **Verification Data - Excavation**

3	Sample	Sample	Sample	Arsenic			Barium			Beryllium			Chromium			Cobalt			Copper			Lead			Manganese			Nickel			Vanadium		
4	Area	Number	Date	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
5	EXC-8	J1TL96	5/16/14	2.6		0.62	65.6		0.071	0.31		0.031	7.2		0.054	7.9	X	0.094	18.6		0.20	3.6		0.25	306		0.094	10.1	X	0.12	57.4		0.088
6	Duplicate of J1TL96	J1TLC1	5/16/14	2.4		0.63	65.5		0.073	0.33		0.032	8.5		0.056	7.0	X	0.096	16.5		0.21	3.7		0.26	312		0.096	9.4	X	0.12	51.4		0.090
7	EXC-1	J1TL89	5/16/14	2.6		0.59	78.4		0.068	0.35		0.030	11.0		0.052	7.5	X	0.090	16.1		0.19	4.7		0.24	354		0.090	12.0	X	0.11	46.7		0.084
8	EXC-2	J1TL90	5/16/14	2.6		0.61	46.9		0.070	0.31		0.031	7.9		0.054	7.3	X	0.092	24.3		0.20	4.0		0.25	349		0.092	12.1	X	0.11	39.6		0.087
9	EXC-3	J1TL91	5/16/14	2.4		0.63	38.7		0.072	0.25		0.031	11.2		0.055	6.4	X	0.095	18.0		0.21	2.8		0.26	258		0.095	13.9	X	0.12	51.0		0.089
10	EXC-4	J1TL92	5/16/14	2.4		0.58	62.9		0.067	0.27		0.029	10.3		0.051	5.9	X	0.088	15.4		0.19	3.3		0.24	257		0.088	9.6	X	0.11	46.1		0.083
11	EXC-5	J1TL93	5/16/14	2.5		0.58	72.4		0.067	0.35		0.029	10.6		0.051	7.0	X	0.088	15.2		0.19	4.8		0.24	340		0.088	12.1	X	0.11	46.7		0.083
12	EXC-6	J1TL94	5/16/14	2.0		0.63	47.5		0.073	0.24		0.032	9.0		0.056	6.2	X	0.096	16.3		0.21	2.9		0.26	242		0.096	9.2	X	0.12	47.1		0.090
13	EXC-7	J1TL95	5/16/14	2.2		0.66	70.5		0.075	0.29		0.033	9.2		0.058	6.8	X	0.099	14.7		0.22	3.9		0.27	268		0.099	9.4	X	0.12	39.5		0.093
14	EXC-9	J1TL97	5/16/14	3.1		0.60	29.9		0.069	0.23		0.030	8.7		0.052	6.2	X	0.090	15.9		0.20	2.7		0.24	249		0.090	9.8	X	0.11	46.8		0.085
15	EXC-10	J1TL98	5/16/14	1.6		0.59	34.6		0.068	0.21		0.030	6.0		0.052	6.3	X	0.090	18.5		0.19	2.2		0.24	237		0.090	7.6	X	0.11	43.4		0.084
16	EXC-11	J1TL99	5/16/14	2.3		0.58	52.7		0.067	0.27		0.029	8.2		0.051	6.5	X	0.088	15.8		0.19	3.6		0.24	279		0.088	8.8	X	0.11	49.4		0.083
17	EXC-12	J1TLC0	5/16/14	2.7		0.67	52.3		0.077	0.32		0.034	8.7		0.059	7.5	X	0.10	18.6		0.22	3.7		0.27	301		0.10	10.3	X	0.13	52.0		0.096

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19 **Statistical Computation Input Data**

20	Sample	Sample	Sample	Arsenic	Barium	Beryllium	Chromium	Cobalt	Copper	Lead	Manganese	Nickel	Vanadium
21	Area	Number	Date	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
22	EXC-8	J1TL96/ J1TLC1	5/16/14	2.5	65.6	0.32	7.9	7.5	17.7	3.7	310	9.8	54.4
23	EXC-1	J1TL89	5/16/14	2.6	78.4	0.35	11.0	7.5	16.1	4.7	354	12.0	46.7
24	EXC-2	J1TL90	5/16/14	2.6	46.9	0.31	7.9	7.3	24.3	4.0	349	12.1	39.6
25	EXC-3	J1TL91	5/16/14	2.4	38.7	0.25	11.2	6.4	18.0	2.8	258	13.9	51.0
26	EXC-4	J1TL92	5/16/14	2.4	62.9	0.27	10.3	5.9	15.4	3.3	257	9.6	46.1
27	EXC-5	J1TL93	5/16/14	2.5	72.4	0.35	10.6	7.0	15.2	4.8	340	12.1	46.7
28	EXC-6	J1TL94	5/16/14	2.0	47.5	0.24	9.0	6.2	16.3	2.9	242	9.2	47.1
29	EXC-7	J1TL95	5/16/14	2.2	70.5	0.29	9.2	6.8	14.7	3.9	268	9.4	39.5
30	EXC-9	J1TL97	5/16/14	3.1	29.9	0.23	8.7	6.2	15.9	2.7	249	9.8	46.8
31	EXC-10	J1TL98	5/16/14	1.6	34.6	0.21	6.0	6.3	18.5	2.2	237	7.6	43.4
32	EXC-11	J1TL99	5/16/14	2.3	52.7	0.27	8.2	6.5	15.8	3.6	279	8.8	49.4
33	EXC-12	J1TLC0	5/16/14	2.7	52.3	0.32	8.7	7.5	18.6	3.7	301	10.3	52.0

34 **Statistical Computations**

35		Arsenic	Barium	Beryllium	Chromium	Cobalt	Copper	Lead	Manganese	Nickel	Vanadium
36	95% UCL based on	Large data set (n ≥ 10), use MTCAStat normal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.
37	N	12	12	12	12	12	12	12	12	12	12
38	% < Detection limit	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
39	Mean	2.4	54.4	0.28	9.1	6.8	17.2	3.5	287	10.4	46.9
40	Standard deviation	0.37	15.7	0.047	1.5	0.58	2.6	0.79	42.6	1.8	4.5
41	95% UCL on mean	2.6	65.4	0.312	10.0	7.1	18.4	4.0	311	11.4	49.4
42	Maximum value	3.1	78.4	0.35	11.2	7.9	24.3	4.8	354	13.9	57.4
43	**Most Stringent Cleanup Limit for nonradionuclide and RAG type (mg/kg)**	20 DE, GW & River Protection	200 GW Protection	1.51 GW & River Protection	18.5 GW & River Protection	32 GW Protection	22.0 River Protection	10.2 GW & River Protection	512 GW Protection	19.1 GW Protection	85.1 GW Protection
44	**WAC 173-340 3-PART TEST**										
45	95% UCL > Cleanup Limit?	NA	NA	NA	NA	NA	NO	NA	NA	NA	NA
46	> 10% above Cleanup Limit?	NA	NA	NA	NA	NA	NO	NA	NA	NA	NA
47	Any sample > 2X Cleanup Limit?	NA	NA	NA	NA	NA	NO	NA	NA	NA	NA
48	**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 (6.5 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.	The data set meets the 3-part test criteria when compared to the most stringent RAG.	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.

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CALCULATION SHEET

Washington Closure Hanford
Originator I. B. Berezovskiy
Project 100-N Field Remediation
Subject 100-N-82 Waste Site Cleanup Verification 95% UCL Calculations

Date 06/16/14
Job No. 14655

Calc. No. 0100N-CA-V0279
Checked J. D. Skoglie

Rev. No. 0
Date 06/16/14
Sheet No. 7 of 11

1 **100-N-82 Statistical Calculations**
2 **Verification Data - Excavation**

3	Sample	Sample	Sample	Zinc			Nitrogen in Nitrite and Nitrate		
4	Area	Number	Date	mg/kg	Q	PQL	mg/kg	Q	PQL
5	EXC-8	J1TL96	5/16/14	43.6	X	0.37	0.37	B	0.37
6	Duplicate of J1TL96	J1TLC1	5/16/14	41.7	X	0.38	0.36	U	0.36
7	EXC-1	J1TL89	5/16/14	42.4	X	0.36	11.1		0.37
8	EXC-2	J1TL90	5/16/14	39.4	X	0.37	2.1		0.37
9	EXC-3	J1TL91	5/16/14	36.5	X	0.38	0.86		0.37
10	EXC-4	J1TL92	5/16/14	34.7	X	0.35	0.37	U	0.37
11	EXC-5	J1TL93	5/16/14	40.7	X	0.35	5.8		0.37
12	EXC-6	J1TL94	5/16/14	37.0	X	0.38	23.9		0.37
13	EXC-7	J1TL95	5/16/14	34.4	X	0.40	3.7		0.37
14	EXC-9	J1TL97	5/16/14	34.2	X	0.36	3.1		0.37
15	EXC-10	J1TL98	5/16/14	30.7	X	0.36	1.0		0.36
16	EXC-11	J1TL99	5/16/14	38.9	X	0.35	0.36	U	0.36
17	EXC-12	J1TLC0	5/16/14	40.4	X	0.40	2.8		0.37

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19 **Statistical Computation Input Data**

20	Sample	Sample	Sample	Zinc			Nitrogen in Nitrite and Nitrate		
21	Area	Number	Date	mg/kg			mg/kg		
22	EXC-8	J1TL96/ J1TLC1	5/16/14	42.7			0.28		
23	EXC-1	J1TL89	5/16/14	42.4			11.1		
24	EXC-2	J1TL90	5/16/14	39.4			2.1		
25	EXC-3	J1TL91	5/16/14	36.5			0.86		
26	EXC-4	J1TL92	5/16/14	34.7			0.19		
27	EXC-5	J1TL93	5/16/14	40.7			5.8		
28	EXC-6	J1TL94	5/16/14	37.0			23.9		
29	EXC-7	J1TL95	5/16/14	34.4			3.7		
30	EXC-9	J1TL97	5/16/14	34.2			3.1		
31	EXC-10	J1TL98	5/16/14	30.7			1.0		
32	EXC-11	J1TL99	5/16/14	38.9			0.18		
33	EXC-12	J1TLC0	5/16/14	40.4			2.8		

34 **Statistical Computations**

35		Zinc			Nitrogen in Nitrite and Nitrate		
36	95% UCL based on	Large data set (n ≥ 10), use MTCAStat lognormal distribution.			Large data set (n ≥ 10), use MTCAStat lognormal distribution.		
37	N	12			12		
38	% < Detection limit	0%			17%		
39	Mean	37.7			4.6		
40	Standard deviation	3.7			6.8		
41	95% UCL on mean	39.8			41.4		
42	Maximum value	43.6			23.9		
43	**Most Stringent Cleanup Limit for nonradionuclide and RAG type (mg/kg)**	67.8	River Protection		1000	GW Protection	
44	**WAC 173-340 3-PART TEST**						
45	95% UCL > Cleanup Limit?	NA			NO		
46	> 10% above Cleanup Limit?	NA			NO		
47	Any sample > 2X Cleanup Limit?	NA			NO		
48	**WAC 173-340 Compliance?**	Because all values are below background (67.8 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.		

