# WASTE SITE RECLASSIFICATION FORM

**Operable Unit:** 100-DR-1 **Control No.:** 2015-002

**Waste Site Code(s)/Subsite Code(s):** 100-D-81

**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-D-81; 100D Burn Areas and Other Stained Areas waste site was a compilation of eight areas that were discovered during the orphan sites evaluation field investigation reported in the *100-D Area Orphan Sites Evaluation Report*, OSR-2006-0001, Rev. 0, Washington Closure Hanford, Richland, Washington (WCH 2009). According to the remove-treat-dispose (RTD) memo, "100-D-81 Remaining Site for Remedial Action," Interoffice Memorandum from M. L. Proctor to S. W. Callison, CCN 153966, Washington Closure Hanford, Richland, Washington, October 12 (WCH 2010), areas 1, 2, 5, 6, and 7 did not require remediation. Areas 4 and 8 were recommended for RTD without confirmatory sampling based on observations at the sites. Area 3 was recommended for RTD because confirmatory sampling results exceeded remedial action goals. Therefore, areas 3, 4, and 8 required remediation.

The 100-D-81 waste site was added to the *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington* (Remaining Sites ROD), U.S. Environmental Protection Agency, Region 10, Seattle, Washington (EPA 1999), as a candidate site for confirmatory sampling by the *Explanation of Significant Differences for the 100 Area Remaining Sites Interim Remedial Action Record of Decision, Hanford Site, Benton County, Washington*, U.S. Environmental Protection Agency, Region 10, Seattle, Washington (EPA 2009).

Remedial action within areas 3, 4, and 8 at the 100-D-81 waste site was performed on July 14, 2014, and July 31, 2014. Excavation extended to a maximum depth of approximately 0.5 m (1.5 ft) below ground surface. On July 14, 2014, approximately 1,718 bank cubic meters (BCM) (2,245 bank cubic yards [BCY]) of material were excavated from areas 3, 4, and 8 within the 100-D-81 waste site. This material was staged and loaded out to the Environmental Restoration and Disposal Facility (ERDF) and closed out with the 100-D-72, 100-D-31:11, 100-D-31:12, 100-D-108, and the 100-D-109 waste sites RSVP (WCH 2015). On July 31, 2014, the remaining 14 BCM (18 BCY) of soil was remediated from areas 4 and 8 and loaded out to the ERDF.

Verification sampling was conducted on October 15, 2014. Remediation, verification sampling, and comparison of residual contaminant concentrations against cleanup levels have been performed in accordance with remedial action objectives and goals established by the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (100 Area RDR/RAWP), DOE/RL-97-17, Rev. 6, U.S. Department of Energy, Richland Operations Office, Richland, Washington (DOE-RL 2009), and the Remaining Sites ROD (EPA 1999). The selected remedy involved (1) excavating the waste site to the extent required to meet specified soil cleanup levels, (2) disposing of contaminated excavation materials at ERDF at the 200 Area of the Hanford Site, (3) demonstrating through verification sampling that cleanup goals have been achieved, and (4) proposing the waste site for reclassification as Interim Closed Out.

## WASTE SITE RECLASSIFICATION FORM

**Operable Unit:** 100-DR-1 **Control No.:** 2015-002

**Waste Site Code(s)/Subsite Code(s):** 100-D-81

**Basis for reclassification:**

Cleanup verification sampling results were evaluated in comparison to the remedial action goals. In accordance with this evaluation, the verification sampling results support a reclassification of the 100-D-81 waste site to Interim Closed Out. The current site conditions achieve the remedial action objectives and the corresponding remedial action goals established in the 100 Area RDR/RAWP (DOE-RL 2009) and the Remaining Sites ROD (EPA 1999). The evaluation, which may include fate-and-transport modeling, of all verification sample data collected from the 100-D-81 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. The basis for reclassification is described in detail in the *Remaining Sites Verification Package for the 100-D-81; 100D Burn Areas and Other Stained Areas Waste Site* (attached). 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 are not required.

**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 | JP Neath | 3/5/15 |
| DOE Federal Project Director (printed) | Signature | Date |
| N. Menard | Nina M. Menard | 3/16/15 |
| Ecology Project Manager (printed) | Signature | Date |
| NA | | |
| EPA Project Manager (printed) | Signature | Date |

# REMAINING SITES VERIFICATION PACKAGE FOR THE 100-D-81; 100D BURN AREAS AND OTHER STAINED AREAS WASTE SITE

**Attachment to Waste Site Reclassification Form 2015-002**

**March 2015**

# REMAINING SITES VERIFICATION PACKAGE FOR THE 100-D-81; 100D BURN AREAS AND OTHER STAINED AREAS WASTE SITE

## EXECUTIVE SUMMARY

The 100-D-81; 100D Burn Areas and Other Stained Areas waste site was a compilation of eight areas that were discovered during the orphan sites evaluation field investigation and reported in the *100-D Area Orphan Sites Evaluation Report* (WCH 2009). According to the remove-treat-dispose (RTD) memo, "100-D-81 Remaining Site for Remedial Action" (WCH 2010), areas 1, 2, 5, 6, and 7 did not require remediation. Areas 4 and 8 were recommended for RTD without confirmatory sampling based on observations at the sites. Area 3 was recommended for RTD because confirmatory sampling results exceeded remedial action goals (RAGs). Therefore, areas 3, 4, and 8 required remediation.

Remedial action within areas 3, 4, and 8 at the 100-D-81 waste site was performed on July 14, 2014, and July 31, 2014. Excavation extended to a maximum depth of approximately 0.5 m (1.5 ft) below ground surface. On July 14, 2014, approximately 1,718 bank cubic meters (BCM) (2,245 bank cubic yards [BCY]) of material were excavated from areas 3, 4, and 8 within the 100-D-81 waste site. This material was staged and loaded out to the Environmental Restoration and Disposal Facility (ERDF) and closed out with the 100-D-72, 100-D-31:11, 100-D-31:12, 100-D-108, and the 100-D-109 waste sites RSVP (WCH 2015). On July 31, 2014, the remaining 14 BCM (18 BCY) of soil was remediated from areas 4 and 8 and loaded out to the ERDF.

Verification sampling was conducted on October 15, 2014, per the *Work Instruction for Verification Sampling of the 100-D-81; 100D Burn Areas and Other Stained Areas* (WCH 2014b). The results indicate that the waste removal action achieved compliance with the remedial action objectives and RAGs of the *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units* (Remaining Sites ROD) (EPA 1999). A summary of the cleanup evaluation for the soil results against the applicable criteria is presented in Table ES-1.

**Table ES-1. Summary of Remedial Action Goals for the 100-D-81 Waste Site. (2 Pages)**

| Regulatory Requirement | Remedial Action Goals | Results | Remedial Action Objectives Attained? |
|---|---|---|---|
| Direct Exposure – Radionuclides | Attain a dose rate of <15 mrem/yr above background for 1,000 years. | Radionuclides were not COPCs for the 100-D-81 waste site. | NA |
| Direct Exposure – Nonradionuclides | Attain individual COPC direct exposure RAGs. | All individual COPC concentrations are below the direct exposure criteria. | Yes |

**Table ES-1. Summary of Remedial Action Goals for the 100-D-81 Waste Site. (2 Pages)**

| Regulatory Requirement | Remedial Action Goals | Results | Remedial Action Objectives Attained? |
|---|---|---|---|
| Risk Requirements – Nonradionuclides | Attain a hazard quotient of <1 for all individual noncarcinogens. | The hazard quotients for individual nonradionuclide COPCs are <1. | Yes |
| | Attain a cumulative hazard quotient of <1 for noncarcinogens. | The cumulative hazard quotient for all sampling areas ($2.6 \times 10^{-3}$) is <1. | |
| | Attain an excess cancer risk of $<1 \times 10^{-6}$ for individual carcinogens. | The excess cancer risk for all individual carcinogens are $<1 \times 10^{-6}$. | |
| | Attain a cumulative excess cancer risk of $<1 \times 10^{-5}$ for carcinogens. | The total excess cancer risk is $2.6 \times 10^{-7}$, and thus is $<1 \times 10^{-5}$. | |
| Groundwater/River Protection – Radionuclides | Attain single COPC groundwater and river protection RAGs. | Radionuclides were not COPCs for the 100-D-81 waste site. | NA |
| | Attain national primary drinking water standards[a]: 4 mrem/yr (beta/gamma) dose rate to target receptor/organs. | | |
| | 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]. | | |
| | Meet total uranium standard of 30 µg/L (21.2 pCi/L)[c]. | | |
| Groundwater/River Protection – Nonradionuclides | Attain individual nonradionuclide groundwater and river cleanup requirements. | All detected COPCs were below soil RAGs for groundwater and/or river protection. Therefore, it is predicted that the residual concentrations of the contaminants will not reach groundwater (and thus the Columbia River) within 1,000 years. | Yes |

[a] "National Primary Drinking Water Regulations" (40 *Code of Federal Regulations* 141).
[b] *Radiation Protection of the Public and the 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).

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

The results of the verification sampling are used to make reclassification decisions for the 100-D-81 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 waste site to Interim Closed Out. The current site conditions achieve the remedial action objectives and the corresponding RAGs established in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area*

(DOE-RL 2009b) and the Remaining Sites ROD (EPA 1999). The results of verification sampling show that residual contaminant concentrations do not preclude any future land 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 (i.e., below 4.6 m [15 ft]); therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are not required.

Soil cleanup levels were established in the Remaining Sites ROD (EPA 1999) based on a limited ecological risk assessment. Although not required by the Remaining Sites ROD, a comparison against ecological risk screening levels has been made for the 100-D-81 waste site contaminants of potential concern and other constituents. Those constituents exceeding the ecological screening level in the *Washington Administrative Code* 173-340, "Model Toxics Control Act – Cleanup," were boron and vanadium. The U.S. Environmental Protection Agency ecological soil screening levels were exceeded for cadmium, manganese, vanadium, and zinc. Exceedance of screening values is intended to trigger additional evaluation and does not necessarily indicate the existence of risk to ecological receptors. Because concentrations of cadmium, manganese, vanadium, and zinc are below background levels, it is believed that the presence of these constituents does not pose a risk to ecological receptors. All exceedances will be evaluated in the context of additional lines of evidence for ecological effects as a part of the final closeout decision for this site. A table showing contaminant concentrations from the 100-D-81 waste site that exceed ecological screening levels is provided in Appendix A.

# REMAINING SITES VERIFICATION PACKAGE FOR THE 100-D-81; 100D BURN AREAS AND OTHER STAINED AREAS WASTE SITE

## STATEMENT OF PROTECTIVENESS

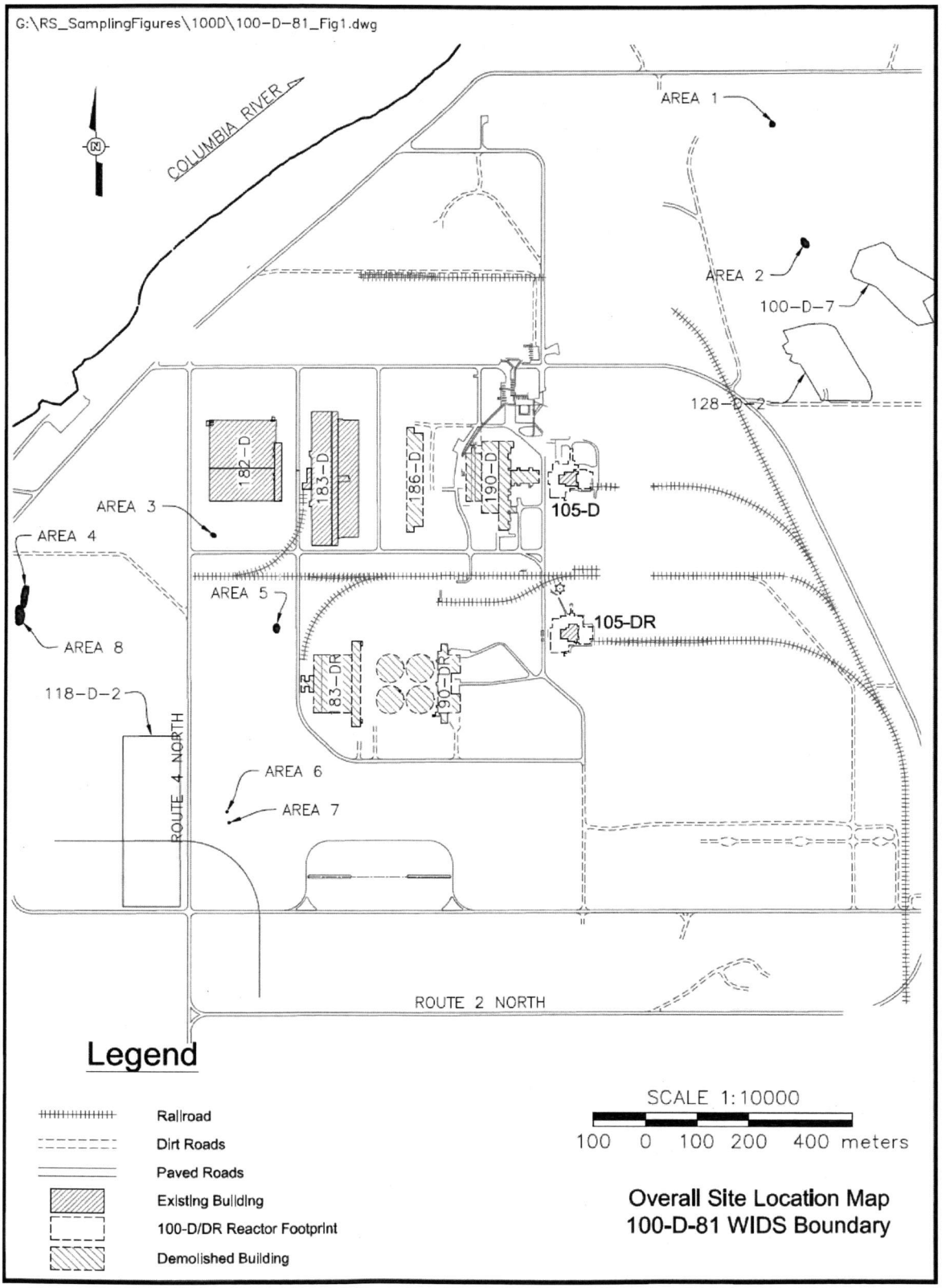
The 100-D-81; 100D Burn Areas and Other Stained Areas waste site verification sampling data, site evaluations, and supporting documentation demonstrate that this site meets the objectives established in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (100 Area RDR/RAWP) (DOE-RL 2009b) and the *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington* (Remaining Sites ROD) (EPA 1999). These results show that residual soil concentrations support future land uses that can be represented (or bounded) by a rural-residential scenario. The results also demonstrate that residual contaminant concentrations support unrestricted future use of shallow zone soil (i.e., surface to 4.6 m [15 ft]) and that contaminant levels remaining in the soil are protective of groundwater and the Columbia River. Contamination 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 are not required.

Soil cleanup levels were established in the Remaining Sites ROD (EPA 1999) based on a limited ecological risk assessment. Although not required by the Remaining Sites ROD, a comparison against ecological risk screening levels has been made for the 100-D-81 waste site contaminants of potential concern (COPCs) and other constituents. Those constituents exceeding the ecological screening level in the *Washington Administrative Code* (WAC) 173-340, "Model Toxics Control Act – Cleanup," were boron and vanadium. The U.S. Environmental Protection Agency (EPA) ecological soil screening levels were exceeded for cadmium, manganese, vanadium, and zinc. Exceedance of screening values is intended to trigger additional evaluation and does not necessarily indicate the existence of risk to ecological receptors. Because concentrations of cadmium, manganese, vanadium, and zinc are below background levels, it is believed that the presence of these constituents does not pose a risk to ecological receptors. All exceedances will be evaluated in the context of additional lines of evidence for ecological effects as a part of the final closeout decision for this site. A table showing contaminant concentrations from the 100-D-81 waste site that exceed ecological screening levels is provided in Appendix A.

## GENERAL SITE INFORMATION AND BACKGROUND

The 100-D-81 waste site is part of the 100-DR-1 Operable Unit. The burned and stained areas discovered during the orphan sites evaluation field investigation (WCH 2009) are scattered throughout the 100-D Area as shown in Figure 1.

**Figure 1. 100-D-81 Waste Site Location Map.**



The 100-D-81, 100D Burn Areas and Other Stained Areas waste site was a compilation of eight areas that were discovered during the orphan sites evaluation field investigation and reported in the *100-D Area Orphan Sites Evaluation Report* (WCH 2009). According to the remove-treat-dispose (RTD) memo, "100-D-81 Remaining Site for Remedial Action" (WCH 2010), areas 1, 2, 5, 6, and 7 did not require remediation. Areas 4 and 8 were recommended for RTD without confirmatory sampling based on observations at the sites. Area 3 was recommended for RTD because confirmatory sampling exceeded cleanup levels. Therefore, areas 3, 4, and 8 required remediation.

Area 1 may have been related to the 107-D Retention Basin. Historical information does not reveal any activity at this location.

Area 2 may have been associated with the 100-D-7 and 128-D-2 waste sites. The 100-D-7 waste site had a variety of building debris and shop waste (WCH 2005). The 128-D-2 waste site contained a white powder that may have been ash and showed evidence of surface burning (WCH 1993).

Area 3 contained evidence of burning, although historical photographs did not reveal any additional information about this site (shown in SIS report).

Areas 4 and 8 were possible vehicle oil-changing areas or may have been associated with 118-D-2. The actual processes that caused these stained areas are unknown and historical photographs from 1943 through 1989 did not reveal any construction or surface disturbance in this area (SIS report).

Area 5 contained evidence of burnt weeds, pieces of wood, and metal wire, however, historical photographs do not indicate any use during plant construction activities (SIS report).

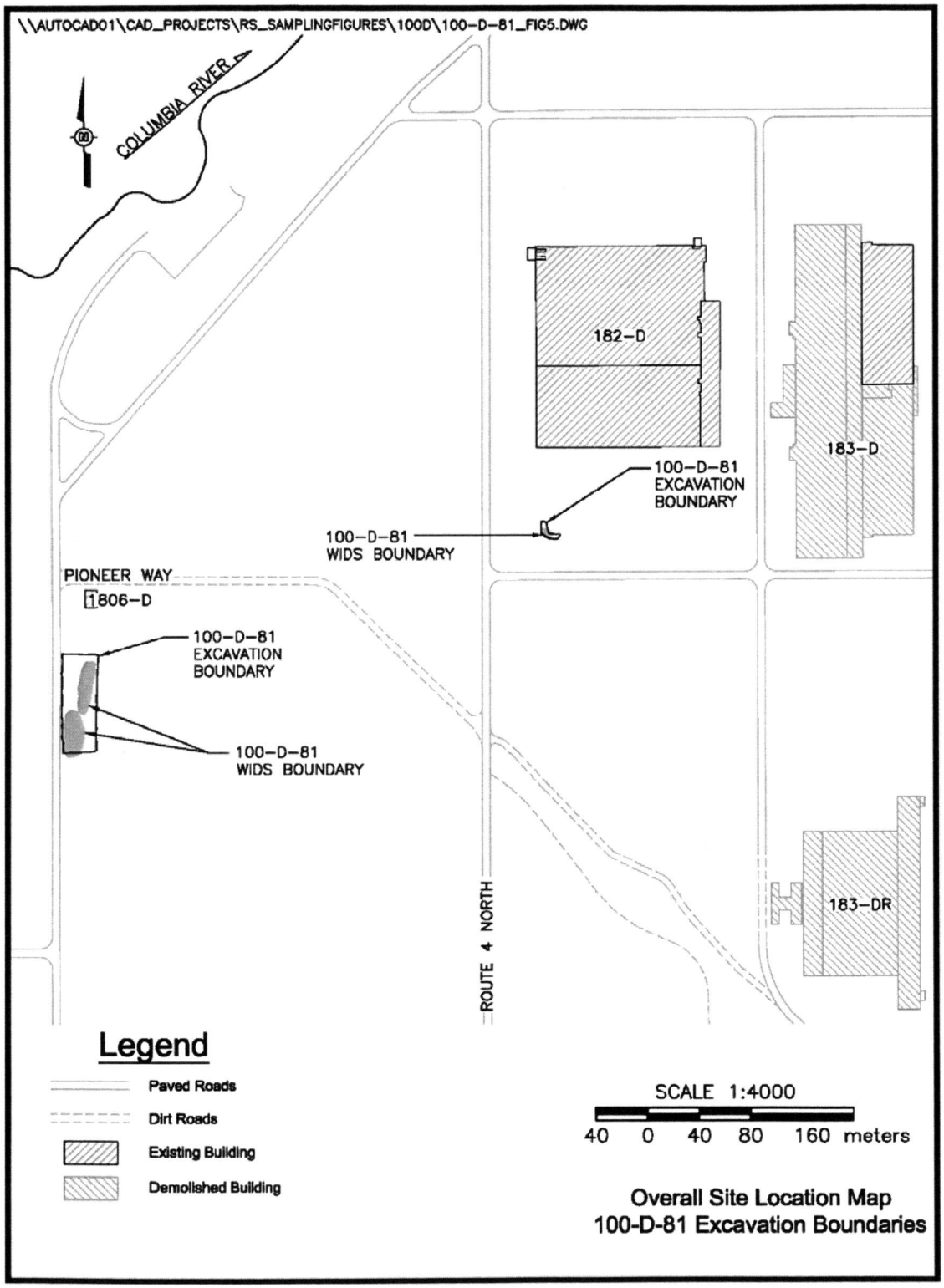
Area 6 may have been associated with the 118-D-2 waste site. This area was a possible sandblasting location. Historical documents show out-buildings that appear to have material lay-down areas surrounding them. The buildings may have been in support of construction of the 183-DR, 190-DR Buildings and the 190-DR Clearwells (SIS report).

Area 7 may have also been associated with 118-D-2 and connected to Area 6 (SIS report).

## REMEDIATION ACTION SUMMARY

Remedial action within areas 3, 4, and 8 at the 100-D-81 waste site was performed on July 14, 2014, and July 31, 2014 (Figure 2). On July 14, 2014, approximately 1,718 bank cubic meters (BCM) (2,245 bank cubic yards [BCY]) of material were excavated from areas 3, 4, and 8 within the 100-D-81 waste site. This material was staged and loaded out to the Environmental Restoration and Disposal Facility (ERDF) and closed out with the 100-D-72, 100-D-31:11, 100-D-31:12, 100-D-108, and the 100-D-109 waste sites RSVP (WCH 2015). On July 31, 2014, the remaining 14 BCM (18 BCY) of soil was remediated from areas 4 and 8 and loaded out to the ERDF.

**Figure 2. 100-D-81 Waste Site Remediated Areas.**



The waste from areas 3, 4, and 8 included soil and debris, including a few old equipment oil filters. Excavation extended to a maximum depth of approximately 0.5 m (1.5 ft) below ground surface.

## VERIFICATION SAMPLING ACTIVITIES

### Verification Sample Design

This section describes the basis for selection of a verification sampling design for the 100-D-81 waste site. One statistical sample design was identified for the 100-D-81 waste site excavation. This decision unit consists of area 3 with an area of 87 $m^2$ (932 $ft^2$), and areas 4 and 8 with an area of 2041 $m^2$ (21,891 $ft^2$) for a total of 2,128-$m^2$ (22,823-$ft^2$). No residual staining was identified within the excavated waste site area.

Verification sampling was conducted on October 15, 2014, per the *Work Instruction for Verification Sampling of the 100-D-81; 100D Burn Areas and Other Stained Areas* (WCH 2014b). Twelve statistical verification soil samples plus one duplicate were collected. All sampling was performed in accordance with ENV-1, *Environmental Monitoring & Management*, to fulfill the requirements of the *100 Area Remedial Action Sampling and Analysis Plan* (DOE-RL 2009a). Sampling was conducted to support a determination that residual contaminant concentrations in the soil meet cleanup criteria specified in the 100 Area RDR/RAWP (DOE-RL 2009b) and the Remaining Sites ROD (EPA 1999). The 100-D-81 waste site verification sample locations are shown in Figures 3 through 5.

A summary of the verification samples collected and laboratory analyses performed is provided in Table 1. Table 2 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).

Visual Sample Plan[1] (VSP) was used as a tool to develop the random statistical sampling design for the 100-D-81 waste site. The footprints of the excavation areas were delineated in VSP and used as the basis for location of a systematic grid for verification soil sample collection. Twelve soil verification sample locations were identified for the area. Additional details concerning the use of VSP to develop the statistical sampling design are provided in the verification sampling work instruction (WCH 2014b).

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

**Figure 3. 100-D-81 Waste Site Verification Sample Locations with WIDS Boundary.**

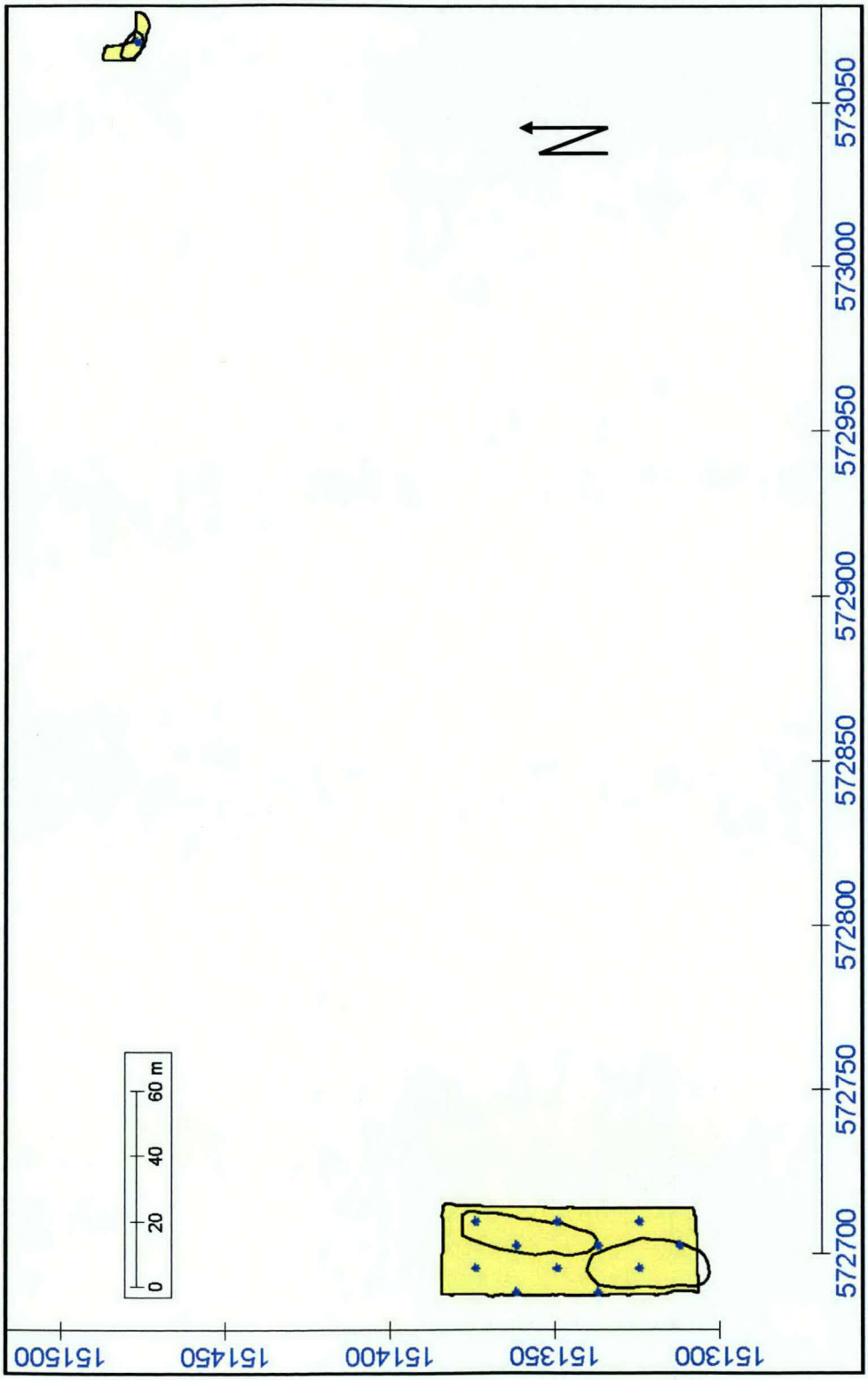


**Figure 4. 100-D-81 Waste Site Verification Sample Locations.**

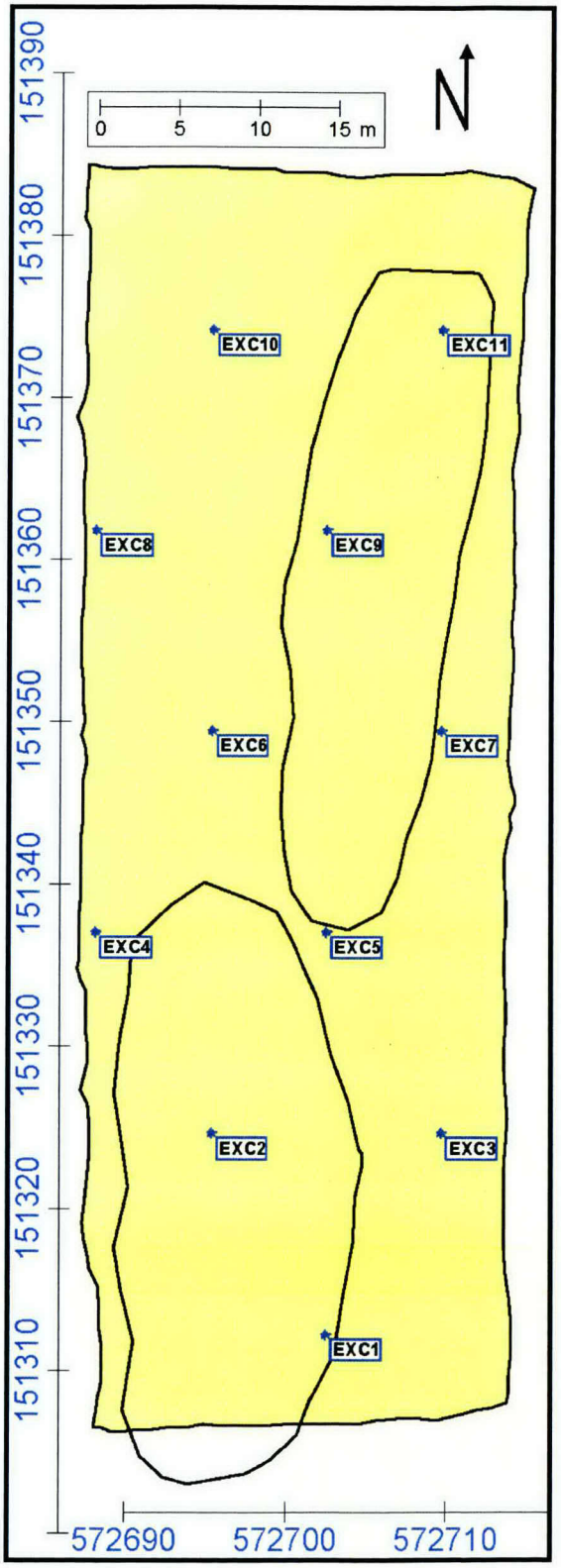
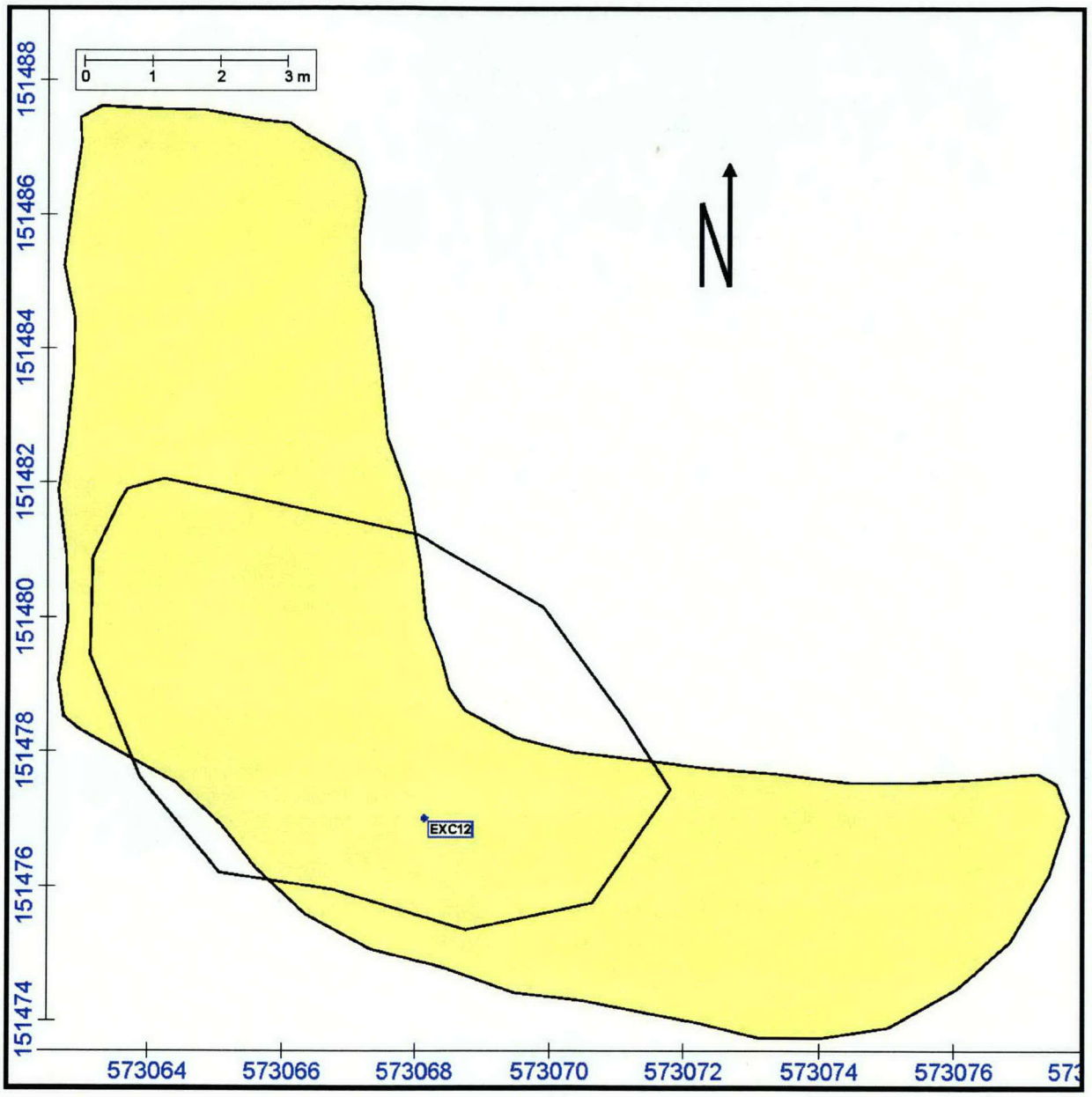


**Figure 5. 100-D-81 Waste Site Verification Sample Locations.**



## Table 1. 100-D-81 Verification Sample Summary.

| Sample Location | HEIS Sample Number | Washington State Plane Coordinates (m) | | Sample Analysis [a] |
|---|---|---|---|---|
| | | Northing | Easting | |
| EXC-1 | J1V113 | 151312.4 | 572702.5 | ICP metals [b], mercury, hexavalent chromium, PCB, PAH, and TPH |
| EXC-2 | J1V114 | 151324.7 | 572695.3 | |
| EXC-3 | J1V115 | 151324.7 | 572709.6 | |
| EXC-4 | J1V116 | 151337.1 | 572688.2 | |
| EXC-5 | J1V117 | 151337.1 | 572702.5 | |
| EXC-6 | J1V118 | 151349.5 | 572695.3 | |
| EXC-7 | J1V119 | 151349.5 | 572709.6 | |
| EXC-8 | J1V120 | 151361.9 | 572688.2 | |
| EXC-9 | J1V121 | 151361.9 | 572702.5 | |
| EXC-10 | J1V122 | 151374.3 | 572695.3 | |
| EXC-11 | J1V123 | 151374.3 | 572709.6 | |
| EXC-12 | J1V124 | 151477.0 | 573068.1 | |
| Duplicate of J1V122 | J1V125 | 151374.3 | 572695.3 | |
| Equipment blank | J1V126 | NA | NA | ICP metals [b], mercury |

[a] Samples were collected at each location and sample analysis were performed as defined in Table 2, Laboratory Analytical Methods. All sampling was performed in accordance with ENV-1, *Environmental Monitoring & Management* consistent with the *100 Area Remedial Action Sampling and Analysis Plan* (DOE-RL 2009a) requirements.