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MAXIMUM VALUE 3-PART TEST CALCULATION SHEET

Washington Closure Hanford

Originator I. B. Berezovskiy
Project 100-N Field Remediation
Subject 100-N-82 Waste Site Cleanup Verification 95% UCL Calculations

Date 06/16/14
Job No. 14655

Calc. No. 0100N-CA-V0279
Checked J. D. Skoglie

Rev. No. 0
Date 06/16/14
Sheet No. 8 of 11

1 **100-N-82 Statistical Calculations**
2 **Verification Data - Excavation**

3	Sample	Sample	Sample	Boron			Hexavalent Chromium			Mercury			Molybdenum		
4	Area	Number	Date	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
5	EXC-8	J1TL96	5/16/14	1.1	B	0.92	0.155	U	0.155	0.0051	U	0.0051	0.24	U	0.24
6	Duplicate of J1TL96	J1TLC1	5/16/14	1.2	B	0.94	0.237		0.155	0.0062	B	0.0048	0.25	U	0.25
7	EXC-1	J1TL89	5/16/14	1.6	B	0.88	0.155	U	0.155	0.0063	U	0.0063	0.28	B	0.23
8	EXC-2	J1TL90	5/16/14	1.0	B	0.91	0.155	U	0.155	0.0061	U	0.0061	0.24	U	0.24
9	EXC-3	J1TL91	5/16/14	0.93	U	0.93	0.178		0.155	0.0055	B	0.0053	0.25	U	0.25
10	EXC-4	J1TL92	5/16/14	0.87	U	0.87	0.155	U	0.155	0.0048	U	0.0048	0.23	U	0.23
11	EXC-5	J1TL93	5/16/14	1.3	B	0.86	0.155	U	0.155	0.0058	B	0.0053	0.26	B	0.23
12	EXC-6	J1TL94	5/16/14	0.94	U	0.94	0.155	U	0.155	0.0064	U	0.0064	0.25	U	0.25
13	EXC-7	J1TL95	5/16/14	1.2	B	0.97	0.283		0.155	0.0057	U	0.0057	0.26	U	0.26
14	EXC-9	J1TL97	5/16/14	0.89	U	0.89	0.155	U	0.155	0.0055	U	0.0055	0.24	U	0.24
15	EXC-10	J1TL98	5/16/14	0.88	U	0.88	0.155	U	0.155	0.0055	U	0.0055	0.24	B	0.23
16	EXC-11	J1TL99	5/16/14	0.86	U	0.86	0.155	U	0.155	0.0057	U	0.0057	0.23	U	0.23
17	EXC-12	J1TLC0	5/16/14	1.0	U	1.0	0.155	U	0.155	0.0056	B	0.0053	0.26	U	0.26

18 **Statistical Computations**

19		Boron	Hexavalent Chromium	Mercury	Molybdenum
20	% < Detection limit	58%	75%	67%	75%
21	Maximum value	1.6	0.283	0.0062	0.28
22	**Most Stringent Cleanup Limit for nonradionuclide and RAG type (mg/kg)**	320 GW Protection	2 River Protection	0.33 GW & River Protection	8 GW Protection
23	**3-PART TEST**				
24	Maximum > Cleanup Limit?	NO	NO	NA	NO
25	> 10% above Cleanup Limit?	NO	NO	NA	NO
26	Any sample > 2X Cleanup Limit?	NO	NO	NA	NO
27	**3-Part Test Compliance?**	The data set meets the 3-part test criteria when compared to the most stringent RAG.	The data set meets the 3-part test criteria when compared to the most stringent RAG.	Because all values are below background (0.33 mg/kg) the 3-part test is not required.	The data set meets the 3-part test criteria when compared to the most stringent RAG.

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CALCULATION SHEET

Washington Closure Hanford

Originator I. B. Berezovskiy
Project 100-N Field Remediation
Subject 100-N-82 Waste Site Cleanup Verification 95% UCL Calculations

Date 06/16/14
Job No. 14655

Calc. No. 0100N-CA-V0279
Checked J. D. Skoglie

Rev. No. 0
Date 06/16/14
Sheet No. 9 of 11

Ecology Software (MTCAStat) Results, 100-N-82 Waste Site Excavation

Arsenic 95% UCL Calculation

DATA	ID
2.5	J1TL96/ J1TLC1
2.6	J1TL89
2.6	J1TL90
2.4	J1TL91
2.4	J1TL92
2.5	J1TL93
2.0	J1TL94
2.2	J1TL95
3.1	J1TL97
1.6	J1TL98
2.3	J1TL99
2.7	J1TLC0

Number of samples		Uncensored values	
Uncensored	12	Mean	2.4
Censored		Lognormal mean	2.4
Detection limit or PQL		Std. devn.	0.37
Method detection limit		Median	2.5
TOTAL	12	Min.	1.6
		Max.	3.1

Lognormal distribution? r-squared is: 0.893
Normal distribution? r-squared is: 0.932
Recommendations:
Use normal distribution.

UCL (based on t-statistic) is 2.6

Barium 95% UCL Calculation

DATA	ID
65.6	J1TL96/ J1TLC1
78.4	J1TL89
46.9	J1TL90
38.7	J1TL91
62.9	J1TL92
72.4	J1TL93
47.5	J1TL94
70.5	J1TL95
29.9	J1TL97
34.6	J1TL98
52.7	J1TL99
52.3	J1TLC0

Number of samples		Uncensored values	
Uncensored	12	Mean	54.4
Censored		Lognormal mean	54.7
Detection limit or PQL		Std. devn.	15.7
Method detection limit		Median	52.5
TOTAL	12	Min.	29.9
		Max.	78.4

Lognormal distribution? r-squared is: 0.962
Normal distribution? r-squared is: 0.976
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 65.4

Beryllium 95% UCL Calculation

DATA	ID
0.32	J1TL96/ J1TLC1
0.35	J1TL89
0.31	J1TL90
0.25	J1TL91
0.27	J1TL92
0.35	J1TL93
0.24	J1TL94
0.29	J1TL95
0.23	J1TL97
0.21	J1TL98
0.27	J1TL99
0.32	J1TLC0

Number of samples		Uncensored values	
Uncensored	12	Mean	0.28
Censored		Lognormal mean	0.28
Detection limit or PQL		Std. devn.	0.047
Method detection limit		Median	0.28
TOTAL	12	Min.	0.21
		Max.	0.35

Lognormal distribution? r-squared is: 0.967
Normal distribution? r-squared is: 0.969
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 0.31

Chromium 95% UCL Calculation

DATA	ID
7.9	J1TL96/ J1TLC1
11.0	J1TL89
7.9	J1TL90
11.2	J1TL91
10.3	J1TL92
10.6	J1TL93
9.0	J1TL94
9.2	J1TL95
8.7	J1TL97
6.0	J1TL98
8.2	J1TL99
8.7	J1TLC0

Number of samples		Uncensored values	
Uncensored	12	Mean	9.1
Censored		Lognormal mean	9.1
Detection limit or PQL		Std. devn.	1.5
Method detection limit		Median	8.9
TOTAL	12	Min.	6.0
		Max.	11.2

Lognormal distribution? r-squared is: 0.925
Normal distribution? r-squared is: 0.952
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 10.0

Cobalt 95% UCL Calculation

DATA	ID
7.5	J1TL96/ J1TLC1
7.5	J1TL89
7.3	J1TL90
6.4	J1TL91
5.9	J1TL92
7.0	J1TL93
6.2	J1TL94
6.8	J1TL95
6.2	J1TL97
6.3	J1TL98
6.5	J1TL99
7.5	J1TLC0

Number of samples		Uncensored values	
Uncensored	12	Mean	6.8
Censored		Lognormal mean	6.8
Detection limit or PQL		Std. devn.	0.58
Method detection limit		Median	6.7
TOTAL	12	Min.	5.9
		Max.	7.5

Lognormal distribution? r-squared is: 0.928
Normal distribution? r-squared is: 0.924
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 7.1

Copper 95% UCL Calculation

DATA	ID
17.7	J1TL96/ J1TLC1
16.1	J1TL89
24.3	J1TL90
18.0	J1TL91
15.4	J1TL92
15.2	J1TL93
16.3	J1TL94
14.7	J1TL95
15.9	J1TL97
18.5	J1TL98
15.8	J1TL99
18.6	J1TLC0

Number of samples		Uncensored values	
Uncensored	12	Mean	17.2
Censored		Lognormal mean	17.2
Detection limit or PQL		Std. devn.	2.6
Method detection limit		Median	16.2
TOTAL	12	Min.	14.7
		Max.	24.3

Lognormal distribution? r-squared is: 0.828
Normal distribution? r-squared is: 0.767
Recommendations:
Reject BOTH lognormal and normal distributions

UCL (based on Z-statistic) is 18.4

Lead 95% UCL Calculation

DATA	ID
3.7	J1TL96/ J1TLC1
4.7	J1TL89
4.0	J1TL90
2.8	J1TL91
3.3	J1TL92
4.8	J1TL93
2.9	J1TL94
3.9	J1TL95
2.7	J1TL97
2.2	J1TL98
3.6	J1TL99
3.7	J1TLC0