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

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

## Table 2. 100-D-81 Waste Site Laboratory Analytical Methods and Contaminants of Potential Concern.

| Analysis | Analytical Method | Contaminant of Potential Concern |
|---|---|---|
| PAH | EPA Method 8310 | Polycyclic aromatic hydrocarbons |
| TPH | NWTPH-Dx | Total petroleum hydrocarbons |
| PCBs | EPA Method 8082 | Polychlorinated biphenyls |
| ICP metals [a] | EPA Method 6010 | Arsenic and lead |
| Mercury | EPA Method 7471 | Mercury |
| Hexavalent chromium | EPA Method 7196 | Hexavalent chromium |

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

EPA = U.S. Environmental Protection Agency
ICP = inductively coupled plasma
NWTPH-Dx = Northwest total petroleum hydrocarbons-diesel range
PAH = polycyclic aromatic hydrocarbons
PCB = polychlorinated biphenyl
TPH = total petroleum hydrocarbons

## Contaminants of Concern for Verification Sampling

Contaminants of potential concern were based on professional judgment and historical documentation. The COPCs for the 100-D-81 waste site included polycyclic aromatic hydrocarbons (PAH), hexavalent chromium, arsenic, lead, and mercury. Total petroleum hydrocarbons (TPH) and polychlorinated biphenyls (PCBs) were also identified as COPCs due to evidence of staining at the site. Although not COPCs, antimony, barium, beryllium, boron, cadmium, chromium (total), cobalt, copper, manganese, molybdenum, nickel, selenium, silver, vanadium, and zinc were evaluated by performing analysis for the constituents of the expanded inductively coupled plasma (ICP) metals analytical list.

## Verification Sampling Results

All verification samples were collected for full protocol laboratory analysis and analyzed using EPA-approved analytical methods. Evaluation of the verification data from the 100-D-81 waste site was performed by direct comparison of the statistical or maximum sample result for each COPC against cleanup criteria.

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-D-81 waste site decision unit as specified by the 100 Area RDR/RAWP (DOE-RL 2009b). The calculations are provided in Appendix B. When a nonradionuclide COPC was detected in fewer than 50% of the verification samples collected for the decision unit, the maximum detected value was used for comparison to the 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 sample results to the site RAGs for the 100-D-81 waste site are presented 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, Volume I: Human Health Evaluation Manual (Part A)* (EPA 1989) recommends that aluminum and iron not be considered in site risk evaluations. Therefore, aluminum, calcium, iron, magnesium, potassium, silicon, and sodium are not considered site COPCs and are also not included in these tables. The complete laboratory results are stored in a Washington Closure Hanford project-specific database prior to submitting to the Hanford Environmental Information System for archiving and are provided in Appendix C.

**Table 3. Comparison of Contaminant Concentrations to Remedial Action Goals for the 100-D-81 Waste Site Excavation Verification Samples.**

| COPC | Statistical or Maximum Result [b] (mg/kg) | Remedial Action Goals (mg/kg) [a] | | | Does the Result Exceed RAGs? | Does the Result Pass RESRAD Modeling? |
|---|---|---|---|---|---|---|
| | | Direct Exposure | Soil Cleanup Level for Groundwater Protection | Soil Cleanup Level for River Protection | | |
| Arsenic | 3.8 (<BG) | 20 [c] | 20 [c] | 20 [c] | No | -- |
| Barium | 75.2 (<BG) | 5,600 | 200 | 400 | No | -- |
| Boron [d] | 1.5 | 7,200 | 320 | -- [e] | No | -- |
| Cadmium [f] | 0.39 (<BG) | 13.9 [g] | 0.81 [c] | 0.81 [c] | No | -- |
| Chromium | 11.0 (<BG) | 80,000 | 18.5 [c] | 18.5 [c] | No | -- |
| Cobalt | 7.5 (<BG) | 24 | 15.7 [c] | -- [e] | No | -- |
| Copper | 16.9 (<BG) | 2,960 | 59.2 | 22.0 [c] | No | -- |
| Hexavalent chromium [d] | 0.394 | 2.1 [g] | 4.8 | 2 | No | -- |
| Lead | 7.0 (<BG) | 353 | 10.2 [c] | 10.2 [c] | No | -- |
| Manganese | 316 (<BG) | 3,760 | 512 [c] | 512 [c] | No | -- |
| Mercury | 0.010 (<BG) | 24 | 0.33 [c] | 0.33 [c] | No | -- |
| Molybdenum [d] | 0.28 | 400 | 8 | -- [e] | No | -- |
| Nickel | 11.7 (<BG) | 1,600 | 19.1 [c] | 27.4 | No | -- |
| Vanadium | 55.2 (<BG) | 560 | 85.1 [c] | -- [c] | No | -- |
| Zinc | 62.4 (<BG) | 24,000 | 480 | 67.8 [c] | No | -- |
| TPH – diesel range | 7.8 | 200 | 200 | 200 | No | -- |
| TPH – diesel range EXT | 13.0 | 200 | 200 | 200 | No | -- |
| Benzo(a)pyrene | 0.0098 | 0.137 | 0.015 [h] | 0.015 [h] | No | -- |
| Benzo(b)fluoranthene | 0.0060 | 1.37 | 0.015 [h] | 0.015 [h] | No | -- |
| Chrysene | 0.0057 | 13.7 | 0.12 | 0.1 [h] | No | -- |

[a] RAGs obtained from the 100 Area RDR/RAWP (DOE-RL 2009b).
[b] Maximum or 95% upper confidence limit, depending on data censorship, as described in the *100-D-81 Waste Site Cleanup Verification 95% UCL Calculations* (Appendix B).
[c] Where cleanup levels are less than background, cleanup levels default to background per WAC 173-340-700(4)(d) (Ecology 1996). The arsenic cleanup level of 20 mg/kg has been agreed to by the Tri-Party Agreement project managers as discussed in Section 2.1.2.1 of the 100 Area RDR/RAWP (DOE-RL 2009b).
[d] No Hanford Site-specific or Washington State background value available.
[e] No parameters (bioconcentration factors or ambient water quality criteria values) are available from the 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]).
[f] Hanford Site-specific background value is not available. Value used is from *Natural Background Soil Metals Concentrations in Washington State* (Ecology 1994).
[g] Carcinogenic cleanup level calculated based on the inhalation exposure pathway (WAC 173-340-750[3], Ecology 1996).
[h] Where cleanup levels are less than RDLs, cleanup levels default to RDLs per WAC 173-340-707(2) (Ecology 1996).

-- = not applicable
BG = background
COPC = contaminant of potential concern
EXT = extended
RAG = remedial action goal
RDL = required detection limit
RDR/RAWP = Remedial Design Report/Remedial Action Work Plan
RESRAD = RESidual RADioactivity (dose model)
TPH = total petroleum hydrocarbons
WAC = *Washington Administrative Code*

## DATA EVALUATION

This section demonstrates that remedial actions at the 100-D-81 waste site have achieved the applicable RAGs developed to support unrestricted land use at the 100 Area as established in the Remaining Sites ROD (EPA 1999) and documented in the 100 Area RDR/RAWP (DOE-RL 2009b).

### Attainment of Nonradionuclide RAGs

Table 3 compares the cleanup verification sample values for the 100-D-81 waste site excavation area to the applicable soil RAGs for direct exposure, protection of groundwater, and the protection of the Columbia River. All COPCs were quantified below direct exposure RAGs. All COPCs were quantified below groundwater and/or river protection soil RAGs.

### Three-Part Test for Nonradionuclides

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

The application of the three-part test for the 100-D-81 waste site is included in the statistical calculations, where half or more of the data set was detected (Appendix B). The results of this evaluation indicate that residual COPC concentrations pass the three-part test in comparison against applicable RAGs with the exception of zinc. Zinc failed the three-part test due to a single result from location EXC-12 that exceeded the soil cleanup level for Columbia River protection. Zinc concentrations in all of the other samples were detected below background. However, the vadose thickness at the 100-D-81 waste site is 24.5 m (81 ft). Zinc, with a distribution coefficient ($K_d$ value) of 30 mL/g, is not predicted to migrate more than 1.8 m (5.9 ft) vertically within 1,000 years and is therefore predicted to be protective of the Columbia River.

An additional application of the three-part test is included for the statistical data sets that default to the maximum because less than half of the data set was detected. The results of this evaluation indicate that residual COPC concentrations pass the three-part test in comparison against applicable RAGs; therefore, residual concentrations of COPCs are predicted to be protective of groundwater and the Columbia River.

### Nonradionuclide Direct Contact Hazard Quotient and Carcinogenic Risk RAGs Attained

Nonradionuclide risk requirements include an individual hazard quotient of less than 1.0, a cumulative hazard quotient of less than 1.0, an individual contaminant carcinogenic risk of less than $1 \times 10^{-6}$, and a cumulative carcinogenic risk of less than $1 \times 10^{-5}$. For the 100-D-81 waste site, these risk values were not calculated for constituents that were either not detected or were detected at concentrations below Hanford Site or Washington State background. All individual hazard quotients for noncarcinogenic constituents were less than 1.0. The cumulative hazard quotient for those noncarcinogenic constituents above background or detected levels is

$2.6 \times 10^{-3}$, which is less than 1.0. The individual carcinogenic risk values for the carcinogenic constituents detected above background are less than $1 \times 10^{-6}$, and the cumulative carcinogenic risk value is $2.7 \times 10^{-7}$, which is less than $1 \times 10^{-5}$. Therefore, the 100-D-81 waste site meets the requirements for the direct contact hazard quotient and excess carcinogenic risk as identified in the 100 Area RDR/RAWP (DOE-RL 2009b).

### Nonradionuclide Groundwater Hazard Quotient and Carcinogenic Risk RAGs Attained

Assessment of the risk requirements for the 100-D-81 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 $1 \times 10^{-6}$, and a cumulative excess carcinogenic risk of less than $1 \times 10^{-5}$. These risk values were conservatively calculated for the entire waste site using the greater of the maximum or statistical value for each COPC. Risk values were calculated for constituents that were detected at concentrations above Hanford Site or Washington State background values or for which there is no background value. In addition, the $K_d$ values for these contaminants are less than that necessary to show no migration to groundwater in 1,000 years based on RESidual RADioactivity (RESRAD) modeling discussed in Appendix C of the 100 Area RDR/RAWP (DOE-RL 2009b). Based on this model and a vadose zone of approximately 24.5 m (81 ft) in thickness at the excavation, a $K_d$ of 3.1 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 groundwater hazard quotient for the 100-D-81 waste site is $8.7 \times 10^{-2}$, which is less than 1.0. No carcinogenic constituents met the criteria for evaluation of groundwater risk at the 100-D-81 waste site; therefore, no calculations of excess carcinogenic risk were performed. Thus, the individual contaminant carcinogenic risk requirement of less than $1 \times 10^{-6}$ is met and the cumulative carcinogenic risk of less than $1 \times 10^{-5}$ is met. Therefore, the criterion for excess cancer risk is met and the nonradionuclide risk requirements related to groundwater are met.

## DATA QUALITY ASSESSMENT

A data quality assessment (DQA) was performed to compare the verification sampling approach, 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-D-81 waste site established that the data are of the right type, quality, and quantity to support site verification decisions within specified error tolerances. The evaluation verified that the sample design was sufficient for the purpose of clean site verification. The cleanup verification sample analytical data are stored in the environmental restoration project-specific database for data evaluation prior to archival in the Hanford Environmental Information System and are summarized in Appendix B. The detailed DQA is presented in Appendix C.

## SUMMARY FOR INTERIM CLOSURE

The 100-D-81 waste site has been evaluated in accordance with the Remaining Sites ROD (EPA 1999) and the 100 Area RDR/RAWP (DOE-RL 2009b). Verification sampling was performed, and the analytical results indicate that the residual concentrations of COPCs at this waste site meet the remedial action objectives for direct exposure, groundwater protection, and river protection. In accordance with this evaluation, the verification sampling results support a reclassification of the 100-D-81 waste site to Interim Closed Out. Contamination above direct exposure levels was not observed in the shallow zone soils and is concluded to not exist in deep zone soils; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are not required.

## REFERENCES

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

BHI, 2001, *Calculation of Total Uranium Activity Corresponding to a Maximum Contaminant Level for Total Uranium of 30 Micrograms per Liter in Groundwater*, 0100X-CA-V0038, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, as amended, U.S. Department of Energy, Washington, D.C.

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

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

DOE-RL, 2011, *Tri-Party Agreement Handbook Management Procedures,* RL-TPA-90-0001, Rev. 2, Guideline Number TPA-MP-14, "Maintenance of the Waste Information Data System (WIDS)," U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Ecology, 1994, *Natural Background Soil Metals Concentrations in Washington State*, Publication No. 94-115, Washington State Department of Ecology, Olympia, Washington.

Ecology, 1996, "Model Toxics Control Act – Cleanup," *Washington Administrative Code* (WAC) 173-340, Washington State Department of Ecology, Olympia, Washington.

Ecology, 2014, Cleanup Levels and Risk Calculations (CLARC) Database, Washington State Department of Ecology, Olympia, Washington, <https://fortress.wa.gov/ecy/clarc/CLARCHome.aspx>.

ENV-1, *Environmental Monitoring & Management*, Washington Closure Hanford, Richland, Washington.

EPA, 1989, *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A),* Interim Final, EPA/540/1-89/002, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1999, *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington*, U.S. Environmental Protection Agency, Region 10, Seattle, Washington.

EPA, 2009, *Explanation of Significant Differences for the 100 Area Remaining Sites Interim Remedial Action Record of Decision, Hanford Site, Benton County, Washington*, U.S. Environmental Protection Agency, Region 10, Seattle, Washington.

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

WCH, 1993, *100-D Area Technical Baseline Report*, WHC-SD-EN-TI-181, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WCH, 2005, *Work Instruction for the 100-D-7 Undocumented Solid Waste Site*, 0100D-WI-G0016, Rev. 0, Washington Closure Hanford, Richland, Washington.

WCH, 2009, *100-D Area Orphan Sites Evaluation Report*, OSR-2006-0001, Rev. 0, Washington Closure Hanford, Richland, Washington.

WCH, 2010, "100-D-81 Remaining Site for Remedial Action," Interoffice Memorandum from M. L. Proctor to S. W. Callison, CCN 153966, Washington Closure Hanford, Richland, Washington, October 12.

WCH, 2014a, *100D Field Remediation Miscellaneous Sampling Activities*, Logbook EL-1662-03, pp. 48-50, Washington Closure Hanford, Richland, Washington.

WCH, 2014b, *Work Instruction for Verification Sampling of the 100-D-81; 100D Burn Areas and Other Stained Areas,* 0100D-WI-G0146, Rev. 0, Washington Closure Hanford, Richland, Washington.

WCH, 2015, *Remaining Sites Verification Package for the 100-D-72, 183-D Acid Facility; 100-D-31:11, 182-D and 183-D Sewer Pipelines; 100-D-31:12, 183-D West Process Sewer Pipelines; 100-D-108, 182-D Remaining Pipeline Stubs; and the 100-D-109, 183-D Remaining Pipeline Stubs Waste Sites*, Attachment to Waste Site Reclassification Forms 2015-003, 2015-004, 2015-005, 2015-006, and 2015-007, Rev. 0, Washington Closure Hanford, Richland, Washington.

# APPENDIX A

# ECOLOGICAL RISK COMPARISON TABLE

**Table A-1. Contaminants Exceeding Ecological Screening Levels for the 100-D-81 Waste Site [a]**

| Hazardous Substance | | 2007 WAC 173-340 Table 749-3 | | | EPA Ecological Soil Screening Levels [b] | | | | Waste Site Analyses |
|---|---|---|---|---|---|---|---|---|---|
| | | Plants | Soil Biota | Wildlife | Plants | Soil Biota | Avian [c] | Mammalian [c] | |
| **Metals (mg/kg):** | | | | | | | | | |
| | **Background** | | | | | | | | |
| Boron [d] | -- | 0.5 | -- | -- | -- | -- | -- | -- | 1.5 |
| Cadmium | 0.81 | 4 | 20 | 14 | 32 | 140 | 0.77 | 0.36 | 0.39 (<BG) |
| Manganese | 512 | 1,100 [e] | -- | 1,500 | 220 | 450 | 4,300 | 4,000 | 316 (<BG) |
| Vanadium | 85.1 | 2 | -- | -- | -- | -- | 7.8 | 280 | 55.2 (<BG) |
| Zinc | 67.8 | 86 [e] | 200 | 360 | 160 | 120 | 46 | 79 | 62.4 (<BG) |

NOTE: Shaded cells are exceeded by the maximum or the statistical result.
Blank cells = Values not available.

[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.

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

[e] Benchmark replaced by Washington State natural background concentration from Ecology, 1994, *Natural Background Soil Metals Concentrations in Washington State*, Publication 94-115, Washington State Department of Ecology, Olympia, Washington.

BG = background
EPA = U.S. Environmental Protection Agency
WAC = *Washington Administrative Code*

# APPENDIX B

# CALCULATIONS

# APPENDIX B

## CALCULATION BRIEFS

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

*100-D-81 Waste Site Cleanup Verification 95% UCL Calculations,* 0100D-CA-V0576, Rev. 0, Washington Closure Hanford, Richland, Washington.

*100-D-81 Waste Site Direct Contact Hazard Quotient and Carcinogenic Risk Calculation,* 0100D-CA-V0577, Rev. 1, Washington Closure Hanford, Richland, Washington.

*100-D-81 Waste Site Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater Hazard*, 0100D-CA-V0578, Rev. 0, Washington Closure Hanford, Richland, Washington.

**DISCLAIMER FOR CALCULATIONS**

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

Acrobat 8.0

# CALCULATION COVER SHEET

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

Area: 100-D

Discipline: Environmental *Calculation No: 0100D-CA-V0576

Subject: 100-D-81 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<br>Sheets = 10<br>Attm. 1 = 4<br>Total = 15 | J. D. Skoglie | R. J. Nielson | T. Q. Howell | S. G. Wilkinson | 1/6/15 |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

## SUMMARY OF REVISION

| | |
|---|---|
| | |
| | |
| | |

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

***Washington Closure Hanford*** **CALCULATION SHEET**

| | | | | | |
|---|---|---|---|---|---|
| **Originator** J. D. Skoglie | **Date** 12/11/14 | **Calc. No.** 0100D-CA-V0576 | **Rev. No.** 0 |
| **Project** 100-D Area Closure Operations | **Job No.** 14655 | **Checked** R. J. Nielson | **Date** 12/11/14 |
| **Subject** 100-D-81 Waste Site Cleanup Verification 95% UCL Calculations | | | **Sheet No.** 1 of 10 |

## Summary

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

**Table of Contents:**
Sheets 1 to 4 - Calculation Sheet Summary
Sheets 5 to 7 - Calculation Sheet Verification Data (Statistical and Maximum) - Excavation Area
Sheets 8 and 9 - Ecology Software (MTCAStat) Results
Sheet 10 - Calculation Sheet - Duplicate Analysis
Attachment 1 - 100-D-81 Waste Site, Verification Sampling Results (4 pages).

**Given/References:**
1) Sample Results (Attachment 1).
2) DOE-RL, 2009a, *100 Area Remedial Action Sampling and Analysis Plan* (SAP), DOE/RL-96-22, Rev. 5, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
3) DOE-RL, 2009b, *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP), DOE/RL-96-17, Rev. 6, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
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 2009b). Use data from attached worksheets to perform the 95% UCL calculation for each analyte, the WAC 173-340-740(7)(e) 3-part test for nonradionuclides, and the RPD calculations for each COC/COPC. The hazard quotient and carcinogenic risk calculations are located in a separate calculation brief as an appendix to the Remaining Sites Verification Package (RSVP).

**Calculation Description:**
The subject calculations were performed on statistical data from soil verification samples (Attachment 1) from the 100-D-81 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 2009b) is documented by this calculation. Duplicate RPD results are used in evaluation of data quality within the RSVP for this site.

**Methodology:**
The 100-D-81 waste site underwent statistical sampling at one decision unit; the excavation area.

**Washington Closure Hanford** **CALCULATION SHEET**

**Originator** J. D. Skoglie **Date** 12/11/14 **Calc. No.** 0100D-CA-V0576 **Rev. No.** 0
**Project** 100-D Area Closure Operations **Job No.** 14655 **Checked** R. J. Nielson **Date** 12/11/14
**Subject** 100-D-81 Waste Site Cleanup Verification 95% UCL Calculations **Sheet No.** 2 of 10

**Summary (continued)**

**Methodology, continued:**

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

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

For nonradionuclides, the WAC 173-340 statistical guidance suggests that a test for distributional form be performed on the data and the 95% UCL calculated on the appropriate distribution using Ecology software. For nonradionuclide small data sets (n<10), the calculations are performed assuming nonparametric distribution, so no tests for distribution are performed. For nonradionuclide data sets of ten or greater, as for the subject site, distributional testing is done using Ecology's MTCAStat software (Ecology 1993). Due to differences in addressing censored data between the RDR/RAWP (DOE-RL 2009b) and MTCAStat coding and due to a limitation in the MTCAStat coding (no direct capability to address variable quantitation limits within a data set), substitutions for censored data are performed before software input and the resulting data set treated as uncensored.

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

The RPD is calculated when both the primary value and the duplicate value for a given analyte are above detection limits and are greater than 5 times the target detection limit (TDL). The TDLs are pre-determined values for analytical methods and constituents with cleanup levels as listed in Table 2-1 of the SAP (DOE-RL 2009a). Table 2-1 includes nominal TDLs for identified methods based organic analyses. The nominal TDLs are also used in support of the RPD calculation for the methods based analytes. TDLs not included in Table 2-1 are based on the laboratory and/or methods used. Where direct evaluation of the attached sample data showed that a given analyte was not detected in the primary and/or duplicate sample, further evaluation of the RPD value was not performed. The RPD calculations use the following formula:

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

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

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

***Washington Closure Hanford*** **CALCULATION SHEET**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Originator** | J. D. Skoglie | **Date** | 12/11/14 | **Calc. No.** | 0100D-CA-V0576 | **Rev. No.** | 0 |
| **Project** | 100-D Area Closure Operations | **Job No.** | 14655 | **Checked** | R. J. Nielson | **Date** | 12/11/14 |
| **Subject** | 100-D-81 Waste Site Cleanup Verification 95% UCL Calculations | | | | | **Sheet No.** | 3 of 10 |

**Summary (continued)**

**QUALIFIER LIST**

B = Estimated result. Result is less than the RL, but greater than MDL.
C = The analyte was detected in both the sample and the associated QC blank, and the sample concentration was ≤5X the blank concentration
J = estimate
N = recovery exceeds upper or lower control limits
U = undetected
X (metals) = Serial dilution in the analytical batch indicates that physical and chemical interferences are present.
X (organics) = > 40% difference between primary and confirmation detector results. Lower of the two results is reported.

**ACRONYM LIST**

-- = not applicable
DE = direct exposure
EXC = excavation
GW = groundwater
MDL = method detection limit
MTCA = *Model Toxics Control Act*
NA = not applicable
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** J. D. Skoglie **Date** 12/11/14 **Calc. No.** 0100D-CA-V0576 **Rev. No.** 0
**Project** 100-D Area Closure Operations **Job No.** 14655 **Checked** R. J. Nielson **Date** 12/11/14
**Subject** 100-D-81 Waste Site Cleanup Verification 95% UCL Calculations **Sheet No.** 4 of 10

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

**Results Summary - Excavation [a]**

| Analyte | EXC 95% UCL Result | EXC Maximum Result | Units |
|---|---|---|---|
| Arsenic | 3.8 | -- | mg/kg |
| Barium | 75.2 | -- | mg/kg |
| Boron | 1.5 | -- | mg/kg |
| Cadmium | 0.39 | -- | mg/kg |
| Chromium | 11.0 | -- | mg/kg |
| Cobalt | 7.5 | -- | mg/kg |
| Copper | 16.9 | -- | mg/kg |
| Hexavalent chromium | 0.394 | -- | mg/kg |
| Lead | 7.0 | -- | mg/kg |
| Manganese | 316 | -- | mg/kg |
| Mercury | -- | 0.010 | mg/kg |
| Molybdenum | -- | 0.28 | mg/kg |
| Nickel | 11.7 | -- | mg/kg |
| Vanadium | 55.2 | -- | mg/kg |
| Zinc | 62.4 | -- | mg/kg |
| TPH - diesel range | -- | 7.8 | mg/kg |
| TPH - diesel range extended | -- | 13.0 | mg/kg |
| Benzo(a)pyrene | -- | 0.0098 | mg/kg |
| Benzo(b)fluoranthene | -- | 0.0060 | mg/kg |
| Chrysene | -- | 0.0057 | mg/kg |

**3-Part Test Evaluation**

| | EXC | |
|---|---|---|
| 95% UCL or Maximum > Cleanup Limit? | NO | NO |
| > 10% above Cleanup Limit? | NO | NO |
| Any sample > 2x Cleanup Limit? | YES | 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 | Duplicate Analysis Excavation |
|---|---|
| Aluminum | 4.2% |
| Barium | 0.6% |
| Calcium | 3.9% |
| Chromium | 2.5% |
| Copper | 5.8% |
| Iron | 3.3% |
| Magnesium | 7.4% |
| Manganese | 1.1% |
| Silicon | 16.3% |
| Vanadium | 1.4% |
| Zinc | 1.4% |

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

**CALCULATION SHEET**

*Washington Closure Hanford*
Originator J. D. Skoglie
Project 100-D Area Closure Operations
Subject 100-D-81 Waste Site Cleanup Verification 95% UCL Calculations

Date 12/11/14
Job No. 14655

Calc. No. 0100D-CA-V0526
Checked R. J. Nielson

Rev. No. 0
Date 12/11/14
Sheet No. 5 of 10

**100-D-81 Waste Site Statistical Calculations**

**Verification Data - Excavation**

| Sample Area | Sample Number | Sample Date | Arsenic mg/kg | Q | PQL | Barium mg/kg | Q | PQL | Boron mg/kg | Q | PQL | Cadmium mg/kg | Q | PQL | Chromium mg/kg | Q | PQL | Cobalt mg/kg | Q | PQL | Copper mg/kg | Q | PQL | Hexavalent Chromium mg/kg | Q | PQL | Lead mg/kg | Q | PQL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EXC-10 | J1V122 | 10/15/14 | 2.7 | | 0.69 | 83.9 | X | 0.078 | 2.5 | | 1.0 | 0.17 | B | 0.043 | 11.9 | X | 0.060 | 7.7 | X | 0.10 | 13.8 | X | 0.23 | 0.155 | U | 0.155 | 4.9 | | 0.28 |
| Duplicate of J1V122 | J1V125 | 10/15/14 | 3.0 | | 0.69 | 83.4 | X | 0.078 | 2.1 | | 1.0 | 0.14 | B | 0.043 | 12.2 | X | 0.060 | 7.8 | X | 0.10 | 14.3 | X | 0.23 | 0.187 | | 0.155 | 5.0 | | 0.28 |
| EXC-1 | J1V113 | 10/15/14 | 2.0 | | 0.64 | 38.5 | X | 0.073 | 0.95 | U | 0.95 | 0.11 | B | 0.040 | 3.8 | X | 0.056 | 7.1 | X | 0.096 | 13.8 | X | 0.21 | 0.184 | | 0.155 | 2.8 | | 0.26 |
| EXC-2 | J1V114 | 10/15/14 | 2.1 | | 0.62 | 58.6 | X | 0.071 | 0.91 | U | 0.91 | 0.13 | B | 0.038 | 3.8 | X | 0.054 | 7.0 | X | 0.093 | 14.1 | X | 0.20 | 0.191 | | 0.155 | 3.1 | | 0.25 |
| EXC-3 | J1V115 | 10/15/14 | 2.7 | | 0.62 | 88.8 | X | 0.072 | 1.5 | B | 0.92 | 0.16 | B | 0.039 | 10.7 | X | 0.055 | 7.1 | X | 0.094 | 14.2 | X | 0.20 | 0.311 | | 0.155 | 3.8 | | 0.25 |
| EXC-4 | J1V116 | 10/15/14 | 2.9 | | 0.70 | 71.8 | X | 0.081 | 1.7 | B | 1.0 | 0.13 | B | 0.044 | 12.5 | X | 0.062 | 7.5 | X | 0.11 | 14.4 | X | 0.23 | 0.358 | | 0.155 | 4.8 | | 0.29 |
| EXC-5 | J1V117 | 10/15/14 | 2.4 | | 0.66 | 45.3 | X | 0.076 | 0.99 | U | 0.99 | 0.12 | B | 0.041 | 7.9 | X | 0.058 | 6.5 | X | 0.10 | 13.8 | X | 0.22 | 0.289 | | 0.155 | 2.9 | | 0.27 |
| EXC-6 | J1V118 | 10/15/14 | 2.2 | | 0.64 | 61.2 | X | 0.073 | 0.95 | U | 0.95 | 0.12 | B | 0.040 | 7.1 | X | 0.056 | 7.6 | X | 0.096 | 15.0 | X | 0.21 | 0.454 | | 0.155 | 3.1 | | 0.26 |
| EXC-7 | J1V119 | 10/15/14 | 3.9 | | 0.69 | 76.8 | X | 0.079 | 1.3 | B | 1.0 | 0.17 | B | 0.043 | 13.3 | X | 0.060 | 6.6 | X | 0.10 | 17.5 | X | 0.23 | 0.271 | | 0.155 | 3.8 | | 0.28 |
| EXC-8 | J1V120 | 10/15/14 | 2.6 | | 0.64 | 56.0 | X | 0.073 | 1.3 | B | 0.94 | 0.16 | B | 0.039 | 9.3 | X | 0.056 | 7.6 | X | 0.096 | 18.2 | X | 0.21 | 0.404 | | 0.155 | 3.6 | | 0.26 |
| EXC-9 | J1V121 | 10/15/14 | 3.1 | | 0.58 | 84.9 | X | 0.067 | 1.5 | B | 0.87 | 0.14 | B | 0.036 | 12.4 | X | 0.051 | 6.6 | X | 0.088 | 20.0 | X | 0.19 | 0.354 | | 0.155 | 4.5 | | 0.24 |
| EXC-11 | J1V123 | 10/15/14 | 2.1 | | 0.59 | 51.1 | X | 0.068 | 0.88 | U | 0.88 | 0.11 | B | 0.037 | 4.9 | X | 0.052 | 7.3 | X | 0.090 | 15.1 | X | 0.19 | 0.271 | | 0.155 | 2.8 | | 0.24 |
| EXC-12 | J1V124 | 10/15/14 | 7.6 | | 0.61 | 81.1 | X | 0.070 | 2.2 | | 0.90 | 1.3 | | 0.038 | 12.4 | X | 0.053 | 7.9 | X | 0.092 | 19.8 | X | 0.20 | 0.155 | U | 0.155 | 18.9 | | 0.25 |

**Statistical Computation Input Data**

| Sample Area | Sample Number | Sample Date | Arsenic mg/kg | Barium mg/kg | Boron mg/kg | Cadmium mg/kg | Chromium mg/kg | Cobalt mg/kg | Copper mg/kg | Hexavalent Chromium mg/kg | Lead mg/kg |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EXC-10 | J1V122/ J1V125 | 10/15/14 | 2.9 | 83.7 | 2.3 | 0.16 | 12.1 | 7.8 | 13.9 | 0.132 | 5.0 |
| EXC-1 | J1V113 | 10/15/14 | 2.0 | 38.5 | 0.46 | 0.11 | 3.8 | 7.1 | 13.8 | 0.184 | 2.8 |
| EXC-2 | J1V114 | 10/15/14 | 2.1 | 58.6 | 0.46 | 0.13 | 3.8 | 7.0 | 14.1 | 0.191 | 3.1 |
| EXC-3 | J1V115 | 10/15/14 | 2.7 | 88.8 | 1.5 | 0.16 | 10.7 | 7.1 | 14.2 | 0.311 | 3.8 |
| EXC-4 | J1V116 | 10/15/14 | 2.9 | 71.8 | 1.7 | 0.13 | 12.5 | 7.5 | 14.4 | 0.358 | 4.8 |
| EXC-5 | J1V117 | 10/15/14 | 2.4 | 45.3 | 0.50 | 0.12 | 7.9 | 6.5 | 13.8 | 0.289 | 2.9 |
| EXC-6 | J1V118 | 10/15/14 | 2.2 | 61.2 | 0.48 | 0.12 | 7.1 | 7.6 | 15.0 | 0.454 | 3.1 |
| EXC-7 | J1V119 | 10/15/14 | 3.9 | 76.8 | 1.3 | 0.17 | 13.3 | 6.6 | 17.5 | 0.271 | 3.8 |
| EXC-8 | J1V120 | 10/15/14 | 2.6 | 56.0 | 1.3 | 0.16 | 9.3 | 7.6 | 18.2 | 0.404 | 3.6 |
| EXC-9 | J1V121 | 10/15/14 | 3.1 | 84.9 | 1.5 | 0.14 | 12.4 | 6.6 | 20.0 | 0.354 | 4.5 |
| EXC-11 | J1V123 | 10/15/14 | 2.1 | 51.1 | 0.44 | 0.11 | 4.9 | 7.3 | 15.1 | 0.271 | 2.8 |
| EXC-12 | J1V124 | 10/15/14 | 7.6 | 81.1 | 2.2 | 1.3 | 12.4 | 7.9 | 19.8 | 0.078 | 18.9 |

**Statistical Computations**

| | Arsenic | Barium | Boron | Cadmium | Chromium | Cobalt | Copper | Hexavalent Chromium | Lead |
|---|---|---|---|---|---|---|---|---|---|
| 95% UCL based on | Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic. | Large data set (n ≥ 10), use MTCAStat lognormal distribution. | Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic | Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic. | Large data set (n ≥ 10), use MTCAStat normal distribution. | Large data set (n ≥ 10), use MTCAStat lognormal distribution. | Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic. | Large data set (n ≥ 10), use MTCAStat lognormal distribution. | Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic. |
| N | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| % < Detection limit | 0% | 0% | 42% | 0% | 0% | 0% | 0% | 8% | 0% |
| Mean | 3.0 | 64.6 | 1.2 | 0.23 | 9.2 | 7.2 | 15.8 | 0.275 | 4.9 |
| Standard deviation | 1.5 | 15.4 | 0.70 | 0.34 | 3.6 | 0.47 | 2.4 | 0.112 | 4.5 |
| 95% UCL on mean | 3.8 | 75.2 | 1.5 | 0.39 | 11.0 | 7.5 | 16.9 | 0.394 | 7.0 |
| Maximum value | 7.6 | 84.9 | 2.5 | 1.3 | 13.3 | 7.9 | 20.0 | 0.454 | 18.9 |
| **Most Stringent Cleanup Limit for nonradionuclide and RAG type (mg/kg)** | 20 DE, GW & River Protection | 200 GW Protection | 320 GW Protection | 0.81 GW & River Protection | 16.5 GW & River Protection | 15.7 GW Protection | 22.0 River Protection | 2 River Protection | 10.2 GW & River Protection |
| **WAC 173-340 3-PART TEST** | | | | | | | | | |
| 95% UCL > Cleanup Limit? | NO | NA | NO | NO | NA | NA | NA | NO | NO |
| > 10% above Cleanup Limit? | NO | NA | NO | NO | NA | NA | NA | NO | NO |
| Any sample > 2X Cleanup Limit? | NO | NA | NO | NO | NA | NA | NA | NO | NO |
| **WAC 173-340 Compliance?** | The data set meets the 3-part test criteria when compared to the most stringent RAG. | Because all values are below background (132 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. | The data set meets the 3-part test criteria when compared to the most stringent RAG | Because all values are below background (18.5 mg/kg) the WAC 173-340 3-part test is not required | Because all values are below background (15.7 mg/kg) the WAC 173-340 3-part test is not required. | Because all values are below background (22.0 mg/kg) the WAC 173-340 3-part test is not required. | The data set meets the 3-part test criteria when compared to the most stringent RAG. | The data set meets the 3-part test criteria when compared to the most stringent RAG. |