Number of samples		Uncensored values	
Uncensored	12	Mean	3.5
Censored		Lognormal mean	3.5
Detection limit or PQL		Std. devn.	0.79
Method detection limit		Median	3.6
TOTAL	12	Min.	2.2
		Max.	4.8

Lognormal distribution? r-squared is: 0.966
Normal distribution? r-squared is: 0.972
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 4.0

Manganese 95% UCL Calculation

DATA	ID
310	J1TL96/ J1TLC1
354	J1TL89
349	J1TL90
258	J1TL91
257	J1TL92
340	J1TL93
242	J1TL94
268	J1TL95
249	J1TL97
237	J1TL98
279	J1TL99
301	J1TLC0

Number of samples		Uncensored values	
Uncensored	12	Mean	287
Censored		Lognormal mean	287
Detection limit or PQL		Std. devn.	42.6
Method detection limit		Median	274
TOTAL	12	Min.	237
		Max.	354

Lognormal distribution? r-squared is: 0.931
Normal distribution? r-squared is: 0.917
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 311

Nickel 95% UCL Calculation

DATA	ID
9.8	J1TL96/ J1TLC1
12.0	J1TL89
12.1	J1TL90
13.9	J1TL91
9.6	J1TL92
12.1	J1TL93
9.2	J1TL94
9.4	J1TL95
9.8	J1TL97
7.6	J1TL98
8.8	J1TL99
10.3	J1TLC0

Number of samples		Uncensored values	
Uncensored	12	Mean	10.4
Censored		Lognormal mean	10.4
Detection limit or PQL		Std. devn.	1.8
Method detection limit		Median	9.8
TOTAL	12	Min.	7.6
		Max.	13.9

Lognormal distribution? r-squared is: 0.947
Normal distribution? r-squared is: 0.930
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 11.4

CALCULATION SHEET

Washington Closure Hanford

Originator I. B. Berezovskiy
Project 100-N Field Remediation
Subject 100-N-82 Waste Site Cleanup Verification 95% UCL Calculations

Date 06/16/14
Job No. 14655

Calc. No. 0100N-CA-V0279
Checked J. D. Skoglie

Rev. No. 0
Date 06/16/14
Sheet No. 10 of 11

Ecology Software (MTCAStat) Results, 100-N-82 Waste Site Excavation

Vanadium 95% UCL Calculation

DATA	ID
54.4	J1TL96/ J1TLC1
46.7	J1TL89
39.6	J1TL90
51.0	J1TL91
46.1	J1TL92
46.7	J1TL93
47.1	J1TL94
39.5	J1TL95
46.8	J1TL97
43.4	J1TL98
49.4	J1TL99
52.0	J1TLC0

Number of samples		Uncensored values	
Uncensored	12	Mean	46.9
Censored		Lognormal mean	46.9
Detection limit or PQL		Std. devn.	4.5
Method detection limit		Median	46.8
TOTAL	12	Min.	39.5
		Max.	54.4

Lognormal distribution?
r-squared is: 0.940
Normal distribution?
r-squared is: 0.951
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 49.4

Zinc 95% UCL Calculation

DATA	ID
42.7	J1TL96/ J1TLC1
42.4	J1TL89
39.4	J1TL90
36.5	J1TL91
34.7	J1TL92
40.7	J1TL93
37.0	J1TL94
34.4	J1TL95
34.2	J1TL97
30.7	J1TL98
38.9	J1TL99
40.4	J1TLC0

Number of samples		Uncensored values	
Uncensored	12	Mean	37.7
Censored		Lognormal mean	37.7
Detection limit or PQL		Std. devn.	3.7
Method detection limit		Median	38.0
TOTAL	12	Min.	30.7
		Max.	42.7

Lognormal distribution?
r-squared is: 0.954
Normal distribution?
r-squared is: 0.964
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 39.8

Nitrogen in Nitrite and nitrtate 95% UCL Calculation

DATA	ID
0.28	J1TL96/ J1TLC1
11.1	J1TL89
2.1	J1TL90
0.86	J1TL91
0.19	J1TL92
5.8	J1TL93
23.9	J1TL94
3.7	J1TL95
3.1	J1TL97
1.0	J1TL98
0.18	J1TL99
2.8	J1TLC0

Number of samples		Uncensored values	
Uncensored	12	Mean	4.6
Censored		Lognormal mean	6.0
Detection limit or PQL		Std. devn.	6.8
Method detection limit		Median	2.5
TOTAL	12	Min.	0.18
		Max.	23.9

Lognormal distribution?
r-squared is: 0.966
Normal distribution?
r-squared is: 0.654
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 41.4

CALCULATION SHEET

Washington Closure Hanford

Originator I. B. Berezovskiy | Date 06/23/14 | Calc. No. 0100N-CA-V0279 | Rev. No. 0
Project 100-N Field Remediation | Job No. 14655 | Checked J. D. Skoglie | Date 06/23/14
Subject 100-N-82 Waste Site Cleanup Verification 95% UCL Calculations | Sheet No. 11 of 11

Duplicate/Split Analysis - 100-N-82 Waste Site Excavation

Sampling Area	Sample Number	Sample Date	Cesium-137			Potassium-40			Radium-226			Thorium-228 - AEA			Thorium-230 - AEA		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
EXC-8	J1TL96	5/16/14	0.0921		0.0203	10.8		0.199	0.375		0.0347	0.335	J	0.0606	0.139		0.0507
Duplicate of J1TL96	J1TLC1	5/16/14	0.0851		0.0278	11.6		0.229	0.405		0.0464	0.341	J	0.0654	0.397		0.0572
Split of J1TL96	J1TLC3	5/16/14	0.110		0.090	11.90		1.200	0.547		0.050	0.434		0.130	0.426		0.090

Sampling Area	Sample Number	Sample Date	Thorium-232 - AEA			Uranium-234 - AEA			Uranium-238 - AEA			Aluminum			Arsenic		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-8	J1TL96	5/16/14	0.334	J	0.0377	0.0924		0.0507	0.161		0.0585	6610		1.4	2.6		0.62
Duplicate of J1TL96	J1TLC1	5/16/14	0.540	J	0.0518	0.144		0.0845	0.175		0.0774	6890		1.5	2.4		0.63
Split of J1TL96	J1TLC3	5/16/14	0.353		0.070				0.378		0.060	5700		6.81	3.38		0.501

Analysis:

		Cesium-137	Potassium-40	Radium-226	Thorium-228 - AEA	Thorium-230 - AEA	Thorium-232 - AEA	Uranium-234 - AEA	Uranium-238 - AEA	Aluminum	Arsenic
TDL		0.05	0.5	0.1	1	1	1	1	1	5	10
Duplicate Analysis	Both > PQL?	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**
	Both >5xTDL?	No-Stop (acceptable)	**Yes (calc RPD)**	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	**Yes (calc RPD)**	No-Stop (acceptable)
	RPD		7.1%							4.1%	
	Difference > 2 TDL?	No - acceptable	Not applicable	No - acceptable	No - acceptable	No - acceptable	No - acceptable	No - acceptable	No - acceptable	Not applicable	No - acceptable
Split Analysis	Both > PQL?	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	No-Stop (acceptable)	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**
	Both >5xTDL?	No-Stop (acceptable)	**Yes (calc RPD)**	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)		No-Stop (acceptable)	**Yes (calc RPD)**	No-Stop (acceptable)
	RPD		9.7%							14.8%	
	Difference > 2 TDL?	No - acceptable	Not applicable	No - acceptable	No - acceptable	No - acceptable	No - acceptable	No - acceptable	No - acceptable	Not applicable	No - acceptable

Duplicate/Split Analysis - 100-N-82 Waste Site Excavation

Sampling Area	Sample Number	Sample Date	Barium			Beryllium			Boron			Calcium			Chromium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-8	J1TL96	5/16/14	65.6		0.071	0.31		0.031	1.1	B	0.92	6460		13.2	7.2		0.054
Duplicate of J1TL96	J1TLC1	5/16/14	65.5		0.073	0.33		0.032	1.2	B	0.94	7340		13.5	8.5		0.056
Split of J1TL96	J1TLC3	5/16/14	64.5		0.100	0.798		0.100	1.20	B	1.00	6260	*	8.01	8.41		0.150

Sampling Area	Sample Number	Sample Date	Cobalt			Copper			Hexavalent Chromium			Iron			Lead		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-8	J1TL96	5/16/14	7.9	X	0.094	18.8		0.20	0.155	U	0.155	22400		3.6	3.6		0.25
Duplicate of J1TL96	J1TLC1	5/16/14	7.0	X	0.096	16.5		0.21	0.237		0.155	20800		3.6	3.7		0.26
Split of J1TL96	J1TLC3	5/16/14	9.44	D	0.751	17.6		0.300	0.144	B	0.121	20200		8.01	9.17		0.330

Analysis:

		Barium	Beryllium	Boron	Calcium	Chromium	Cobalt	Copper	Hexavalent Chromium	Iron	Lead
TDL		2	0.5	2	100	1	2	1	0.5	5	5
Duplicate Analysis	Both > PQL?	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	No-Stop (acceptable)	**Yes (continue)**	**Yes (continue)**
	Both >5xTDL?	**Yes (calc RPD)**	No-Stop (acceptable)	No-Stop (acceptable)	**Yes (calc RPD)**	**Yes (calc RPD)**	No-Stop (acceptable)	**Yes (calc RPD)**		**Yes (calc RPD)**	No-Stop (acceptable)
	RPD	0.2%			12.8%	16.6%		13.0%		7.4%	
	Difference > 2 TDL?	Not applicable	No - acceptable	No - acceptable	Not applicable	Not applicable	No - acceptable	Not applicable	No - acceptable	Not applicable	No - acceptable
Split Analysis	Both > PQL?	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	No-Stop (acceptable)	**Yes (continue)**	**Yes (continue)**
	Both >5xTDL?	**Yes (calc RPD)**	No-Stop (acceptable)	No-Stop (acceptable)	**Yes (calc RPD)**	**Yes (calc RPD)**	No-Stop (acceptable)	**Yes (calc RPD)**		**Yes (calc RPD)**	No-Stop (acceptable)
	RPD	1.7%			3.1%	15.5%		6.6%		10.3%	
	Difference > 2 TDL?	Not applicable	No - acceptable	No - acceptable	Not applicable	Not applicable	No - acceptable	Not applicable	No - acceptable	Not applicable	No - acceptable