**CALCULATION SHEET**

***Washington Closure Hanford***

| | | | |
|---|---|---|---|
| Originator J. D. Skoglie | Date 12/11/14 | Calc. No. 0100D-CA-V0576 | Rev. No. 0 |
| Project 100-D Area Closure Operations | Job No. 14655 | Checked R. J. Nielson | Date 12/11/14 |
| Subject 100-D-81 Waste Site Cleanup Verification 95% UCI Calculations | | | Sheet No. 6 of 10 |

1 **100-D-81 Waste Site Statistical Calculations**

2 **Verification Data - Excavation**

| 3 | Sample | Sample | Sample | Manganese | | | Nickel | | | Vanadium | | | Zinc | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | Area | Number | Date | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| 5 | EXC-10 | J1V122 | 10/15/14 | 376 | X | 0.10 | 11.8 | | 0.13 | 50.4 | X | 0.098 | 43.6 | X | 0.41 |
| 6 | Duplicate of J1V122 | J1V125 | 10/15/14 | 380 | X | 0.10 | 12.2 | | 0.13 | 49.7 | X | 0.098 | 44.2 | X | 0.41 |
| 7 | EXC-1 | J1V113 | 10/15/14 | 248 | X | 0.098 | 6.5 | | 0.12 | 51.7 | X | 0.091 | 35.4 | X | 0.36 |
| 8 | EXC-2 | J1V114 | 10/15/14 | 252 | X | 0.093 | 6.2 | | 0.11 | 64.9 | X | 0.088 | 38.8 | X | 0.37 |
| 9 | EXC-3 | J1V115 | 10/15/14 | 309 | X | 0.094 | 11.9 | | 0.12 | 42.9 | X | 0.089 | 36.2 | X | 0.38 |
| 10 | EXC-4 | J1V116 | 10/15/14 | 347 | X | 0.11 | 12.5 | | 0.13 | 45.9 | X | 0.10 | 39.9 | X | 0.42 |
| 11 | EXC-5 | J1V117 | 10/16/14 | 259 | X | 0.10 | 9.4 | | 0.12 | 49.0 | X | 0.095 | 37.1 | X | 0.40 |
| 12 | EXC-6 | J1V118 | 10/15/14 | 271 | X | 0.096 | 10.4 | | 0.12 | 54.1 | X | 0.091 | 40.1 | X | 0.38 |
| 13 | EXC-7 | J1V119 | 10/15/14 | 299 | X | 0.10 | 13.0 | | 0.13 | 46.4 | X | 0.096 | 36.2 | X | 0.41 |
| 14 | EXC-8 | J1V120 | 10/15/14 | 273 | X | 0.096 | 11.1 | | 0.12 | 51.9 | X | 0.090 | 40.2 | X | 0.38 |
| 15 | EXC-9 | J1V121 | 10/15/14 | 305 | X | 0.088 | 12.2 | | 0.11 | 43.1 | X | 0.083 | 37.7 | X | 0.35 |
| 16 | EXC-11 | J1V123 | 10/15/14 | 274 | X | 0.090 | 8.8 | | 0.11 | 58.4 | X | 0.084 | 40.7 | X | 0.36 |
| 17 | EXC-12 | J1V124 | 10/15/14 | 320 | X | 0.092 | 12.6 | | 0.11 | 59.0 | X | 0.086 | 146 | X | 0.37 |

18

19 **Statistical Computation Input Data**

| 20 | Sample | Sample | Sample | Manganese | Nickel | Vanadium | Zinc |
|---|---|---|---|---|---|---|---|
| 21 | Area | Number | Date | mg/kg | mg/kg | mg/kg | mg/kg |
| 22 | EXC-10 | J1V122/ J1V125 | 10/15/14 | 378 | 12.0 | 50.1 | 43.9 |
| 23 | EXC-1 | J1V113 | 10/15/14 | 248 | 6.5 | 51.7 | 35.4 |
| 24 | EXC-2 | J1V114 | 10/15/14 | 252 | 6.2 | 64.9 | 38.8 |
| 25 | EXC-3 | J1V115 | 10/15/14 | 309 | 11.9 | 42.9 | 36.2 |
| 26 | EXC-4 | J1V116 | 10/15/14 | 347 | 12.5 | 45.9 | 39.9 |
| 27 | EXC-5 | J1V117 | 10/15/14 | 259 | 9.4 | 49.0 | 37.1 |
| 28 | EXC-6 | J1V118 | 10/15/14 | 271 | 10.4 | 54.1 | 40.1 |
| 29 | EXC-7 | J1V119 | 10/15/14 | 299 | 13.0 | 46.4 | 36.2 |
| 30 | EXC-8 | J1V120 | 10/15/14 | 273 | 11.1 | 51.9 | 40.2 |
| 31 | EXC-9 | J1V121 | 10/15/14 | 305 | 12.2 | 43.1 | 37.7 |
| 32 | EXC-11 | J1V123 | 10/15/14 | 274 | 8.8 | 58.4 | 40.7 |
| 33 | EXC-12 | J1V124 | 10/15/14 | 320 | 12.6 | 59.0 | 146 |

34 **Statistical Computations**

| 35 | | Manganese | Nickel | Vanadium | Zinc |
|---|---|---|---|---|---|
| 36 | 95% UCL based on | Large data set (n ≥ 10), use MTCAStat lognormal distribution. | Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic | Large data set (n ≥ 10), use MTCAStat lognormal distribution. | Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic. |
| 37 | N | 12 | 12 | 12 | 12 |
| 38 | % < Detection limit | 0% | 0% | 0% | 0% |
| 39 | Mean | 295 | 10.6 | 51.4 | 47.7 |
| 40 | Standard deviation | 39.8 | 2.3 | 6.7 | 31.1 |
| 41 | 95% UCL on mean | 316 | 11.7 | 55.2 | 62.4 |
| 42 | Maximum value | 380 | 13.0 | 64.9 | 146 |
| 43 | **Most Stringent Cleanup Limit for nonradionuclide and RAG type (mg/kg)** | 512 GW & River Protection | 19.1 GW Protection | 85.1 GW Protection | 67.8 River Protection |
| 44 | **WAC 173-340 3-PART TEST** | | | | |
| 45 | 95% UCL > Cleanup Limit? | NA | NA | NA | NO |
| 46 | > 10% above Cleanup Limit? | NA | NA | NA | NO |
| 47 | Any sample > 2X Cleanup Limit? | NA | NA | NA | YES |
| 48 | **WAC 173-340 Compliance?** | 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 | A detailed assessment will be performed. The data set meets the 3-part test criteria when compared to the direct exposure RAG. |

49

**MAXIMUM VALUE 3-PART TEST CALCULATION SHEET**

***Washington Closure Hanford***

**Originator** J. D. Skoglie

**Project** 100-D Area Closure Operations

**Subject** 100-D-81 Waste Site Cleanup Verification 95% UCL Calculations

**Date** 12/11/14 **Job No.** 14655

**Calc. No.** 0100D-CA-V0576 **Checked** R. J. Nielson

**Rev. No.** 0 **Date** 12/11/14 **Sheet No.** 7 of 10

1 **100-D-81 Waste Site Maximum Calculations**

2 **Verification Data - Excavation**

| 3 | Sample | Sample | Sample | Mercury | | | Molybdenum | | | TPH - Diesel Range | | | TPH - Diesel Range EXT | | | Benzo(a)pyrene | | | Benzo(b)fluoranthene | | | Chrysene | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | Area | Number | Date | mg/kg | Q | PQL | mg/kg | Q | PQL | ug/kg | Q | PQL | ug/kg | Q | PQL | ug/kg | Q | PQL | ug/kg | Q | PQL | ug/kg | Q | PQL |
| 5 | EXC-10 | J1V122 | 10/15/14 | 0.0053 | U | 0.0053 | 0.27 | U | 0.27 | 890 | UJB | 700 | 1300 | UJB | 1000 | 6.5 | U | 6.5 | 4.2 | U | 4.2 | 4.9 | U | 4.9 |
| 6 | Duplicate of J1V122 | J1V125 | 10/15/14 | 0.0063 | U | 0.0063 | 0.27 | U | 0.27 | 870 | UJB | 720 | 1200 | UJB | 1100 | 7.0 | U | 7.0 | 4.6 | U | 4.6 | 5.3 | U | 5.3 |
| 7 | EXC-1 | J1V113 | 10/15/14 | 0.0050 | U | 0.0050 | 0.25 | U | 0.25 | 670 | U | 670 | 980 | U | 980 | 6.7 | U | 6.7 | 4.4 | U | 4.4 | 5.0 | U | 5.0 |
| 8 | EXC-2 | J1V114 | 10/15/14 | 0.0063 | U | 0.0063 | 0.24 | U | 0.24 | 710 | U | 710 | 1000 | U | 1000 | 6.5 | U | 6.5 | 4.2 | U | 4.2 | 4.9 | U | 4.9 |
| 9 | EXC-3 | J1V115 | 10/15/14 | 0.0052 | U | 0.0052 | 0.25 | U | 0.25 | 1200 | UJB | 680 | 1800 | UJB | 1000 | 6.7 | U | 6.7 | 4.4 | U | 4.4 | 5.0 | U | 5.0 |
| 10 | EXC-4 | J1V116 | 10/15/14 | 0.0069 | U | 0.0069 | 0.28 | U | 0.28 | 730 | UJB | 710 | 1800 | UJB | 1000 | 6.7 | U | 6.7 | 4.4 | U | 4.4 | 5.1 | U | 5.1 |
| 11 | EXC-5 | J1V117 | 10/15/14 | 0.0053 | U | 0.0053 | 0.26 | B | 0.26 | 700 | U | 700 | 1100 | UJB | 1000 | 6.2 | U | 6.2 | 4.0 | U | 4.0 | 4.7 | U | 4.7 |
| 12 | EXC-6 | J1V118 | 10/15/14 | 0.0051 | U | 0.0051 | 0.25 | U | 0.25 | 700 | U | 700 | 1000 | U | 1000 | 6.6 | U | 6.6 | 4.3 | U | 4.3 | 4.9 | U | 4.9 |
| 13 | EXC-7 | J1V119 | 10/15/14 | 0.0054 | U | 0.0054 | 0.28 | B | 0.27 | 710 | U | 710 | 1000 | U | 1000 | 6.4 | U | 6.4 | 4.2 | U | 4.2 | 4.8 | U | 4.8 |
| 14 | EXC-8 | J1V120 | 10/15/14 | 0.0063 | U | 0.0063 | 0.25 | U | 0.25 | 830 | UJB | 720 | 1300 | UJB | 1100 | 6.2 | U | 6.2 | 4.1 | U | 4.1 | 4.7 | U | 4.7 |
| 15 | EXC-9 | J1V121 | 10/15/14 | 0.0057 | U | 0.0057 | 0.23 | U | 0.23 | 680 | U | 680 | 1000 | U | 1000 | 6.5 | U | 6.5 | 4.3 | U | 4.3 | 4.9 | U | 4.9 |
| 16 | EXC-11 | J1V123 | 10/15/14 | 0.0062 | U | 0.0062 | 0.23 | U | 0.23 | 840 | UJB | 670 | 1300 | UJB | 990 | 6.6 | U | 6.6 | 4.3 | U | 4.3 | 5.0 | U | 5.0 |
| 17 | EXC-12 | J1V124 | 10/15/14 | 0.010 | B | 0.0055 | 0.24 | U | 0.24 | 7800 | | 710 | 13000 | | 1000 | 9.8 | JX | 6.6 | 6.0 | JX | 4.3 | 5.7 | J | 5.0 |

18 **Statistical Computations**

| 19 | | Mercury | | Molybdenum | | TPH - Diesel Range | | TPH - Diesel Range EXT | | Benzo(a)pyrene | | Benzo(b)fluoranthene | | Chrysene | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20 | % < Detection limit | 85% | | 77% | | 85% | | 85% | | 85% | | 85% | | 85% | |
| 21 | Maximum value | 0.010 | | 0.28 | | 7800 | | 13000 | | 9.8 | | 6.0 | | 5.7 | |
| 22 | **Most Stringent Cleanup Limit for nonradionuclide and RAG type (mg/kg) unless otherwise noted** | 0.33 | GW & River Protection | 8 | GW Protection | 200,000 ug/kg | DE,GW, & River Protection | 200,000 ug/kg | DE,GW, & River Protection | 15 ug/kg | GW & River Protection | 15 ug/kg | GW & River Protection | 100 ug/kg | River Protection |
| 23 | **3-PART TEST** | | | | | | | | | | | | | | |
| 24 | Maximum > Cleanup Limit? | NA | | NO | | NO | | NO | | NO | | NO | | NO | |
| 25 | > 10% above Cleanup Limit? | NA | | NO | | NO | | NO | | NO | | NO | | NO | |
| 26 | Any sample > 2X Cleanup Limit? | NA | | NO | | NO | | NO | | NO | | NO | | NO | |
| 27 | **3-Part Test Compliance?** | 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. | | 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. | | 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. | | The data set meets the 3-part test criteria when compared to the most stringent RAG. | |

**CALCULATION SHEET**

| | | | | | |
|---|---|---|---|---|---|
| ***Washington Closure Hanford*** | | | | | |
| **Originator** | J. D. Skoglie | **Date** | 12/11/14 | **Calc. No.** | 0100D-CA-V0576 | **Rev. No.** | 0 |
| **Project** | 100-D Area Closure Operations | **Job No.** | 14655 | **Checked** | R. J. Nelson | **Date** | 12/11/14 |
| **Subject** | 100-D-81 Waste Site Cleanup Verification 95% UCL Calculations | | | | | **Sheet No.** | 8 of 10 |

**Ecology Software (MTCAStat) Results, 100-D-81 Waste Site**

**Arsenic 95% UCL Calculation**

| DATA | ID |
|---|---|
| 2.9 | J1V122/ J1V125 |
| 2.0 | J1V113 |
| 2.1 | J1V114 |
| 2.7 | J1V115 |
| 2.9 | J1V116 |
| 2.4 | J1V117 |
| 2.2 | J1V118 |
| 3.0 | J1V119 |
| 2.6 | J1V120 |
| 3.1 | J1V121 |
| 2.1 | J1V123 |
| 7.6 | J1V124 |

| | | | |
|---|---|---|---|
| Number of samples | | Uncensored values | |
| Uncensored | 12 | Mean | 3.0 |
| Censored | | Lognormal mean | 3.0 |
| Detection limit or PQL | | Std. devn. | 1.5 |
| Method detection limit | | Median | 2.7 |
| TOTAL | 12 | Min. | 2.0 |
| | | Max. | 7.6 |

Lognormal distribution? r-squared is: 0.782
Normal distribution? r-squared is: 0.810
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 3.8

**Barium 95% UCL Calculation**

| DATA | ID |
|---|---|
| 63.7 | J1V122/ J1V125 |
| 38.5 | J1V113 |
| 58.6 | J1V114 |
| 58.8 | J1V115 |
| 71.8 | J1V116 |
| 45.3 | J1V117 |
| 61.2 | J1V118 |
| 76.6 | J1V119 |
| 56.0 | J1V120 |
| 84.9 | J1V121 |
| 51.1 | J1V123 |
| 81.1 | J1V124 |

| | | | |
|---|---|---|---|
| Number of samples | | Uncensored values | |
| Uncensored | 12 | Mean | 64.8 |
| Censored | | Lognormal mean | 65.1 |
| Detection limit or PQL | | Std. devn. | 15.4 |
| Method detection limit | | Median | 65.0 |
| TOTAL | 12 | Min. | 38.5 |
| | | Max. | 84.9 |

Lognormal distribution? r-squared is: 0.952
Normal distribution? r-squared is: 0.969
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 75.2

**Boron 95% UCL Calculation**

| DATA | ID |
|---|---|
| 2.3 | J1V122/ J1V125 |
| 0.48 | J1V113 |
| 0.46 | J1V114 |
| 1.5 | J1V115 |
| 1.7 | J1V116 |
| 0.50 | J1V117 |
| 0.48 | J1V118 |
| 1.3 | J1V119 |
| 1.3 | J1V120 |
| 1.5 | J1V121 |
| 0.44 | J1V123 |
| 2.2 | J1V124 |

| | | | |
|---|---|---|---|
| Number of samples | | Uncensored values | |
| Uncensored | 12 | Mean | 1.2 |
| Censored | | Lognormal mean | 1.2 |
| Detection limit or PQL | | Std. devn. | 0.70 |
| Method detection limit | | Median | 1.3 |
| TOTAL | 12 | Min. | 0.44 |
| | | Max. | 2.3 |

Lognormal distribution? r-squared is: 0.848
Normal distribution? r-squared is: 0.882
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 1.5

**Cadmium 95% UCL Calculation**

| DATA | ID |
|---|---|
| 0.16 | J1V122/ J1V125 |
| 0.11 | J1V113 |
| 0.13 | J1V114 |
| 0.18 | J1V115 |
| 0.13 | J1V116 |
| 0.12 | J1V117 |
| 0.12 | J1V118 |
| 0.17 | J1V119 |
| 0.16 | J1V120 |
| 0.14 | J1V121 |
| 0.11 | J1V123 |
| 1.3 | J1V124 |

| | | | |
|---|---|---|---|
| Number of samples | | Uncensored values | |
| Uncensored | 12 | Mean | 0.23 |
| Censored | | Lognormal mean | 0.20 |
| Detection limit or PQL | | Std. devn. | 0.34 |
| Method detection limit | | Median | 0.14 |
| TOTAL | 12 | Min | 0.11 |
| | | Max | 1.3 |

Lognormal distribution? r-squared is: 0.506
Normal distribution? r-squared is: 0.350
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 0.39

**Chromium 95% UCL Calculation**

| DATA | ID |
|---|---|
| 12.1 | J1V122/ J1V125 |
| 3.6 | J1V113 |
| 3.8 | J1V114 |
| 10.7 | J1V115 |
| 12.5 | J1V116 |
| 7.9 | J1V117 |
| 7.1 | J1V118 |
| 13.3 | J1V119 |
| 9.3 | J1V120 |
| 12.4 | J1V121 |
| 4.9 | J1V123 |
| 12.4 | J1V124 |

| | | | |
|---|---|---|---|
| Number of samples | | Uncensored values | |
| Uncensored | 12 | Mean | 9.2 |
| Censored | | Lognormal mean | 9.4 |
| Detection limit or PQL | | Std. devn. | 3.6 |
| Method detection limit | | Median | 10.0 |
| TOTAL | 12 | Min | 3.6 |
| | | Max | 13.3 |

Lognormal distribution? r-squared is: 0.859
Normal distribution? r-squared is: 0.902
Recommendations:
Use normal distribution.

UCL (based on t-statistic) is 11.0

**Cobalt 95% UCL Calculation**

| DATA | ID |
|---|---|
| 7.6 | J1V122/ J1V125 |
| 7.1 | J1V113 |
| 7.0 | J1V114 |
| 7.1 | J1V115 |
| 7.5 | J1V116 |
| 6.5 | J1V117 |
| 7.6 | J1V118 |
| 6.6 | J1V119 |
| 7.6 | J1V120 |
| 6.6 | J1V121 |
| 7.3 | J1V123 |
| 7.9 | J1V124 |

| | | | |
|---|---|---|---|
| Number of samples | | Uncensored values | |
| Uncensored | 12 | Mean | 7.2 |
| Censored | | Lognormal mean | 7.2 |
| Detection limit or PQL | | Std. devn. | 0.47 |
| Method detection limit | | Median | 7.2 |
| TOTAL | 12 | Min | 6.5 |
| | | Max. | 7.9 |

Lognormal distribution? r-squared is: 0.947
Normal distribution? r-squared is: 0.952
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 7.5

**Copper 95% UCL Calculation**

| DATA | ID |
|---|---|
| 13.9 | J1V122/ J1V125 |
| 13.8 | J1V113 |
| 14.1 | J1V114 |
| 14.2 | J1V115 |
| 14.4 | J1V116 |
| 13.8 | J1V117 |
| 15.0 | J1V118 |
| 17.5 | J1V119 |
| 18.2 | J1V120 |
| 20.0 | J1V121 |
| 15.1 | J1V123 |
| 16.8 | J1V124 |

| | | | |
|---|---|---|---|
| Number of samples | | Uncensored values | |
| Uncensored | 12 | Mean | 15.6 |
| Censored | | Lognormal mean | 15.6 |
| Detection limit or PQL | | Std. devn. | 2.4 |
| Method detection limit | | Median | 14.7 |
| TOTAL | 12 | Min | 13.8 |
| | | Max. | 20.0 |

Lognormal distribution? r-squared is: 0.828
Normal distribution? r-squared is: 0.813
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 16.9

**Hexavalent Chromium 95% UCL Calculation**

| DATA | ID |
|---|---|
| 0.132 | J1V122/ J1V125 |
| 0.184 | J1V113 |
| 0.191 | J1V114 |
| 0.311 | J1V115 |
| 0.358 | J1V116 |
| 0.289 | J1V117 |
| 0.454 | J1V118 |
| 0.271 | J1V119 |
| 0.404 | J1V120 |
| 0.354 | J1V121 |
| 0.271 | J1V123 |
| 0.076 | J1V124 |

| | | | |
|---|---|---|---|
| Number of samples | | Uncensored values | |
| Uncensored | 12 | Mean | 0.275 |
| Censored | | Lognormal mean | 0.283 |
| Detection limit or PQL | | Std. devn. | 0.112 |
| Method detection limit | | Median | 0.280 |
| TOTAL | 12 | Min. | 0.076 |
| | | Max. | 0.454 |

Lognormal distribution? r-squared is: 0.900
Normal distribution? r-squared is: 0.983
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 0.394

**Lead 95% UCL Calculation**

| DATA | ID |
|---|---|
| 5.0 | J1V122/ J1V125 |
| 2.6 | J1V113 |
| 3.1 | J1V114 |
| 3.8 | J1V115 |
| 4.8 | J1V116 |
| 2.9 | J1V117 |
| 3.1 | J1V118 |
| 3.8 | J1V119 |
| 3.6 | J1V120 |
| 4.5 | J1V121 |
| 2.6 | J1V123 |
| 18.9 | J1V124 |

| | | | |
|---|---|---|---|
| Number of samples | | Uncensored values | |
| Uncensored | 12 | Mean | 4.9 |
| Censored | | Lognormal mean | 4.7 |
| Detection limit or PQL | | Std. devn. | 4.5 |
| Method detection limit | | Median | 3.7 |
| TOTAL | 12 | Min | 2.6 |
| | | Max | 18.9 |

Lognormal distribution? r-squared is: 0.661
Normal distribution? r-squared is: 0.449
Recommendations:
Reject BOTH lognormal and normal distributions

UCL (based on Z-statistic) is 7.0

**CALCULATION SHEET**

**Washington Closure Hanford**

| | | | | | |
|---|---|---|---|---|---|
| Originator | J. D. Skoglie | Date | 12/11/14 | Calc. No. | 0100D-CA-V0576 |
| Project | 100-D Area Closure Operations | Job No. | 14655 | Checked | R. J. Nielson |
| Subject | 100-D-81 Waste Site Cleanup Verification 95% UCL Calculations | | | | |

Rev. No. 0
Date 12/11/14
Sheet No. 9 of 10

**Ecology Software (MTCAStat) Results, 100-D-81 Waste Site**

**Manganese 95% UCL Calculation**

| DATA | ID |
|---|---|
| 378 | J1V122/ J1V125 |
| 248 | J1V113 |
| 252 | J1V114 |
| 309 | J1V115 |
| 347 | J1V116 |
| 259 | J1V117 |
| 271 | J1V118 |
| 299 | J1V119 |
| 273 | J1V120 |
| 305 | J1V121 |
| 274 | J1V123 |
| 320 | J1V124 |

| | | | |
|---|---|---|---|
| Number of samples | | Uncensored values | |
| Uncensored | 12 | Mean | 295 |
| Censored | | Lognormal mean | 295 |
| Detection limit or PQL | | Std. devn. | 39.8 |
| Method detection limit | | Median | 287 |
| TOTAL | 12 | Min. | 248 |
| | | Max. | 378 |

Lognormal distribution? r-squared is: 0.952
Normal distribution? r-squared is: 0.930
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 316

**Nickel 95% UCL Calculation**

| DATA | ID |
|---|---|
| 12.0 | J1V122/ J1V125 |
| 6.5 | J1V113 |
| 6.2 | J1V114 |
| 11.9 | J1V115 |
| 12.5 | J1V116 |
| 9.4 | J1V117 |
| 10.4 | J1V118 |
| 13 | J1V119 |
| 11.1 | J1V120 |
| 12.2 | J1V121 |
| 8.8 | J1V123 |
| 12.6 | J1V124 |

| | | | |
|---|---|---|---|
| Number of samples | | Uncensored values | |
| Uncensored | 12 | Mean | 10.6 |
| Censored | | Lognormal mean | 10.6 |
| Detection limit or PQL | | Std. devn. | 2.3 |
| Method detection limit | | Median | 11.5 |
| TOTAL | 12 | Min. | 6.2 |
| | | Max. | 13.0 |

Lognormal distribution? r-squared is: 0.830
Normal distribution? r-squared is: 0.877
Recommendations:
Reject BOTH lognormal and normal distributions

UCL (based on Z-statistic) is 11.7

**Vanadium 95% UCL Calculation**

| DATA | ID |
|---|---|
| 50.1 | J1V122/ J1V125 |
| 51.7 | J1V113 |
| 64.9 | J1V114 |
| 42.9 | J1V115 |
| 45.9 | J1V116 |
| 46.0 | J1V117 |
| 54.1 | J1V118 |
| 46.4 | J1V119 |
| 51.9 | J1V120 |
| 43.1 | J1V121 |
| 58.4 | J1V123 |
| 59.0 | J1V124 |

| | | | |
|---|---|---|---|
| Number of samples | | Uncensored values | |
| Uncensored | 12 | Mean | 51.4 |
| Censored | | Lognormal mean | 51.5 |
| Detection limit or PQL | | Std. devn | 6.7 |
| Method detection limit | | Median | 50.9 |
| TOTAL | 12 | Min | 42.9 |
| | | Max | 64.9 |

Lognormal distribution? r-squared is: 0.972
Normal distribution? r-squared is: 0.957
Recommendations:
Use lognormal distribution

UCL (Land's method) is 55.2

**Zinc 95% UCL Calculation**

| DATA | ID |
|---|---|
| 43.9 | J1V122/ J1V125 |
| 35.4 | J1V113 |
| 38.6 | J1V114 |
| 36.2 | J1V115 |
| 39.9 | J1V116 |
| 37.1 | J1V117 |
| 40.1 | J1V118 |
| 36.2 | J1V119 |
| 40.2 | J1V120 |
| 37.7 | J1V121 |
| 40.7 | J1V123 |
| 146 | J1V124 |

| | | | |
|---|---|---|---|
| Number of samples | | Uncensored values | |
| Uncensored | 12 | Mean | 47.7 |
| Censored | | Lognormal mean | 46.6 |
| Detection limit or PQL | | Std. devn | 31.1 |
| Method detection limit | | Median | 39.4 |
| TOTAL | 12 | Min | 35.4 |
| | | Max. | 146 |

Lognormal distribution? r-squared is: 0.442
Normal distribution? r-squared is: 0.385
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 82.4

**CALCULATION SHEET**

***Westinghton Closure Hanford***

Originator J. D. Skoglie
Project 100-D Area Closure Operations
Subject 100-D-81 Waste Site Cleanup Verification 95% UCL Calculations

Date 12/11/14
Job No. 14655

Calc. No. 0100D-CA-V0576
Checked R. J. Nielson

Rev. No. 0
Date 12/11/14
Sheet No. 10 of 10

**Duplicate Analysis - 100-D-81 Waste Site Excavation**

| Sampling Area | Sample Number | Sample Date | Aluminum | | | Arsenic | | | Barium | | | 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 | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| EXC-10 | J1V122 | 10/15/14 | 9190 | X | 1.6 | 2.7 | | 0.69 | 83.9 | X | 0.079 | 2.5 | | 1.0 | 0.17 | B | 0.043 | 3820 | X | 14.6 | 11.9 | X | 0.060 | 7.7 | X | 0.10 |
| Duplicate of J1V122 | J1V125 | 10/15/14 | 9580 | X | 1.6 | 3.0 | | 0.69 | 83.4 | X | 0.079 | 2.1 | | 1.0 | 0.14 | B | 0.043 | 3970 | X | 14.7 | 12.2 | X | 0.060 | 7.8 | X | 0.10 |

**Analysis:**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| TDL | | 5 | 10 | 2 | 2 | 0.2 | 100 | 1 | 2 |
| Duplicate Analysis | Both > PQL? | Yes (continue) | Yes (continue) | Yes (continue) | Yes (continue) | Yes (continue) | Yes (continue) | Yes (continue) | Yes (continue) |
| | Both >5xTDL? | Yes (calc RPD) | No-Stop (acceptable) | Yes (calc RPD) | No-Stop (acceptable) | No-Stop (acceptable) | Yes (calc RPD) | Yes (calc RPD) | No-Stop (acceptable) |
| | RPD | 4.2% | | 0.6% | | | 3.9% | 2.5% | |
| | Difference > 2 TDL? | Not applicable | No - acceptable | Not applicable | No - acceptable | No - acceptable | Not applicable | Not applicable | No - acceptable |

**Duplicate Analysis - 100-D-81 Waste Site Excavation**

| Sampling Area | Sample Number | Sample Date | Copper | | | Iron | | | Lead | | | 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 | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| EXC-10 | J1V122 | 10/15/14 | 13.5 | X | 0.23 | 23500 | X | 3.9 | 4.9 | | 0.28 | 4190 | X | 3.8 | 376 | X | 0.10 | 11.8 | | 0.13 | 1930 | | 42.6 | 796 | JNX | 5.9 |
| Duplicate of J1V122 | J1V125 | 10/15/14 | 14.3 | X | 0.23 | 24300 | X | 4.0 | 5.0 | | 0.28 | 4510 | X | 3.9 | 380 | X | 0.10 | 12.2 | | 0.13 | 2020 | | 42.7 | 676 | JNX | 5.9 |

**Analysis:**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| TDL | | 1 | 5 | 5 | 75 | 5 | 4 | 400 | 2 |
| Duplicate Analysis | Both > PQL? | Yes (continue) | Yes (continue) | Yes (continue) | Yes (continue) | Yes (continue) | Yes (continue) | Yes (continue) | Yes (continue) |
| | Both >5xTDL? | Yes (calc RPD) | Yes (calc RPD) | No-Stop (acceptable) | Yes (calc RPD) | Yes (calc RPD) | No-Stop (acceptable) | No-Stop (acceptable) | Yes (calc RPD) |
| | RPD | 5.8% | 3.3% | | 7.4% | 1.1% | | | 16.3% |
| | Difference > 2 TDL? | Not applicable | Not applicable | No - acceptable | Not applicable | Not applicable | No - acceptable | No - acceptable | Not applicable |

**Duplicate Analysis - 100-D-81 Waste Site Excavation**

| Sampling Area | Sample Number | Sample Date | Sodium | | | Vanadium | | | Zinc | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| EXC-10 | J1V122 | 10/15/14 | 173 | | 61.2 | 50.4 | X | 0.098 | 43.6 | X | 0.41 |
| Duplicate of J1V122 | J1V125 | 10/15/14 | 175 | | 61.4 | 49.7 | X | 0.098 | 44.2 | X | 0.41 |

**Analysis:**

| | | | | |
|---|---|---|---|---|
| TDL | | 50 | 2.5 | 1 |
| Duplicate Analysis | Both > PQL? | Yes (continue) | Yes (continue) | Yes (continue) |
| | Both >5xTDL? | No-Stop (acceptable) | Yes (calc RPD) | Yes (calc RPD) |
| | RPD | | 1.4% | 1.4% |
| | Difference > 2 TDL? | No - acceptable | Not applicable | Not applicable |

**Attachment 1. 100-D-81 Waste Site Verification Sample Results (Metals, TPH, and Physical).**

| Sample Location | HEIS Number | Sample Date | Aluminum | | | Antimony | | | Arsenic | | | Barium | | | Beryllium | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| EXC-10 | J1V122 | 10/15/14 | 9190 | X | 1.6 | 0.39 | UJ | 0.39 | 2.7 | | 0.69 | 83.9 | X | 0.079 | 0.034 | U | 0.034 |
| Duplicate of J1V122 | J1V125 | 10/15/14 | 9580 | X | 1.6 | 0.40 | UJ | 0.40 | 3.0 | | 0.69 | 83.4 | X | 0.079 | 0.034 | U | 0.034 |
| EXC-1 | J1V113 | 10/15/14 | 4540 | X | 1.5 | 0.37 | UJ | 0.37 | 2.0 | | 0.64 | 38.5 | X | 0.073 | 0.064 | U | 0.064 |
| EXC-2 | J1V114 | 10/15/14 | 5070 | X | 1.4 | 0.35 | UJ | 0.35 | 2.1 | | 0.62 | 58.6 | X | 0.071 | 0.062 | U | 0.062 |
| EXC-3 | J1V115 | 10/15/14 | 7180 | X | 1.5 | 0.36 | UJ | 0.36 | 2.7 | | 0.62 | 68.8 | X | 0.072 | 0.031 | U | 0.031 |
| EXC-4 | J1V116 | 10/15/14 | 8830 | X | 1.6 | 0.40 | UJ | 0.40 | 2.9 | | 0.70 | 71.8 | X | 0.081 | 0.035 | U | 0.035 |
| EXC-5 | J1V117 | 10/15/14 | 5670 | X | 1.6 | 0.38 | UJ | 0.38 | 2.4 | | 0.66 | 45.3 | X | 0.076 | 0.033 | U | 0.033 |
| EXC-6 | J1V118 | 10/15/14 | 5560 | X | 1.5 | 0.37 | UJ | 0.37 | 2.2 | | 0.64 | 61.2 | X | 0.073 | 0.064 | U | 0.064 |
| EXC-7 | J1V119 | 10/15/14 | 7360 | X | 1.6 | 0.40 | UJ | 0.40 | 3.9 | | 0.69 | 76.6 | X | 0.079 | 0.034 | U | 0.034 |
| EXC-8 | J1V120 | 10/15/14 | 6750 | X | 1.5 | 0.37 | UJ | 0.37 | 2.6 | | 0.64 | 56.0 | X | 0.073 | 0.032 | U | 0.032 |
| EXC-9 | J1V121 | 10/15/14 | 8260 | X | 1.4 | 0.34 | UJ | 0.34 | 3.1 | | 0.58 | 84.9 | X | 0.067 | 0.029 | U | 0.029 |
| EXC-11 | J1V123 | 10/15/14 | 5140 | X | 1.4 | 0.34 | UJ | 0.34 | 2.1 | | 0.59 | 51.1 | X | 0.068 | 0.059 | U | 0.059 |
| EXC-12 | J1V124 | 10/15/14 | 8050 | X | 1.4 | 0.35 | UJ | 0.35 | 7.6 | | 0.61 | 81.1 | X | 0.070 | 0.061 | U | 0.061 |
| Equipment Blank | J1V126 | 10/15/14 | 118 | X | 1.3 | 0.32 | UJ | 0.32 | 0.55 | U | 0.55 | 1.2 | X | 0.064 | 0.028 | U | 0.028 |