Duplicate/Split Analysis - 100-N-82 Waste Site Excavation

Sampling Area	Sample Number	Sample Date	Magnesium			Manganese			Nickel			Potassium			Silicon		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-8	J1TL96	5/16/14	4470		3.5	308		0.094	10.1	X	0.12	1140		38.3	361	XJ	5.3
Duplicate of J1TL96	J1TLC1	5/16/14	4300		3.5	312		0.096	9.4	X	0.12	1250		39.3	427	XJ	5.4
Split of J1TL96	J1TLC3	5/16/14	4160		8.51	307		0.200	9.43		0.150	1070		6.41	702	*N	1.50

Sampling Area	Sample Number	Sample Date	Sodium			Vanadium			Zinc			Nitrogen in Nitrite and Nitrate		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-8	J1TL96	5/16/14	313		55.2	57.4		0.088	43.6	X	0.37	0.37	B	0.37
Duplicate of J1TL96	J1TLC1	5/16/14	276		56.6	51.4		0.090	41.7	X	0.38	0.36	U	0.36
Split of J1TL96	J1TLC3	5/16/14	212		7.01	68.2	D	0.501	51.3	*D	2.00	0.226	B	0.172

Analysis:

		Magnesium	Manganese	Nickel	Potassium	Silicon	Sodium	Vanadium	Zinc	Nitrogen in Nitrite and Nitrate
TDL		75	5	4	400	2	50	2.5	1	0.75
Duplicate Analysis	Both > PQL?	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	No-Stop (acceptable)
	Both >5xTDL?	**Yes (calc RPD)**	**Yes (calc RPD)**	No-Stop (acceptable)	No-Stop (acceptable)	**Yes (calc RPD)**	**Yes (calc RPD)**	**Yes (calc RPD)**	**Yes (calc RPD)**	
	RPD	3.9%	1.3%			16.8%	12.6%	11.0%	4.5%	
	Difference > 2 TDL?	Not applicable	Not applicable	No - acceptable	No - acceptable	Not applicable	Not applicable	Not applicable	Not applicable	No - acceptable
Split Analysis	Both > PQL?	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	No-Stop (acceptable)
	Both >5xTDL?	**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	7.2%	0.3%			*64.2%*		17.2%	16.2%	
	Difference > 2 TDL?	Not applicable	Not applicable	No - acceptable	No - acceptable	Not applicable	Yes - assess further	Not applicable	Not applicable	No - acceptable

Attachment 1. 100-N-82 Waste Site Verification Sample Results (Radionuclides).

Location	HEIS Number	Sample Date	Americium-241			Cesium-137			Cobalt-60			Europium-152			Europium-154			Europium-155		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
EXC-8	J1TL96	5/16/14	0.00863	U	0.0272	0.0921		0.0203	0.0240	U	0.0281	-0.00291	U	0.0433	0.0334	U	0.0785	-0.0234	U	0.0388
Duplicate of J1TL96	J1TLC1	5/16/14	-0.00730	U	0.0408	0.0851		0.0278	0.0480	U	0.0372	0.000358	U	0.0639	-0.00883	U	0.0860	0.0258	U	0.0632
EXC-1	J1TL89	5/16/14	-0.0401	U	0.128	0.256		0.0408	0.00350	U	0.0386	0.00482	U	0.100	-0.00289	U	0.119	0.0283	U	0.0989
EXC-2	J1TL90	5/16/14	-0.0442	U	0.143	0.0413	U	0.0348	0.00342	U	0.0289	0.0365	U	0.0849	-0.0120	U	0.0906	-0.0002	U	0.103
EXC-3	J1TL91	5/16/14	-0.0408	U	0.163	0.00274	U	0.0255	0.00927	U	0.0285	0.00791	U	0.0615	-0.0185	U	0.0802	0.0320	U	0.0703
EXC-4	J1TL92	5/16/14	-0.0177	U	0.0382	0.000226	U	0.0246	-0.00217	U	0.0249	-0.00358	U	0.0608	0.00633	U	0.0869	0.0289	U	0.0600
EXC-5	J1TL93	5/16/14	0.00120	U	0.0320	0.0501		0.0244	0.0106	U	0.0278	-0.000539	U	0.0521	0.0338	U	0.0926	0.0368	U	0.0445
EXC-6	J1TL94	5/16/14	0.00755	U	0.0272	-0.00925	U	0.0168	-0.00369	U	0.0199	-0.0124	U	0.0416	0.00276	U	0.0663	0.0352	U	0.0383
EXC-7	J1TL95	5/16/14	0.00603	U	0.0328	0.0181	U	0.0283	0.00216	U	0.0272	0.00998	U	0.0531	-0.0305	U	0.0774	0.0500	U	0.0497
EXC-9	J1TL97	5/16/14	-0.106	U	0.116	0.000341	U	0.0245	-0.00126	U	0.0248	0.0145	U	0.0694	-0.0407	U	0.0811	-0.0075	U	0.0888
EXC-10	J1TL98	5/16/14	0.000565	U	0.138	-0.00110	U	0.0217	0.00287	U	0.0256	0.00523	U	0.0541	-0.0369	U	0.0725	0.0401	U	0.0622
EXC-11	J1TL99	5/16/14	0.0239	U	0.0404	0.00908	U	0.0254	0.00554	U	0.0271	0.00214	U	0.0619	0.0333	U	0.0877	0.0300	U	0.0594
EXC-12	J1TLC0	5/16/14	0.0481	U	0.145	0.0259	U	0.0259	-0.0034	U	0.0239	0.0187	U	0.0563	0.000303	U	0.0735	0.0183	U	0.0654
Split of J1TL96	J1TLC3	5/16/14	-0.120	U	0.130	0.110		0.090	0.015	U	0.070	-0.057	U	0.180	-0.085	U	0.090	0.674		0.150

Location	HEIS Number	Sample Date	Lead-212			Lead-214			Potassium-40			Potassium-40			Radium-226			Thallium-208		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
EXC-8	J1TL96	5/16/14							10.8		0.199				0.375		0.0347			
Duplicate of J1TL96	J1TLC1	5/16/14							11.6		0.229				0.405		0.0464			
EXC-1	J1TL89	5/16/14							15.2		0.355				0.711		0.0699			
EXC-2	J1TL90	5/16/14							14.6		0.215				0.597		0.0543			
EXC-3	J1TL91	5/16/14							12.6		0.210				0.372		0.0429			
EXC-4	J1TL92	5/16/14							13.3		0.191				0.449		0.0424			
EXC-5	J1TL93	5/16/14							14.0		0.256				0.566		0.0415			
EXC-6	J1TL94	5/16/14							12.2		0.192				0.367		0.0324			
EXC-7	J1TL95	5/16/14							15.1		0.231				0.626		0.0396			
EXC-9	J1TL97	5/16/14							12.5		0.198				0.427		0.0472			
EXC-10	J1TL98	5/16/14							9.51		0.222				0.351		0.0380			
EXC-11	J1TL99	5/16/14							11.6		0.192				0.446		0.0412			
EXC-12	J1TLC0	5/16/14							11.3		0.187				0.412		0.0398			
Split of J1TL96	J1TLC3	5/16/14	0.674		0.150	0.601		0.190	11.90		1.200	3.189	U	7.230	0.547		0.050	0.510		0.030

Note: Data qualified with B, C, and/or J are considered acceptable values.
* = duplicate analysis not within control limits
AEA = alpha energy analysis
B = blank contamination (inorganic constituents)
D = reported from a dilution.
EXC = excavation
HEIS = Hanford Environmental Information System
J = estimate
LCS = liquid scintillation counting
N = recovery outside control limits
PQL = practical quantitation limit

Q = qualifier
U = undetected
X = >40% difference between primary and confirmation detector results.

Attachment	1	Sheet No.	1 of 5
Originator	I. B. Berezovskiy	Date	6/23/14
Checked	J. D. Skoglie	Date	6/23/14
Calc. No.	0100N-CA-V0279	Rev. No.	0

Attachment 1. 100-N-82 Waste Site Verification Sample Results (Radionuclides).

Location	HEIS Number	Sample Date	Thorium-234			Uranium-235			Plutonium-238 - AEA			Plutonium-239/240 - AEA			Thorium-228 - AEA			Thorium-230 - AEA		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
EXC-8	J1TL96	5/16/14							-0.00571	UJ	0.0807	-0.00228	U	0.0652	0.335	J	0.0606	0.139		0.0507
Duplicate of J1TL96	J1TLC1	5/16/14							-0.00467	UJ	0.0779	0.0134	U	0.0587	0.341	J	0.0654	0.397		0.0572
EXC-1	J1TL89	5/16/14							-0.0006	UJ	0.0547	-0.000602	U	0.0547	0.375	J	0.0858	0.274		0.0794
EXC-2	J1TL90	5/16/14							-0.00056	UJ	0.0508	-0.00279	U	0.0668	0.583	J	0.0713	0.280		0.0708
EXC-3	J1TL91	5/16/14							-0.00074	UJ	0.0668	-0.000734	U	0.0668	0.305	J	0.0950	0.394		0.0625
EXC-4	J1TL92	5/16/14							-0.00068	UJ	0.0620	-0.00136	U	0.0686	0.480	J	0.0625	0.245		0.0621
EXC-5	J1TL93	5/16/14							-0.00270	UJ	0.0771	-0.00135	U	0.0679	0.411	J	0.0674	0.336		0.0533
EXC-6	J1TL94	5/16/14							-0.00122	UJ	0.0612	-0.00122	U	0.0612	0.352	J	0.0599	0.312		0.0524
EXC-7	J1TL95	5/16/14							0.0131	UJ	0.0859	-0.00138	U	0.0693	0.446	J	0.0933	0.179		0.0653
EXC-9	J1TL97	5/16/14							-0.00822	UJ	0.0909	-0.000587	U	0.0534	0.319	J	0.0582	0.236		0.0686
EXC-10	J1TL98	5/16/14							-0.00259	UJ	0.0740	-0.000647	U	0.0589	0.261	J	0.0633	0.259		0.0629
EXC-11	J1TL99	5/16/14							0.0295	UJ	0.0939	0.0330	U	0.0759	0.498	J	0.0685	0.283		0.0572
EXC-12	J1TLC0	5/16/14							-0.00503	UJ	0.0839	-0.00126	U	0.0632	0.436	J	0.0735	0.272		0.0590
Split of J1TL96	J1TLC3	5/16/14	1.863		1.340	0.266	U	0.390	0.007	U	0.130	-0.008	U	0.110	0.434		0.130	0.426		0.090

Location	HEIS Number	Sample Date	Thorium-232 - AEA			Uranium-233/234 - AEA			Uranium-234 - AEA			Uranium-235 - AEA			Uranium-238 - AEA			Total beta		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
EXC-8	J1TL96	5/16/14	0.334	J	0.0377				0.0924		0.0507	0.0117	UJ	0.0318	0.161		0.0585	0.141	U	0.346
Duplicate of J1TL96	J1TLC1	5/16/14	0.540	J	0.0518				0.144		0.0845	-0.00240	UJ	0.0684	0.175		0.0774	0.0983	U	0.332
EXC-1	J1TL89	5/16/14	0.610	J	0.0718				0.138		0.0665	-0.000515	UJ	0.0468	0.166		0.0556	0.298	U	0.402
EXC-2	J1TL90	5/16/14	0.580	J	0.0640				0.181		0.0937	-0.000681	UJ	0.0620	0.117		0.0736	0.152	U	0.335
EXC-3	J1TL91	5/16/14	0.343	J	0.0625				0.294		0.128	0.0131	UJ	0.103	0.402		0.0881	0.0491	U	0.350
EXC-4	J1TL92	5/16/14	0.416	J	0.0561				0.222		0.0614	0.00854	UJ	0.0614	0.198		0.0634	-0.0135	U	0.318
EXC-5	J1TL93	5/16/14	0.424	J	0.0533				0.178		0.0554	0.0128	UJ	0.0348	0.161		0.0744	0.0824	U	0.327
EXC-6	J1TL94	5/16/14	0.364	J	0.0474				0.134		0.0542	0.0258	UJ	0.0542	0.227		0.0615	0.153	U	0.372
EXC-7	J1TL95	5/16/14	0.412	J	0.0653				0.218		0.0735	0.0141	UJ	0.0537	0.290		0.0787	0.0875	U	0.363
EXC-9	J1TL97	5/16/14	0.476	J	0.0578				0.147		0.0717	0.000	UJ	0.0405	0.224		0.0545	0.0326	U	0.330
EXC-10	J1TL98	5/16/14	0.204	J	0.0629				0.201		0.0565	-0.000621	UJ	0.0565	0.0912		0.0670	0.0883	U	0.314
EXC-11	J1TL99	5/16/14	0.269	J	0.0572				0.192		0.0773	-0.00169	UJ	0.0607	0.249		0.0727	0.203	U	0.339
EXC-12	J1TLC0	5/16/14	0.218	J	0.0497				0.158		0.0773	0.0310	UJ	0.0650	0.192		0.0650	0.133	U	0.319
Split of J1TL96	J1TLC3	5/16/14	0.353		0.070	0.471		0.080				0.0310	U	0.090	0.378		0.060	-0.163	U	0.840

Location	HEIS Number	Sample Date	Nickel-63 - LCS			Tritium - LCS		
			pCi/g	Q	MDA	pCi/g	Q	MDA
EXC-8	J1TL96	5/16/14	2.43	U	4.78	-0.00407	UJ	0.0412
Duplicate of J1TL96	J1TLC1	5/16/14	5.54		5.04	0.0193	UJ	0.0575
EXC-1	J1TL89	5/16/14	-0.364	U	5.26	0.0255	UJ	0.0850
EXC-2	J1TL90	5/16/14	-0.509	U	5.25	0.0128	UJ	0.0501
EXC-3	J1TL91	5/16/14	0.665	U	5.02	-0.0128	UJ	0.0615
EXC-4	J1TL92	5/16/14	-0.385	U	5.22	0.0173	UJ	0.0601
EXC-5	J1TL93	5/16/14	0.969	U	5.01	0.00653	UJ	0.0668
EXC-6	J1TL94	5/16/14	0.179	U	5.25	0.0325	UJ	0.0689
EXC-7	J1TL95	5/16/14	1.55	U	5.06	0.0673	UJ	0.0714
EXC-9	J1TL97	5/16/14	-0.892	U	5.45	-0.000757	UJ	0.0761
EXC-10	J1TL98	5/16/14	2.48	U	5.25	-0.0149	UJ	0.0647
EXC-11	J1TL99	5/16/14	0.680	U	5.17	0.0314	UJ	0.0465
EXC-12	J1TLC0	5/16/14	1.920	U	4.89	0.0280	UJ	0.0660
Split of J1TL96	J1TLC3	5/16/14	1.091	U	2.75	0.000	U	38.13

Attachment	1	Sheet No.	2 of 5
Originator	I. B. Berezovskiy	Date	6/23/14
Checked	J. D. Skoglie	Date	6/23/14
Calc. No.	0100N-CA-V0279	Rev. No.	0

Attachment 1. 100-N-82 Waste Site Verification Sample Results (Metals).

Location	HEIS Number	Sample Date	Aluminum			Antimony			Arsenic			Barium			Beryllium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-8	J1TL96	5/16/14	6610		1.4	0.36	UJ	0.36	2.6		0.62	65.6		0.071	0.31		0.031
Duplicate of J1TL96	J1TLC1	5/16/14	6890		1.5	0.36	UJ	0.36	2.4		0.63	65.5		0.073	0.33		0.032
EXC-1	J1TL89	5/16/14	9140		1.4	0.34	UJ	0.34	2.6		0.59	78.4		0.068	0.35		0.030
EXC-2	J1TL90	5/16/14	7580		1.4	0.35	UJ	0.35	2.6		0.61	46.9		0.070	0.31		0.031
EXC-3	J1TL91	5/16/14	5980		1.5	0.36	UJ	0.36	2.4		0.63	38.7		0.072	0.25		0.031
EXC-4	J1TL92	5/16/14	7000		1.4	0.34	UJ	0.34	2.4		0.58	62.9		0.067	0.27		0.029
EXC-5	J1TL93	5/16/14	8480		1.4	0.33	UJ	0.33	2.5		0.58	72.4		0.067	0.35		0.029
EXC-6	J1TL94	5/16/14	5550		1.5	0.36	UJ	0.36	2.0		0.63	47.5		0.073	0.24		0.032
EXC-7	J1TL95	5/16/14	7040		1.5	0.38	UJ	0.38	2.2		0.66	70.5		0.075	0.29		0.033
EXC-9	J1TL97	5/16/14	5840		1.4	0.34	UJ	0.34	3.1		0.60	29.9		0.069	0.23		0.030
EXC-10	J1TL98	5/16/14	4310		1.4	0.34	UJ	0.34	1.6		0.59	34.6		0.068	0.21		0.030
EXC-11	J1TL99	5/16/14	6280		1.4	0.33	UJ	0.33	2.3		0.58	52.7		0.067	0.27		0.029
EXC-12	J1TLC0	5/16/14	7310		1.6	0.39	UJ	0.39	2.7		0.67	52.3		0.077	0.32		0.034
Split of J1TL96	J1TLC3	5/16/14	5700		6.81	1.65	DU	1.65	3.38		0.501	64.5		0.100	0.798		0.100
Equipment Blank	J1TLC2	5/16/14	96.9		1.5	0.36	UJ	0.36	0.62	U	0.62	1.1		0.072	0.031	U	0.031

Location	HEIS Number	Sample Date	Boron			Cadmium			Calcium			Chromium			Cobalt		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-8	J1TL96	5/16/14	1.1	B	0.92	0.038	U	0.038	6460		13.2	7.2		0.054	7.9	X	0.094
Duplicate of J1TL96	J1TLC1	5/16/14	1.2	B	0.94	0.039	U	0.039	7340		13.5	8.5		0.056	7.0	X	0.096
EXC-1	J1TL89	5/16/14	1.6	B	0.88	0.037	U	0.037	4010		12.6	11.0		0.052	7.5	X	0.090
EXC-2	J1TL90	5/16/14	1.0	B	0.91	0.038	U	0.038	4490		13.0	7.9		0.054	7.3	X	0.092
EXC-3	J1TL91	5/16/14	0.93	U	0.93	0.039	U	0.039	6070		13.4	11.2		0.055	6.4	X	0.095
EXC-4	J1TL92	5/16/14	0.87	U	0.87	0.036	U	0.036	8530		12.5	10.3		0.051	5.9	X	0.088
EXC-5	J1TL93	5/16/14	1.3	B	0.86	0.036	U	0.036	3850		12.4	10.6		0.051	7.0	X	0.088
EXC-6	J1TL94	5/16/14	0.94	U	0.94	0.039	U	0.039	3990		13.5	9.0		0.056	6.2	X	0.096
EXC-7	J1TL95	5/16/14	1.2	B	0.97	0.041	U	0.041	3730		14.0	9.2		0.058	6.8	X	0.099
EXC-9	J1TL97	5/16/14	0.89	U	0.89	0.037	U	0.037	10900		12.8	8.7		0.052	6.2	X	0.090
EXC-10	J1TL98	5/16/14	0.88	U	0.88	0.037	U	0.037	6100		12.7	6.0		0.052	6.3	X	0.090
EXC-11	J1TL99	5/16/14	0.86	U	0.86	0.036	U	0.036	5780		12.4	8.2		0.051	6.5	X	0.088
EXC-12	J1TLC0	5/16/14	1.0	U	1.0	0.042	U	0.042	7620		14.3	8.7		0.059	7.5	X	0.100
Split of J1TL96	J1TLC3	5/16/14	1.20	B	1.00	0.515		0.100	6260	*	8.01	8.41		0.150	9.44	D	0.751
Equipment Blank	J1TLC2	5/16/14	0.92	U	0.92	0.039	U	0.039	20.1	B	13.3	0.13	B	0.055	0.094	UX	0.094

Attachment	1	Sheet No.	3 of 5
Originator	I. B. Berezovskiy	Date	6/16/14
Checked	J. D. Skoglie	Date	6/16/14
Calc. No.	0100N-CA-V0279	Rev. No.	0

Attachment 1. 100-N-82 Waste Site Verification Sample Results (Metals).