| Sample Location | HEIS Number | Sample Date | Boron | | | Cadmium | | | Calcium | | | Chromium | | | Cobalt | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| EXC-10 | J1V122 | 10/15/14 | 2.5 | | 1.0 | 0.17 | B | 0.043 | 3820 | X | 14.6 | 11.9 | X | 0.060 | 7.7 | X | 0.10 |
| Duplicate of J1V122 | J1V125 | 10/15/14 | 2.1 | | 1.0 | 0.14 | B | 0.043 | 3970 | X | 14.7 | 12.2 | X | 0.060 | 7.8 | X | 0.10 |
| EXC-1 | J1V113 | 10/15/14 | 0.95 | U | 0.95 | 0.11 | B | 0.040 | 7970 | X | 13.6 | 3.6 | X | 0.056 | 7.1 | X | 0.096 |
| EXC-2 | J1V114 | 10/15/14 | 0.91 | U | 0.91 | 0.13 | B | 0.038 | 5420 | X | 13.1 | 3.8 | X | 0.054 | 7.0 | X | 0.093 |
| EXC-3 | J1V115 | 10/15/14 | 1.5 | B | 0.92 | 0.16 | B | 0.039 | 7310 | X | 13.3 | 10.7 | X | 0.055 | 7.1 | X | 0.094 |
| EXC-4 | J1V116 | 10/15/14 | 1.7 | B | 1.0 | 0.13 | B | 0.044 | 4010 | X | 15.0 | 12.5 | X | 0.062 | 7.5 | X | 0.11 |
| EXC-5 | J1V117 | 10/15/14 | 0.99 | U | 0.99 | 0.12 | B | 0.041 | 10400 | X | 14.2 | 7.9 | X | 0.058 | 6.5 | X | 0.10 |
| EXC-6 | J1V118 | 10/15/14 | 0.95 | U | 0.95 | 0.12 | B | 0.040 | 8250 | X | 13.6 | 7.1 | X | 0.056 | 7.6 | X | 0.096 |
| EXC-7 | J1V119 | 10/15/14 | 1.3 | B | 1.0 | 0.17 | B | 0.043 | 19800 | X | 14.7 | 13.3 | X | 0.060 | 6.6 | X | 0.10 |
| EXC-8 | J1V120 | 10/15/14 | 1.3 | B | 0.94 | 0.16 | B | 0.039 | 5800 | X | 13.6 | 9.3 | X | 0.056 | 7.6 | X | 0.096 |
| EXC-9 | J1V121 | 10/15/14 | 1.5 | B | 0.87 | 0.14 | B | 0.036 | 11500 | X | 12.5 | 12.4 | X | 0.051 | 6.6 | X | 0.088 |
| EXC-11 | J1V123 | 10/15/14 | 0.88 | U | 0.88 | 0.11 | B | 0.037 | 8150 | X | 12.7 | 4.9 | X | 0.052 | 7.3 | X | 0.090 |
| EXC-12 | J1V124 | 10/15/14 | 2.2 | | 0.90 | 1.3 | | 0.038 | 5580 | X | 13.0 | 12.4 | X | 0.053 | 7.9 | X | 0.092 |
| Equipment Blank | J1V126 | 10/15/14 | 0.82 | U | 0.82 | 0.034 | U | 0.034 | 24.6 | BX | 11.8 | 0.099 | BX | 0.049 | 0.084 | UX | 0.084 |

| Sample 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-10 | J1V122 | 10/15/14 | 13.5 | X | 0.23 | 0.155 | U | 0.155 | 23500 | X | 3.9 | 4.9 | | 0.28 | 4190 | X | 3.8 |
| Duplicate of J1V122 | J1V125 | 10/15/14 | 14.3 | X | 0.23 | 0.187 | | 0.155 | 24300 | X | 4.0 | 5.0 | | 0.28 | 4510 | X | 3.9 |
| EXC-1 | J1V113 | 10/15/14 | 13.8 | X | 0.21 | 0.184 | | 0.155 | 21600 | X | 3.7 | 2.8 | | 0.26 | 3370 | X | 3.6 |
| EXC-2 | J1V114 | 10/15/14 | 14.1 | X | 0.20 | 0.191 | | 0.155 | 23300 | X | 3.5 | 3.1 | | 0.25 | 3200 | X | 3.5 |
| EXC-3 | J1V115 | 10/15/14 | 14.2 | X | 0.20 | 0.311 | | 0.155 | 20700 | X | 3.6 | 3.8 | | 0.25 | 4460 | X | 3.5 |
| EXC-4 | J1V116 | 10/15/14 | 14.4 | X | 0.23 | 0.358 | | 0.155 | 22600 | X | 4.0 | 4.8 | | 0.29 | 4520 | X | 3.9 |
| EXC-5 | J1V117 | 10/15/14 | 13.8 | X | 0.22 | 0.289 | | 0.155 | 20800 | X | 3.8 | 2.9 | | 0.27 | 4150 | X | 3.7 |
| EXC-6 | J1V118 | 10/15/14 | 15.0 | X | 0.21 | 0.454 | | 0.155 | 23100 | X | 3.7 | 3.1 | | 0.26 | 4060 | X | 3.6 |
| EXC-7 | J1V119 | 10/15/14 | 17.5 | X | 0.23 | 0.271 | | 0.155 | 20100 | X | 4.0 | 3.8 | | 0.28 | 4690 | X | 3.9 |
| EXC-8 | J1V120 | 10/15/14 | 18.2 | X | 0.21 | 0.404 | | 0.155 | 22900 | X | 3.7 | 3.6 | | 0.26 | 4400 | X | 3.6 |
| EXC-9 | J1V121 | 10/15/14 | 20.0 | X | 0.19 | 0.354 | | 0.155 | 20500 | X | 3.4 | 4.5 | | 0.24 | 4480 | X | 3.3 |
| EXC-11 | J1V123 | 10/15/14 | 15.1 | X | 0.19 | 0.271 | | 0.155 | 24400 | X | 3.4 | 2.8 | | 0.24 | 4010 | X | 3.3 |
| EXC-12 | J1V124 | 10/15/14 | 19.8 | X | 0.20 | 0.155 | U | 0.155 | 24600 | X | 3.5 | 18.9 | | 0.25 | 4550 | X | 3.4 |
| Equipment Blank | J1V126 | 10/15/14 | 0.22 | BX | 0.18 | | | | 177 | X | 3.2 | 0.23 | U | 0.23 | 12.3 | BX | 3.1 |

**Grey cells indicate not applicable or data will not be used.**

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

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

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

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

EXC = excavation

HEIS = Hanford Environmental Information System

J = estimate

MDL = method detection limit

N = recovery exceeds upper or lower control limits.

PQL = practical quantitation limit

Q = qualifier

RAG = remedial action goal

U = undetected

X (metals) = Serial dilution in the analytical batch indicates that physical and chemical interferences are present.

X (organics) = MS, MSD: recovery exceeds upper or lower control limits.

| | | | |
|---|---|---|---|
| Attachment | 1 | Sheet No. | 1 of 4 |
| Originator | J. D. Skoglie | Date | 12/11/14 |
| Checked | R. J. Nielson | Date | 12/11/14 |
| Calc. No. | 0100D-CA-V0576 | Rev. No. | 0 |

**Attachment 1. 100-D-81 Waste Site Verification Sample Results (Metals, TPH, and Physical).**

| Sample 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-10 | J1V122 | 10/15/14 | 376 | X | 0.10 | 0.0053 | U | 0.0053 | 0.27 | U | 0.27 | 11.8 | | 0.13 | 1930 | | 42.6 |
| Duplicate of J1V122 | J1V125 | 10/15/14 | 380 | X | 0.10 | 0.0063 | U | 0.0063 | 0.27 | U | 0.27 | 12.2 | | 0.13 | 2020 | | 42.7 |
| EXC-1 | J1V113 | 10/15/14 | 248 | X | 0.096 | 0.0050 | U | 0.0050 | 0.25 | U | 0.25 | 6.5 | | 0.12 | 466 | | 39.5 |
| EXC-2 | J1V114 | 10/15/14 | 252 | X | 0.093 | 0.0063 | U | 0.0063 | 0.24 | U | 0.24 | 6.2 | | 0.11 | 541 | | 38.2 |
| EXC-3 | J1V115 | 10/15/14 | 309 | X | 0.094 | 0.0052 | U | 0.0052 | 0.25 | U | 0.25 | 11.9 | | 0.12 | 1200 | | 38.7 |
| EXC-4 | J1V116 | 10/15/14 | 347 | X | 0.11 | 0.0069 | U | 0.0069 | 0.28 | U | 0.28 | 12.5 | | 0.13 | 1610 | | 43.6 |
| EXC-5 | J1V117 | 10/15/14 | 259 | X | 0.10 | 0.0053 | U | 0.0053 | 0.28 | B | 0.26 | 9.4 | | 0.12 | 634 | | 41.2 |
| EXC-6 | J1V118 | 10/15/14 | 271 | X | 0.096 | 0.0051 | U | 0.0051 | 0.25 | U | 0.25 | 10.4 | | 0.12 | 670 | | 39.6 |
| EXC-7 | J1V119 | 10/15/14 | 299 | X | 0.10 | 0.0054 | U | 0.0054 | 0.28 | B | 0.27 | 13.0 | | 0.13 | 922 | | 42.7 |
| EXC-8 | J1V120 | 10/15/14 | 273 | X | 0.096 | 0.0063 | U | 0.0063 | 0.25 | U | 0.25 | 11.1 | | 0.12 | 739 | | 39.4 |
| EXC-9 | J1V121 | 10/15/14 | 305 | X | 0.088 | 0.0057 | U | 0.0057 | 0.23 | U | 0.23 | 12.2 | | 0.11 | 1020 | | 36.3 |
| EXC-11 | J1V123 | 10/15/14 | 274 | X | 0.090 | 0.0062 | U | 0.0062 | 0.23 | U | 0.23 | 8.8 | | 0.11 | 562 | | 36.8 |
| EXC-12 | J1V124 | 10/15/14 | 320 | X | 0.092 | 0.010 | B | 0.0055 | 0.24 | U | 0.24 | 12.6 | | 0.11 | 1230 | | 37.7 |
| Equipment Blank | J1V126 | 10/15/14 | 2.8 | X | 0.084 | 0.0059 | U | 0.0059 | 0.22 | U | 0.22 | 0.10 | U | 0.10 | 36.0 | B | 34.5 |

| Sample 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-10 | J1V122 | 10/15/14 | 0.89 | U | 0.89 | 796 | JNX | 5.9 | 0.19 | UJBC | 0.17 | 173 | | 61.2 | 50.4 | X | 0.098 |
| Duplicate of J1V122 | J1V125 | 10/15/14 | 0.90 | U | 0.90 | 676 | JNX | 5.9 | 0.17 | U | 0.17 | 175 | | 61.4 | 49.7 | X | 0.098 |
| EXC-1 | J1V113 | 10/15/14 | 0.83 | U | 0.83 | 325 | JNX | 5.5 | 0.15 | U | 0.15 | 386 | | 56.9 | 51.7 | X | 0.091 |
| EXC-2 | J1V114 | 10/15/14 | 0.80 | U | 0.80 | 281 | JNX | 5.3 | 0.15 | U | 0.15 | 234 | | 55.0 | 64.9 | X | 0.088 |
| EXC-3 | J1V115 | 10/15/14 | 0.81 | U | 0.81 | 553 | JNX | 5.3 | 0.15 | U | 0.15 | 187 | | 55.7 | 42.9 | X | 0.089 |
| EXC-4 | J1V116 | 10/15/14 | 0.91 | U | 0.91 | 696 | JNX | 6.0 | 0.17 | U | 0.17 | 179 | | 62.7 | 45.9 | X | 0.10 |
| EXC-5 | J1V117 | 10/15/14 | 0.87 | U | 0.87 | 408 | JNX | 5.7 | 0.16 | U | 0.16 | 243 | | 59.3 | 49.0 | X | 0.095 |
| EXC-6 | J1V118 | 10/15/14 | 0.83 | U | 0.83 | 695 | JNX | 5.5 | 0.15 | U | 0.15 | 222 | | 56.9 | 54.1 | X | 0.091 |
| EXC-7 | J1V119 | 10/15/14 | 0.90 | U | 0.90 | 461 | JNX | 5.9 | 0.17 | U | 0.17 | 220 | | 61.5 | 46.4 | X | 0.098 |
| EXC-8 | J1V120 | 10/15/14 | 0.83 | U | 0.83 | 721 | JNX | 5.4 | 0.15 | U | 0.15 | 295 | | 56.8 | 51.9 | X | 0.090 |
| EXC-9 | J1V121 | 10/15/14 | 0.76 | U | 0.76 | 745 | JNX | 5.0 | 0.15 | UJBC | 0.14 | 204 | | 52.2 | 43.1 | X | 0.083 |
| EXC-11 | J1V123 | 10/15/14 | 0.77 | U | 0.77 | 488 | JNX | 5.1 | 0.14 | U | 0.14 | 331 | | 53.0 | 58.4 | X | 0.084 |
| EXC-12 | J1V124 | 10/15/14 | 0.79 | U | 0.79 | 473 | JNX | 5.2 | 0.15 | U | 0.15 | 276 | | 54.2 | 59.0 | X | 0.086 |
| Equipment Blank | J1V126 | 10/15/14 | 0.72 | U | 0.72 | 98.8 | JNX | 4.8 | 0.16 | UJBC | 0.13 | 49.6 | U | 49.6 | 0.17 | BX | 0.079 |

| Sample Location | HEIS Number | Sample Date | Zinc | | | TPH - Diesel Range | | | TPH - Diesel Range EXT | | | Percent moisture (wet sample) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | ug/kg | Q | PQL | ug/kg | Q | PQL | % | Q | PQL |
| EXC-10 | J1V122 | 10/15/14 | 43.6 | X | 0.41 | 890 | UJB | 700 | 1300 | UJB | 1000 | 3.7 | | 0.10 |
| Duplicate of J1V122 | J1V125 | 10/15/14 | 44.2 | X | 0.41 | 870 | UJB | 720 | 1200 | UJB | 1100 | 9.4 | | 0.10 |
| EXC-1 | J1V113 | 10/15/14 | 35.4 | X | 0.38 | 670 | U | 670 | 980 | U | 980 | 4.0 | | 0.10 |
| EXC-2 | J1V114 | 10/15/14 | 38.8 | X | 0.37 | 710 | U | 710 | 1000 | U | 1000 | 4.3 | | 0.10 |
| EXC-3 | J1V115 | 10/15/14 | 36.2 | X | 0.38 | 1200 | UJB | 680 | 1800 | UJB | 1000 | 3.6 | | 0.10 |
| EXC-4 | J1V116 | 10/15/14 | 39.9 | X | 0.42 | 730 | UJB | 710 | 1800 | UJB | 1000 | 5.9 | | 0.10 |
| EXC-5 | J1V117 | 10/15/14 | 37.1 | X | 0.40 | 700 | U | 700 | 1100 | UJB | 1000 | 3.5 | | 0.10 |
| EXC-6 | J1V118 | 10/15/14 | 40.1 | X | 0.38 | 700 | U | 700 | 1000 | U | 1000 | 3.1 | | 0.10 |
| EXC-7 | J1V119 | 10/15/14 | 36.2 | X | 0.41 | 710 | U | 710 | 1000 | U | 1000 | 4.0 | | 0.10 |
| EXC-8 | J1V120 | 10/15/14 | 40.2 | X | 0.38 | 830 | UJB | 720 | 1300 | UJB | 1100 | 5.5 | | 0.10 |
| EXC-9 | J1V121 | 10/15/14 | 37.7 | X | 0.35 | 680 | U | 680 | 1000 | U | 1000 | 5.0 | | 0.10 |
| EXC-11 | J1V123 | 10/15/14 | 40.7 | X | 0.36 | 840 | UJB | 670 | 1300 | UJB | 990 | 3.2 | | 0.10 |
| EXC-12 | J1V124 | 10/15/14 | 146 | X | 0.37 | 7800 | | 710 | 13000 | | 1000 | 5.3 | | 0.10 |
| Equipment Blank | J1V126 | 10/15/14 | 0.92 | UJCX | 0.33 | | | | | | | 0.10 | U | 0.10 |

| | | | |
|---|---|---|---|
| Attachment | 1 | Sheet No. | 2 of 4 |
| Originator | J. D. Skoglie | Date | 12/11/14 |
| Checked | R. J. Nielson | Date | 12/11/14 |
| Calc. No. | 0100D-CA-V0576 | Rev. No. | 0 |