Location	HEIS Number	Sample Date	Copper			Hexavalent Chromium			Iron			Lead			Magnesium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-8	J1TL96	5/16/14	18.8		0.20	0.155	U	0.155	22400		3.6	3.6		0.25	4470		3.5
Duplicate of J1TL96	J1TLC1	5/16/14	16.5		0.21	0.237		0.155	20800		3.6	3.7		0.26	4300		3.5
EXC-1	J1TL89	5/16/14	16.1		0.19	0.155	U	0.155	20200		3.4	4.7		0.24	4430		3.3
EXC-2	J1TL90	5/16/14	24.3		0.20	0.155	U	0.155	19400		3.5	4.0		0.25	5080		3.4
EXC-3	J1TL91	5/16/14	18.0		0.21	0.178		0.155	18000		3.6	2.8		0.26	4540		3.5
EXC-4	J1TL92	5/16/14	15.4		0.19	0.155	U	0.155	18300		3.4	3.3		0.24	4480		3.3
EXC-5	J1TL93	5/16/14	15.2		0.19	0.155	U	0.155	19400		3.3	4.8		0.24	4180		3.3
EXC-6	J1TL94	5/16/14	16.3		0.21	0.155	U	0.155	17300		3.6	2.9		0.26	4090		3.6
EXC-7	J1TL95	5/16/14	14.7		0.22	0.283		0.155	16600		3.8	3.9		0.27	3630		3.7
EXC-9	J1TL97	5/16/14	15.9		0.20	0.155	U	0.155	17600		3.4	2.7		0.24	4370		3.3
EXC-10	J1TL98	5/16/14	18.5		0.19	0.155	U	0.155	17900		3.4	2.2		0.24	3670		3.3
EXC-11	J1TL99	5/16/14	15.8		0.19	0.155	U	0.155	18900		3.3	3.6		0.24	4000		3.2
EXC-12	J1TLC0	5/16/14	18.6		0.22	0.155	U	0.155	20900		3.9	3.7		0.27	4750		3.8
Split of J1TL96	J1TLC3	5/16/14	17.6		0.300	0.144	B	0.121	20200		8.01	9.17		0.330	4160		8.51
Equipment Blank	J1TLC2	5/16/14	0.20	U	0.20				135		3.6	0.25	U	0.25	10.9	B	3.5

Location	HEIS Number	Sample Date	Manganese			Mercury			Molybdenum			Nickel			Potassium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-8	J1TL96	5/16/14	308		0.094	0.0051	U	0.0051	0.24	U	0.24	10.1	X	0.12	1140		38.3
Duplicate of J1TL96	J1TLC1	5/16/14	312		0.096	0.0062	B	0.0048	0.25	U	0.25	9.4	X	0.12	1250		39.3
EXC-1	J1TL89	5/16/14	354		0.090	0.0063	U	0.0063	0.28	B	0.23	12.0	X	0.11	1870		36.8
EXC-2	J1TL90	5/16/14	349		0.092	0.0061	U	0.0061	0.24	U	0.24	12.1	X	0.11	962		37.9
EXC-3	J1TL91	5/16/14	258		0.095	0.0055	B	0.0053	0.25	U	0.25	13.9	X	0.12	865		39.0
EXC-4	J1TL92	5/16/14	257		0.088	0.0048	U	0.0048	0.23	U	0.23	9.6	X	0.11	1030		36.2
EXC-5	J1TL93	5/16/14	340		0.088	0.0058	B	0.0053	0.26	B	0.23	12.1	X	0.11	1790		36.0
EXC-6	J1TL94	5/16/14	242		0.096	0.0064	U	0.0064	0.25	U	0.25	9.2	X	0.12	836		39.3
EXC-7	J1TL95	5/16/14	268		0.099	0.0057	U	0.0057	0.26	U	0.26	9.4	X	0.12	1430		40.7
EXC-9	J1TL97	5/16/14	249		0.090	0.0055	U	0.0055	0.24	U	0.24	9.8	X	0.11	770		37.1
EXC-10	J1TL98	5/16/14	237		0.090	0.0055	U	0.0055	0.24	B	0.23	7.6	X	0.11	751		36.8
EXC-11	J1TL99	5/16/14	279		0.088	0.0057	U	0.0057	0.23	U	0.23	8.8	X	0.11	1040		36.0
EXC-12	J1TLC0	5/16/14	301		0.10	0.0056	B	0.0053	0.26	U	0.26	10.3	X	0.13	1100		41.7
Split of J1TL96	J1TLC3	5/16/14	307		0.200	0.00400	U	0.00400	0.317	B	0.200	9.43		0.150	1070		6.41
Equipment Blank	J1TLC2	5/16/14	2.8		0.094	0.0060	U	0.0060	0.25	U	0.25	0.12	UX	0.12	38.7	U	38.7

Attachment	1	Sheet No.	4 of 5
Originator	I. B. Berezovskiy	Date	6/16/14
Checked	J. D. Skoglie	Date	6/16/14
Calc. No.	0100N-CA-V0279	Rev. No.	0

Attachment 1. 100-N-82 Waste Site Verification Sample Results (Metals, Nitrate/nitrite and Physical).

Location	HEIS Number	Sample Date	Selenium			Silicon			Silver			Sodium			Vanadium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-8	J1TL96	5/16/14	0.80	U	0.80	361	XJ	5.3	0.15	U	0.15	313		55.2	57.4		0.088
Duplicate of J1TL96	J1TLC1	5/16/14	0.83	U	0.83	427	XJ	5.4	0.15	U	0.15	276		56.6	51.4		0.090
EXC-1	J1TL89	5/16/14	0.77	U	0.77	441	NXJ	5.1	0.14	U	0.14	293		52.9	46.7		0.084
EXC-2	J1TL90	5/16/14	0.80	U	0.80	264	XJ	5.2	0.15	U	0.15	148		54.5	39.6		0.087
EXC-3	J1TL91	5/16/14	0.82	U	0.82	263	XJ	5.4	0.15	U	0.15	220		56.1	51.0		0.089
EXC-4	J1TL92	5/16/14	0.76	U	0.76	220	XJ	5.0	0.14	U	0.14	406		52.1	46.1		0.083
EXC-5	J1TL93	5/16/14	0.76	U	0.76	329	XJ	5.0	0.14	U	0.14	265		51.9	46.7		0.083
EXC-6	J1TL94	5/16/14	0.83	U	0.83	240	XJ	5.4	0.15	U	0.15	193		56.6	47.1		0.090
EXC-7	J1TL95	5/16/14	0.85	U	0.85	386	XJ	5.6	0.16	U	0.16	195		58.6	39.5		0.093
EXC-9	J1TL97	5/16/14	0.78	U	0.78	179	XJ	5.1	0.14	U	0.14	280		53.4	46.8		0.085
EXC-10	J1TL98	5/16/14	0.77	U	0.77	217	XJ	5.1	0.14	U	0.14	258		53.0	43.4		0.084
EXC-11	J1TL99	5/16/14	0.76	U	0.76	288	XJ	5.0	0.14	U	0.14	258		51.8	49.4		0.083
EXC-12	J1TLC0	5/16/14	0.87	U	0.87	323	XJ	5.8	0.16	U	0.16	321		60.0	52.0		0.096
Split of J1TL96	J1TLC3	5/16/14	0.305	DU	0.305	702	*N	1.50	0.256	B	0.100	212		7.01	68.2	D	0.501
Equipment Blank	J1TLC2	5/16/14	0.81	U	0.81	105	XJ	5.3	0.15	U	0.15	55.7	U	55.7	0.22	B	0.089

Location	HEIS Number	Sample Date	Zinc			Nitrogen in Nitrite and Nitrate			Percent moisture (wet sample)		
			mg/kg	Q	PQL	mg/kg	Q	PQL	%	Q	PQL
EXC-8	J1TL96	5/16/14	43.6	X	0.37	0.37	B	0.37	1.9		0.10
Duplicate of J1TL96	J1TLC1	5/16/14	41.7	X	0.38	0.36	U	0.36	1.7		0.10
EXC-1	J1TL89	5/16/14	42.4	X	0.36	11.1		0.37	2.2		0.10
EXC-2	J1TL90	5/16/14	39.4	X	0.37	2.1		0.37	2.6		0.10
EXC-3	J1TL91	5/16/14	36.5	X	0.38	0.86		0.37	2.6		0.10
EXC-4	J1TL92	5/16/14	34.7	X	0.35	0.37	U	0.37	2.4		0.10
EXC-5	J1TL93	5/16/14	40.7	X	0.35	5.8		0.37	2.8		0.10
EXC-6	J1TL94	5/16/14	37.0	X	0.38	23.9		0.37	4.4		0.10
EXC-7	J1TL95	5/16/14	34.4	X	0.40	3.7		0.37	2.2		0.10
EXC-9	J1TL97	5/16/14	34.2	X	0.36	3.1		0.37	3.1		0.10
EXC-10	J1TL98	5/16/14	30.7	X	0.36	1.0		0.36	1.4		0.10
EXC-11	J1TL99	5/16/14	38.9	X	0.35	0.36	U	0.36	1.8		0.10
EXC-12	J1TLC0	5/16/14	40.4	X	0.40	2.8		0.37	2.6		0.10
Split of J1TL96	J1TLC3	5/16/14	51.3	*D	2.00	0.226	B	0.172			
Equipment Blank	J1TLC2	5/16/14	0.46	BX	0.38				0.10	U	0.10

Attachment	1	Sheet No.	5 of 5
Originator	I. B. Berezovskiy	Date	6/16/14
Checked	J. D. Skoglie	Date	6/16/14
Calc. No.	0100N-CA-V0279	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-V0282

Subject: 100-N-82 Waste Site Direct Contact Hazard Quotient, Carcinogenic Risk, and Sum of Fractions Calculations

Computer Program: Excel Program No: Excel 2010

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

Committed Calculation ☒ Preliminary ☐ Superseded ☐ Voided ☐

Rev	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover = 1 Summary = 5 Total = 6	I. B. Berezovskiy	J. D. Skoglie	H. M. Sulloway	D. F. Obenauer	6/19/14

SUMMARY OF REVISION

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

Washington Closure Hanford CALCULATION SHEET

Originator:	I. B. Berezovskiy	Date:	6/19/2014	Calc. No.:	0100N-CA-V0282	Rev.:	0
Project:	100-N Field Remediation	Job No:	14655	Checked:	J. D. Skoglie	Date:	6/19/2014
Subject:	100-N-82 Waste Site Direct Contact Hazard Quotient, Carcinogenic Risk, 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-82 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.

This calculation also provides documentation to support the calculation of the sum of fractions evaluation for radionuclide direct exposure risk. Attainment of direct exposure remedial action goals (RAGs) is demonstrated using the single-radionuclide dose-equivalence lookup values to perform sum of fractions evaluations for comparison of the total radionuclide dose to the RAG of 15 mrem/yr above background. The model used to develop these dose-equivalence lookup values is presented in the 100-N RDR/RAWP (DOE-RL 2013).

GIVEN/REFERENCES:

1) DOE-RL, 1996, *Hanford Site Background: Part 2, Soil Background for Radioactive Analytes,* DOE/RL-96-12, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

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

5) WCH, 2014, *100-N-82 Waste Site Cleanup Verification 95% UCL Calculations,* 0100N-CA-V0279, Washington Closure Hanford, Inc., Richland, Washington.

SOLUTION:

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

Washington Closure Hanford CALCULATION SHEET

Originator:	I. B. Berezovskiy	Date:	6/19/2014	Calc. No.:	0100N-CA-V0282	Rev.:	0
Project:	100-N Field Remediation	Job No:	14655	Checked:	J. D. Skoglie	Date:	6/19/2014
Subject:	100-N-82 Waste Site Direct Contact Hazard Quotient, Carcinogenic Risk, and Sum of Fractions Calculations					Sheet No. 2 of 5	

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 $<1 \times 10^{-5}$.

Summation of Fractions

The sum-of-fractions compares the radionuclide cleanup verification results from the 100-N-82 excavation area to 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 two columns of the table present the COPCs and the maximum radionuclide activities for the samples. The third column presents the single radionuclide 15 mrem/yr dose-equivalence activities, and the last column presents the radionuclide activities divided by the dose-equivalence activities, followed by the sum of the fractions and determination of the total waste site dose for comparison to the 15 mrem/yr RAG.

METHODOLOGY:

The 100-N-82 waste site is comprised of one decision unit for verification sampling consisting of the excavation area. The direct contact hazard quotient and carcinogenic risk calculations for the 100-N-82 waste site were conservatively calculated for the entire waste site using the greater of the maximum or statistical verification soil sample results (WCH 2014). Of the contaminants of potential concern (COPCs) for this site, boron, hexavalent chromium, and molybdenum require HQ and risk calculations because these analytes were detected and a Washington State or Hanford Site background value is not available. Nitrogen in nitrate and nitrite is included because it was quantitated at a concentration above Hanford Site background. All other site nonradionuclide COPCs were not detected or were quantified below background levels. An example of the HQ and risk calculations is presented below:

1) For example, the maximum value for boron is 1.6 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]), is 1.0×10^{-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 2.3×10^{-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, then multiplied by 1.0×10^{-6}. For example, the maximum value for hexavalent chromium is 0.283 mg/kg, divided by 2.1 mg/kg, and multiplied as indicated, is 1.3×10^{-7}. Comparing this value, and all other individual values, to the requirement of $<1 \times 10^{-6}$, this criterion is met.

Washington Closure Hanford CALCULATION SHEET

Originator:	I. B. Berezovskiy	Date:	6/19/2014	Calc. No.:	0100N-CA-V0282	Rev.:	0
Project:	100-N Field Remediation	Job No:	14655	Checked:	J. D. Skoglie	Date:	6/19/2014
Subject:	100-N-82 Waste Site Direct Contact Hazard Quotient, Carcinogenic Risk, and Sum of Fractions Calculations					Sheet No. 3 of 5	

4) After these calculations are completed for the carcinogenic analytes, the cumulative excess cancer risk can be obtained by summing the individual values. To avoid errors due to intermediate rounding, the individual cancer risk values prior to rounding are used for this calculation. The sum of the excess cancer risk values is 1.3×10^{-7}. Comparing this value to the requirement of $<1 \times 10^{-5}$, this criterion is met.

Summation of Fractions

The sum of fractions were calculated for the data set using the greater of the statistical or maximum value for each radionuclide COPC from the 95% upper confidence limit (UCL) calculation (WCH 2014).

Calculations for 100-N-82 waste site were performed using RAGs from the 100-N RDR/RAWP (DOE/RL 2013). An example of the sum of fractions calculation of COPCs is presented below:

1) To calculate the fraction, the statistical value for cesium-137 (0.0741 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 0.0120.

2) The fractions for the remaining COPCs are determined and summed. The sum of these fractions equals 0.115. The sum of fractions is then multiplied by 15 mrem/yr to determine the total equivalent dose of 1.73 mrem/yr for the 100-N-82 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 $>1 \times 10^{-6}$: None
4) List the cumulative excess cancer risk for carcinogens $>1 \times 10^{-5}$: None

Table 1 shows the results of the hazard quotient and excess cancer risk calculations.

Summation of Fractions

As demonstrated by the summation of the fractions, the maximum cumulative dose values contributed by the residual radionuclide populations (1.73 mrem/yr) is predicted to be less than the RAG of 15 mrem/yr above background.

Table 2 shows the results of the sum of fraction evaluation for radionuclide direct exposure risk.

Washington Closure Hanford CALCULATION SHEET

Originator:	I. B. Berezovskiy	Date:	6/19/2014	Calc. No.:	0100N-CA-V0282	Rev.:	0
Project:	100-N Field Remediation	Job No:	14655	Checked:	J. D. Skoglie	Date:	6/19/2014
Subject:	100-N-82 Waste Site Direct Contact Hazard Quotient, Carcinogenic Risk, 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-82 Waste Site.

Contaminants of Potential Concern	Statistical or Maximum Value [a] (mg/kg)	Noncarcinogen RAG [b] (mg/kg)	Hazard Quotient	Carcinogen RAG [b] (mg/kg)	Carcinogen Risk
Metals					
Boron	1.6	16,000	1.0E-04	--	--
Chromium, hexavalent[c]	0.283	240	1.2E-03	2.1	1.3E-07
Molybdenum	0.28	400	7.0E-04	--	--
Anions					
Nitrogen in Nitrate and Nitrite	41.4	128,000	3.2E-04	--	--
Totals					
Cumulative Hazard Quotient:			**2.3E-03**		
Cumulative Excess Cancer Risk:					**1.3E-07**

Notes:

[a] = From WCH (2014)

[b] = Value obtained from the 100-N 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. Attainment of Radionuclide Direct Exposure Remedial Action Goals at 100-N-82 Waste Site.

COPC	95% UCL Statistical or Maximum Values (pCi/g) [a]	Soil Activity for 15 mrem/yr Dose (pCi/g) [b]	Fraction
Cesium-137	0.0741	6.2	0.0120
Thorium-230	0.303	2.95	0.103
Uranium-234	0	1.1	0
Uranium-238	0	1.1	0
Nickel-63	1.54	4,013	0.0004
		Sum of Fractions	0.115
		Equivalent Dose (mrem/yr)	1.73

[a] Hanford Site background values for uranium-233/234 (1.1 pCi/g), and uranium-238 (1.1 pCi/g) (Hanford Site Background: Part 2, Soil Background for Radionuclides [DOE-RL 1996]) have been subtracted from 95% UCL values for the shallow-zone excavation.

[b] Single radionuclide 15 mrem/yr dose-equivalence values and methodology are presented in the *Remedial Design Report/Remedial Action Work Plan for the 100 N Area* (DOE-RL 20013).

COPC = contaminant of potential concern

Washington Closure Hanford CALCULATION SHEET

Originator:	I. B. Berezovskiy	Date:	6/19/2014	Calc. No.:	0100N-CA-V0282	Rev.:	0
Project:	100-N Field Remediation	Job No:	14655	Checked:	J. D. Skoglie	Date:	6/19/2014
Subject:	100-N-82 Waste Site Direct Contact Hazard Quotient, Carcinogenic Risk, and Sum of Fractions Calculations					Sheet No. 5 of 5	

CONCLUSION:

The calculations in Tables 1 and 2 demonstrate that the 100-N-82 waste site meets the requirements for the direct contact hazard quotient, carcinogenic (excess cancer) risk, and radionuclide direct exposure risk as identified in the RDR/RAWP (DOE-RL 2013) and SAP (DOE-RL 2006). The direct contact hazard quotient, carcinogenic (excess cancer) risk calculations and the sum of fractions evaluation for radionuclide direct exposure risk are for use in the RSVP for the 100-N-82 waste site.

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CALCULATION COVER SHEET

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

Area: 100-N

Discipline: Environmental *Calculation No: 0100N-CA-V0283

Subject: 100-N-82 Waste Site Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater

Computer Program: Excel Program No: Excel 2010

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

Committed Calculation ☒ Preliminary ☐ Superseded ☐ Voided ☐

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover = 1 Sheets = 3 Total = 4	I. B. Berezovskiy	J. D. Skoglie	H. M. Sulloway	D. F. Obenauer	6/19/14

SUMMARY OF REVISION

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

Washington Closure Hanford CALCULATION SHEET

Originator:	I. B. Berezovskiy	Date:	06/16/14	Calc. No.:	0100N-CA-V0283	Rev.:	0
Project:	100-N Field Remediation	Job No:	14655	Checked:	J. D. Skoglie	Date:	06/16/14
Subject:	100-N-82 Waste Site Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater					Sheet No.	1 of 3

PURPOSE:

Provide documentation to support the calculation of the hazard quotient (HQ) and excess carcinogenic risk associated with soil contaminant levels compared to soil cleanup levels for protection of groundwater for the 100-N-82 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, 2014, *100-N-82 Waste Site Cleanup Verification 95% UCL Calculations*, 0100N-CA-V0279, 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 CALCULATION SHEET

Originator:	I. B. Berezovskiy	Date:	06/16/14	Calc. No.:	0100N-CA-V0283	Rev.:	0
Project:	100-N Field Remediation	Job No:	14655	Checked:	J. D. Skoglie	Date:	06/16/14
Subject:	100-N-82 Waste Site Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater					Sheet No. 2 of 3	

METHODOLOGY:

The 100-N-82 waste site is comprised of one decision unit for verification sampling consisting of the excavation area. The protection of groundwater hazard quotient and carcinogenic risk calculations for the 100-N-82 waste site were conservatively calculated for the entire waste site using the statistical or maximum value for each analyte (WCH 2014). Based on the generic site RESRAD model (DOE-RL 2013) and a vadose zone of approximately 21 m (69 ft) thickness, a K_d of 3.6 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 3.6, and no Hanford background value has been established. Nitrogen in nitrate and nitrite is included because it was detected above background and has a K_d of zero, which is less than 3.6. All other site nonradionuclide COPCs were undetected, quantified below background levels, or have a K_d greater than or equal to 3.6. 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 maximum value for boron of 1.6 mg/kg, divided by the noncarcinogenic RAG value of 320 mg/kg is 5.0×10^{-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-82 waste site is 8.0×10^{-2}. 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 not any constituents in this calculation that had a carcinogenic RAG associated with it. Therefore, the requirement of $<1 \times 10^{-6}$ is met. Furthermore, the criterion for cumulative excess cancer risk for carcinogens is also met.

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

Washington Closure Hanford CALCULATION SHEET

Originator:	I. B. Berezovskiy	Date:	06/16/14	Calc. No.:	0100N-CA-V0283	Rev.:	0
Project:	100-N Field Remediation	Job No:	14655	Checked:	J. D. Skoglie	Date:	06/16/14
Subject:	100-N-82 Waste Site Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater					Sheet No. 3 of 3	

RESULTS:

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

Table 1 shows the results of the calculations.

Table 1. Hazard Quotient and Excess Cancer Risk Results for the 100-N-82 Waste Site.

Contaminants of Potential Concern	Maximum or Statistical Value[a] (mg/kg)	Noncarcinogen RAG[b] (mg/kg)	Hazard Quotient	Carcinogen RAG[b] (mg/kg)	Carcinogen Risk
Metals					
Boron	1.6	320	5.0E-03	--	--
Chromium, hexavalent	0.283	4.8	5.9E-02	--	--
Anions					
Nitrogen in Nitrate and Nitrite	41.4	2560	1.6E-02	--	--
Totals					
Cumulative Hazard Quotient:			**8.0E-02**		
Cumulative Excess Cancer Risk:					**0.0E+00**

Notes:
[a] = From WCH (2014).
[b] = Value obtained from the Cleanup Levels and Risk Calculations (CLARC) database using Groundwater, Method B, results and the 100 times model.
-- = not applicable
RAG = remedial action goal

CONCLUSION:

This calculation demonstrates that the 100-N-82 waste site meets the requirements for the hazard quotient and excess carcinogenic risk for protection of groundwater as identified in the RDR/RAWP (DOE-RL 2013).

APPENDIX C

100-N-82 DATA QUALITY ASSESSMENT

APPENDIX C

DATA QUALITY ASSESSMENT

VERIFICATION SAMPLING

A data quality assessment (DQA) was performed to compare the verification sampling approach and resulting analytical data with the sampling and data requirements specified in the site-specific sample design (WCH 2014b). This DQA was performed in accordance with 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 2014b), the field logbook (WCH 2014a), and the applicable analytical data packages has been performed as part of this DQA. All samples were collected and analyzed per the sample design.

To ensure quality data, the 100-N Area SAP (DOE-RL 2006) data assurance requirements and the data validation procedures for chemical analysis and radiochemical analysis (BHI 2000a, 2000b) 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 data from samples collected at the 100-N-82 waste site were provided by the laboratories in two sample delivery groups (SDGs): SDG JP0802 and XP0092. SDG JP0802 was submitted for third-party validation. No major deficiencies were noted in the data results. Minor deficiencies are discussed for 100-N-82 data set, as follows below. If no comments are made about a specific analysis, it should be assumed that no deficiencies affecting the quality of the data were found.

MINOR DEFICIENCIES

SDG JP0802

This SDG comprises 12 statistical soil samples (J1TL89 through J1TL99, and J1TLC0) collected from the 100-N-82 waste site excavation area. This SDG includes one field duplicate pair (J1TL96/J1TLC1). These samples were analyzed for gamma energy analysis (GEA), nickel-63, strontium-90, isotopic plutonium, isotopic thorium, isotopic uranium, tritium, inductively coupled plasma (ICP) metals, mercury, hexavalent chromium, nitrogen in nitrate, and nitrite. In addition, one equipment blank (J1TLC2) was collected and analyzed for ICP metals and mercury. The SDG JP0802 was submitted for third-party validation. Minor deficiencies are as follows.

In the radionuclide analysis, due to the lack of laboratory control sample (LCS) analysis, all plutonium-238, thorium-228, thorium-232, and uranium-235 results were qualified as estimates with "J" flags by third party validation. Estimated data are usable for decision-making purposes.

In the tritium analysis, due to the lack of matrix spike (MS) analysis, all tritium results were qualified as estimates with "J" flags by third party validation. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, the MS recoveries are out of the project acceptance criteria for five analytes (aluminum [1,483%], antimony [52%], iron [1,555%], manganese [157%], and silicon [7%]). For the aluminum, iron, and manganese analytes, the spiking concentration was insignificant compared to the native concentration in the sample from which the MS was prepared. The deficiency in the MS is a reflection of the variability of the native concentration rather than a measure of the recovery from the sample. The antimony and silicon analytes did not have mismatched spike and native concentrations in the MS. All antimony and silicon results for SDG JP0802 were qualified as estimates with "J" flags by third-party validation. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, the LCS recovery for silicon (25%) is outside the quality control (QC) limits. All silicon data in SDG JP0802 was qualified by third-party validation as estimated with "J" flags. Estimated data are acceptable for decision-making purposes.

SDG XP0092

This SDG comprises one statistical soil sample (J1TLC3) collected from the 100-N-82 excavation sample location EXC-8. Field sample J1TLC3 is a split sample associated with sample J1TL96. This sample was analyzed for GEA, nickel-63, strontium-90, isotopic plutonium, isotopic thorium, isotopic uranium, tritium, ICP metals, mercury, hexavalent chromium, nitrogen in nitrate, and nitrite. Minor deficiencies are as follows.

In the radionuclide analysis, due to the lack of LCS analysis, all plutonium-238, thorium-228, and uranium-235 results may be considered estimated. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, the laboratory duplicate relative percent difference (RPDs) for calcium (53.5%), molybdenum (67.1%), silicon (46.1%), and silver (38.1%) are above the acceptance criteria of 30%. Elevated RPDs in environmental samples are generally attributed to natural heterogeneities in the sample matrix. Data are usable for decision-making purposes.

In the ICP metals analysis, the MS recovery for silicon (4.41%) is below the project acceptance criteria. Although not qualified for MS recovery below the acceptance criteria, all silicon results for SDG XP0092 may be considered estimated. Estimated data are usable for decision-making purposes.

In the hexavalent chromium analysis, the MS and matrix spike duplicate (MSD) recoveries were outside the project acceptance criteria at 55.9% and 50.2%, respectively. Although not qualified

for MS and MSD recoveries outside the project acceptance criteria, all hexavalent chromium results for SDG XP0092 may be considered estimated. Estimated data are usable for decision-making purposes.

FIELD QUALITY ASSURANCE/QUALITY CONTROL

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

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

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

Sample Area	Main Sample	Duplicate Sample	Split Sample
Excavation	J1TL96	J1TLC1	J1TLC3

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

Field split samples are used to determine systematic differences (bias) between laboratories. A statistical determination of systematic differences would require larger data sets than are presented here. Such a determination is complicated by variability introduced by the natural heterogeneities inherent in field soil samples, and the analytical variability that each individual laboratory experiences. Therefore, when evaluating limited field split data, relatively large RPDs are expected. No major deficiencies in the RPD calculations were found for the split sample. Minor deficiencies for the field duplicates and split samples are as follows.

None of the RPD calculated for the field duplicate sample are above the acceptance criteria (30%). In the split evaluation, the RPD calculated for silicon (64.2%) was above the field split acceptance criteria (less than 35%). Elevated RPDs in environmental samples are generally attributed to natural heterogeneity in the sample matrix. There is no indication that the analytical system was operating out of control. The data are usable for decision-making purposes.

A secondary check of the data variability is used when one or both of the samples being evaluated (main and duplicate, or main and split) is less than five times the TDL, including undetected analytes. In these cases, a control limit of ±2 times the TDL is used (Appendix B) to indicate that a visual check of the data is required by the reviewer. Sodium in the split sample evaluation required this check. A visual inspection of all of the data is also performed. No additional major or minor deficiencies are noted. The data are usable for decision-making purposes.

Summary

Limited, random, or sample matrix-specific influenced batch QC issues, such as those discussed above, are a potential for any analysis. The number and types seen in these data sets are within expectations for the matrix types and analyses performed. The DQA review of the 100-N-82 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-82 data set concludes that the reviewed data are of the right type, quality, and quantity to support the intended use. The analytical data were found acceptable for decision-making purposes.

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

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