**Attachment 1. 100-D-81 Waste Site Verification Sample Results (Organics).**

| CONSTITUENT | CLASS | EXC-10 - J1V122 | | | Duplicate of J1V122 - J1V125 | | | EXC-1 - J1V113 | | | EXC-2 - J1V114 | | | EXC-3 - J1V115 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 10/15/14 | | | 10/15/14 | | | 10/15/14 | | | 10/15/14 | | | 10/15/14 | | |
| | | ug/kg | Q | PQL | ug/kg | Q | PQL | ug/kg | Q | PQL | ug/kg | Q | PQL | ug/kg | Q | PQL |
| Acenaphthene | PAH | 10 | U | 10 | 11 | U | 11 | 10 | U | 10 | 10 | U | 10 | 10 | U | 10 |
| Acenaphthylene | PAH | 9.1 | U | 9.1 | 9.8 | U | 9.8 | 9.3 | U | 9.3 | 9.1 | U | 9.1 | 9.3 | U | 9.3 |
| Anthracene | PAH | 3.1 | U | 3.1 | 3.3 | U | 3.3 | 3.2 | U | 3.2 | 3.1 | U | 3.1 | 3.2 | U | 3.2 |
| Benzo(a)anthracene | PAH | 3.2 | U | 3.2 | 3.5 | U | 3.5 | 3.3 | U | 3.3 | 3.2 | U | 3.2 | 3.3 | U | 3.3 |
| Benzo(a)pyrene | PAH | 6.5 | U | 6.5 | 7.0 | U | 7.0 | 6.7 | U | 6.7 | 6.5 | U | 6.5 | 6.7 | U | 6.7 |
| Benzo(b)fluoranthene | PAH | 4.2 | U | 4.2 | 4.6 | U | 4.6 | 4.4 | U | 4.4 | 4.2 | U | 4.2 | 4.4 | U | 4.4 |
| Benzo(ghi)perylene | PAH | 7.3 | U | 7.3 | 7.8 | U | 7.8 | 7.5 | U | 7.5 | 7.3 | U | 7.3 | 7.5 | U | 7.5 |
| Benzo(k)fluoranthene | PAH | 4.0 | U | 4.0 | 4.3 | U | 4.3 | 4.1 | U | 4.1 | 4.0 | U | 4.0 | 4.1 | U | 4.1 |
| Chrysene | PAH | 4.9 | U | 4.9 | 5.3 | U | 5.3 | 5.0 | U | 5.0 | 4.9 | U | 4.9 | 5.0 | U | 5.0 |
| Dibenz[a,h]anthracene | PAH | 11 | U | 11 | 12 | U | 12 | 11 | U | 11 | 11 | U | 11 | 11 | U | 11 |
| Fluoranthene | PAH | 13 | U | 13 | 14 | U | 14 | 13 | U | 13 | 13 | U | 13 | 13 | U | 13 |
| Fluorene | PAH | 5.3 | U | 5.3 | 5.8 | U | 5.8 | 5.5 | U | 5.5 | 5.3 | U | 5.3 | 5.5 | U | 5.5 |
| Indeno(1,2,3-cd)pyrene | PAH | 12 | U | 12 | 13 | U | 13 | 12 | U | 12 | 12 | U | 12 | 12 | U | 12 |
| Naphthalene | PAH | 12 | U | 12 | 13 | U | 13 | 12 | U | 12 | 12 | U | 12 | 12 | U | 12 |
| Phenanthrene | PAH | 12 | U | 12 | 13 | U | 13 | 12 | U | 12 | 12 | U | 12 | 12 | U | 12 |
| Pyrene | PAH | 12 | U | 12 | 13 | U | 13 | 12 | U | 12 | 12 | U | 12 | 12 | U | 12 |
| Aroclor-1016 | PCB | 2.8 | U | 2.8 | 3.0 | U | 3.0 | 2.8 | U | 2.8 | 2.8 | U | 2.8 | 2.9 | U | 2.9 |
| Aroclor-1221 | PCB | 8.0 | U | 8.0 | 8.8 | U | 8.8 | 8.1 | U | 8.1 | 8.1 | U | 8.1 | 8.3 | U | 8.3 |
| Aroclor-1232 | PCB | 2.0 | U | 2.0 | 2.2 | U | 2.2 | 2.0 | U | 2.0 | 2.0 | U | 2.0 | 2.1 | U | 2.1 |
| Aroclor-1242 | PCB | 4.7 | U | 4.7 | 5.1 | U | 5.1 | 4.7 | U | 4.7 | 4.7 | U | 4.7 | 4.8 | U | 4.8 |
| Aroclor-1248 | PCB | 4.7 | U | 4.7 | 5.1 | U | 5.1 | 4.7 | U | 4.7 | 4.7 | U | 4.7 | 4.8 | U | 4.8 |
| Aroclor-1254 | PCB | 2.6 | U | 2.6 | 2.9 | U | 2.9 | 2.6 | U | 2.6 | 2.6 | U | 2.6 | 2.7 | U | 2.7 |
| Aroclor-1260 | PCB | 2.6 | U | 2.6 | 2.9 | U | 2.9 | 2.6 | U | 2.6 | 2.6 | U | 2.6 | 2.7 | U | 2.7 |

| CONSTITUENT | CLASS | EXC-4 - J1V116 | | | EXC-5 - J1V117 | | | EXC-6 - J1V118 | | | EXC-7 - J1V119 | | | EXC-8 - J1V120 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 10/15/14 | | | 10/15/14 | | | 10/15/14 | | | 10/15/14 | | | 10/15/14 | | |
| | | ug/kg | Q | PQL | ug/kg | Q | PQL | ug/kg | Q | PQL | ug/kg | Q | PQL | ug/kg | Q | PQL |
| Acenaphthene | PAH | 10 | U | 10 | 9.6 | U | 9.6 | 10 | U | 10 | 10 | U | 10 | 9.7 | U | 9.7 |
| Acenaphthylene | PAH | 9.4 | U | 9.4 | 8.7 | U | 8.7 | 9.2 | U | 9.2 | 9.0 | U | 9.0 | 8.8 | U | 8.8 |
| Anthracene | PAH | 3.2 | U | 3.2 | 2.9 | U | 2.9 | 3.1 | U | 3.1 | 3.1 | U | 3.1 | 3.0 | U | 3.0 |
| Benzo(a)anthracene | PAH | 3.3 | U | 3.3 | 3.1 | U | 3.1 | 3.3 | U | 3.3 | 3.2 | U | 3.2 | 3.1 | U | 3.1 |
| Benzo(a)pyrene | PAH | 6.7 | U | 6.7 | 6.2 | U | 6.2 | 6.6 | U | 6.6 | 6.4 | U | 6.4 | 6.2 | U | 6.2 |
| Benzo(b)fluoranthene | PAH | 4.4 | U | 4.4 | 4.0 | U | 4.0 | 4.3 | U | 4.3 | 4.2 | U | 4.2 | 4.1 | U | 4.1 |
| Benzo(ghi)perylene | PAH | 7.5 | U | 7.5 | 6.9 | U | 6.9 | 7.4 | U | 7.4 | 7.2 | U | 7.2 | 7.0 | U | 7.0 |
| Benzo(k)fluoranthene | PAH | 4.1 | U | 4.1 | 3.8 | U | 3.8 | 4.0 | U | 4.0 | 3.9 | U | 3.9 | 3.8 | U | 3.8 |
| Chrysene | PAH | 5.1 | U | 5.1 | 4.7 | U | 4.7 | 4.9 | U | 4.9 | 4.8 | U | 4.8 | 4.7 | U | 4.7 |
| Dibenz[a,h]anthracene | PAH | 11 | U | 11 | 11 | U | 11 | 11 | U | 11 | 11 | U | 11 | 11 | U | 11 |
| Fluoranthene | PAH | 14 | U | 14 | 13 | U | 13 | 13 | U | 13 | 13 | U | 13 | 13 | U | 13 |
| Fluorene | PAH | 5.5 | U | 5.5 | 5.1 | U | 5.1 | 5.4 | U | 5.4 | 5.3 | U | 5.3 | 5.1 | U | 5.1 |
| Indeno(1,2,3-cd)pyrene | PAH | 13 | U | 13 | 12 | U | 12 | 12 | U | 12 | 12 | U | 12 | 12 | U | 12 |
| Naphthalene | PAH | 13 | U | 13 | 12 | U | 12 | 12 | U | 12 | 12 | U | 12 | 12 | U | 12 |
| Phenanthrene | PAH | 13 | U | 13 | 12 | U | 12 | 12 | U | 12 | 12 | U | 12 | 12 | U | 12 |
| Pyrene | PAH | 13 | U | 13 | 12 | U | 12 | 12 | U | 12 | 12 | U | 12 | 12 | U | 12 |
| Aroclor-1016 | PCB | 2.9 | U | 2.9 | 2.8 | U | 2.8 | 2.8 | U | 2.8 | 2.8 | U | 2.8 | 2.9 | U | 2.9 |
| Aroclor-1221 | PCB | 8.4 | U | 8.4 | 8.0 | U | 8.0 | 8.0 | U | 8.0 | 8.2 | U | 8.2 | 8.3 | U | 8.3 |
| Aroclor-1232 | PCB | 2.1 | U | 2.1 | 2.0 | U | 2.0 | 2.0 | U | 2.0 | 2.0 | U | 2.0 | 2.1 | U | 2.1 |
| Aroclor-1242 | PCB | 4.9 | U | 4.9 | 4.7 | U | 4.7 | 4.7 | U | 4.7 | 4.8 | U | 4.8 | 4.8 | U | 4.8 |
| Aroclor-1248 | PCB | 4.9 | U | 4.9 | 4.7 | U | 4.7 | 4.7 | U | 4.7 | 4.8 | U | 4.8 | 4.8 | U | 4.8 |
| Aroclor-1254 | PCB | 2.7 | U | 2.7 | 2.6 | U | 2.6 | 2.6 | U | 2.6 | 2.7 | U | 2.7 | 2.7 | U | 2.7 |
| Aroclor-1260 | PCB | 2.7 | U | 2.7 | 2.6 | U | 2.6 | 2.6 | U | 2.6 | 2.7 | U | 2.7 | 2.7 | U | 2.7 |

| | | | |
|---|---|---|---|
| Attachment | 1 | Sheet No. | 3 of 4 |
| Originator | J. D. Skoglie | Date | 12/11/14 |
| Checked | R. J. Nielson | Date | 12/11/14 |
| Calc. No. | 0100D-CA-V0576 | Rev. No. | 0 |

**Attachment 1. 100-D-81 Waste Site Verification Sample Results (Organics).**

| CONSTITUENT | CLASS | EXC-9 - J1V121 | | | EXC-11 - J1V123 | | | EXC-12 - J1V124 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 10/15/14 | | | 10/15/14 | | | 10/15/14 | | |
| | | ug/kg | Q | PQL | ug/kg | Q | PQL | ug/kg | Q | PQL |
| Acenaphthene | PAH | 10 | U | 10 | 10 | U | 10 | 10 | U | 10 |
| Acenaphthylene | PAH | 9.2 | U | 9.2 | 9.3 | U | 9.3 | 9.3 | U | 9.3 |
| Anthracene | PAH | 3.1 | U | 3.1 | 3.2 | U | 3.2 | 3.1 | U | 3.1 |
| Benzo(a)anthracene | PAH | 3.2 | U | 3.2 | 3.3 | U | 3.3 | 3.3 | U | 3.3 |
| Benzo(a)pyrene | PAH | 6.5 | U | 6.5 | 6.6 | U | 6.6 | 9.8 | JX | 6.6 |
| Benzo(b)fluoranthene | PAH | 4.3 | U | 4.3 | 4.3 | U | 4.3 | 6.0 | JX | 4.3 |
| Benzo(ghi)perylene | PAH | 7.3 | U | 7.3 | 7.4 | U | 7.4 | 7.4 | U | 7.4 |
| Benzo(k)fluoranthene | PAH | 4.0 | U | 4.0 | 4.1 | U | 4.1 | 4.1 | U | 4.1 |
| Chrysene | PAH | 4.9 | U | 4.9 | 5.0 | U | 5.0 | 5.7 | J | 5.0 |
| Dibenz[a,h]anthracene | PAH | 11 | U | 11 | 11 | U | 11 | 11 | U | 11 |
| Fluoranthene | PAH | 13 | U | 13 | 13 | U | 13 | 13 | U | 13 |
| Fluorene | PAH | 5.4 | U | 5.4 | 5.5 | U | 5.5 | 5.4 | U | 5.4 |
| Indeno(1,2,3-cd)pyrene | PAH | 12 | U | 12 | 12 | U | 12 | 12 | U | 12 |
| Naphthalene | PAH | 12 | U | 12 | 12 | U | 12 | 12 | U | 12 |
| Phenanthrene | PAH | 12 | U | 12 | 12 | U | 12 | 12 | U | 12 |
| Pyrene | PAH | 12 | U | 12 | 12 | U | 12 | 12 | U | 12 |
| Aroclor-1016 | PCB | 2.8 | U | 2.8 | 2.8 | U | 2.8 | 2.9 | U | 2.9 |
| Aroclor-1221 | PCB | 8.2 | U | 8.2 | 8.1 | U | 8.1 | 8.4 | U | 8.4 |
| Aroclor-1232 | PCB | 2.1 | U | 2.1 | 2.0 | U | 2.0 | 2.1 | U | 2.1 |
| Aroclor-1242 | PCB | 4.8 | U | 4.8 | 4.7 | U | 4.7 | 4.9 | U | 4.9 |
| Aroclor-1248 | PCB | 4.8 | U | 4.8 | 4.7 | U | 4.7 | 4.9 | U | 4.9 |
| Aroclor-1254 | PCB | 2.7 | U | 2.7 | 2.6 | U | 2.6 | 2.7 | U | 2.7 |
| Aroclor-1260 | PCB | 2.7 | U | 2.7 | 2.6 | U | 2.6 | 2.7 | U | 2.7 |

| | | | |
|---|---|---|---|
| Attachment | 1 | Sheet No. | 4 of 4 |
| Originator | J. D. Skoglie | Date | 12/11/14 |
| Checked | R. J. Nielson | Date | 12/11/14 |
| Calc. No. | 0100D-CA-V0576 | Rev. No. | 0 |

Acrobat 8.0

# CALCULATION COVER SHEET

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

Area: 100-D

Discipline: Environmental *Calculation No: 0100D-CA-V0577

Subject: 100-D-81 Waste Site Direct Contact Hazard Quotient and Carcinogenic Risk Calculation

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<br>Sheets = 3<br>Total = 4 | J. D. Skoglie | R. J. Nielson | T. Q. Howell | S. G. Wilkinson | Signed on 1/6/15 |
| 1 | Cover = 1<br>Sheets = 3<br>Total = 4 | J. D. Skoglie | R. J. Nielson | NA | S. G. Wilkinson | 1/19/15 |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

## SUMMARY OF REVISION

| | |
|---|---|
| 1 | Sheet 3, line 14: corrected significant figures for the benzo(a)pyrene maximum result from 0.01 mg/kg to 0.0098 mg/kg. |
| | |
| | |

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

Washington Closure Hanford CALCULATION SHEET

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Originator: | J. D. Skoglie | Date: | 01/19/15 | Calc. No.: | 0100D-CA-V0577 | Rev.: | 1 |
| Project: | 100-D Area Closure Operations | Job No: | 14655 | Checked: | R. J. Nielson | Date: | 01/19/15 |
| Subject: | 100-D-81 Waste Site Direct Contact Hazard Quotient and Carcinogenic Risk Calculation | | | | | Sheet No. | 1 of 3 |

**PURPOSE:**

Provide documentation to support the calculation of the direct contact hazard quotient (HQ) and excess carcinogenic risk for the 100-D-81 waste site. In accordance with the remedial action goals (RAGs) in the remedial design report/remedial action work plan (RDR/RAWP) (DOE-RL 2009a), the following criteria must be met:

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

**GIVEN/REFERENCES:**

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

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

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

4) WCH, 2014, *100-D-81 Waste Site Cleanup Verification 95% UCL Calculation*, 0100D-CA-V0576, Rev. 0, Washington Closure Hanford, Richland, Washington.

**SOLUTION:**

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

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

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

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

Washington Closure Hanford CALCULATION SHEET

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Originator: | J. D. Skoglie | Date: | 01/19/15 | Calc. No.: | 0100D-CA-V0577 | Rev.: | 1 |
| Project: | 100-D Area Closure Operations | Job No: | 14655 | Checked: | R. J. Nielson | Date: | 01/19/15 |
| Subject: | 100-D-81 Waste Site Direct Contact Hazard Quotient and Carcinogenic Risk Calculation | | | | | Sheet No. | 2 of 3 |

## METHODOLOGY:

The 100-D-81 waste site is comprised of one decision unit for verification sampling; the excavation area. The direct contact hazard quotient and carcinogenic risk calculations for the 100-D-81 waste site were conservatively calculated for the entire waste site using the greater of the statistical or maximum value for each analyte in all decision units from WCH (2014). Of the contaminants of potential concern (COPCs) for this site, boron, hexavalent chromium, molybdenum, and the detected polycyclic aromatic hydrocarbons (PAHs) require HQ and risk calculations because these analytes were detected and a Washington State or Hanford Site background value is not available. Although total petroleum hydrocarbons (diesel range extended) were detected and no background value is available, the risk associated with total petroleum hydrocarbons do not contribute to the cumulative toxicity calculation. All other site nonradionuclide COPCs were not detected or were quantified below background levels. An example of the HQ and risk calculations is presented below:

1) For example, the statistical value for boron is 1.5 mg/kg, divided by the noncarcinogenic RAG value of 7,200 mg/kg (calculated in accordance with the noncarcinogenic toxics effects formula in WAC 173-340-740[3]), is $2.1 \times 10^{-4}$. 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 $2.6 \times 10^{-3}$. 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 $1.0 \times 10^{-6}$. For example, the statistical value for hexavalent chromium is 0.394 mg/kg; divided by 2.1 mg/kg, and multiplied as indicated, is $1.9 \times 10^{-7}$. Comparing this value to the requirement of $<1 \times 10^{-6}$, this criterion is met.

4) After these calculations are completed for the carcinogenic analytes, the cumulative excess cancer risk is obtained by summing the individual values. The excess cancer risk for the carcinogenic constituents detected is $2.6 \times 10^{-7}$. Comparing this value to the requirement of $<1 \times 10^{-5}$, this criterion is met.

## RESULTS:

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

Table 1 shows the results of the calculations.

Washington Closure Hanford CALCULATION SHEET

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Originator: | J. D. Skoglie | Date: | 01/19/15 | Calc. No.: | 0100D-CA-V0577 | Rev.: | 1 |
| Project: | 100-D Area Closure Operations | Job No: | 14655 | Checked: | R. J. Nielson | Date: | 01/19/15 |
| Subject: | 100-D-81 Waste Site Direct Contact Hazard Quotient and Carcinogenic Risk Calculation | | | | | Sheet No. | 3 of 3 |

**Table 1. Direct Contact Hazard Quotient and Excess Cancer Risk Results for the 100-D-81 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 | 1.5 | 7,200 | 2.1E-04 | -- | -- |
| Chromium, hexavalent [c] | 0.394 | 240 | 1.6E-03 | 2.1 | 1.9E-07 |
| Molybdenum | 0.28 | 400 | 7.0E-04 | -- | -- |
| ***Polycyclic Aromatic Hydrocarbons*** | | | | | |
| Benzo(a)pyrene | 0.0098 | -- | -- | 0.137 | 7.2E-08 |
| Benzo(b)fluoranthene | 0.0060 | -- | -- | 1.37 | 4.4E-09 |
| Chrysene | 0.0057 | -- | -- | 13.7 | 4.2E-10 |
| ***Total Petroleum Hydrocarbons*** | | | | | |
| TPH - diesel range extended [d] | 13.0 | 200 | -- | -- | -- |
| ***Totals*** | | | | | |
| **Cumulative Hazard Quotient:** | | | **2.6E-03** | | |
| **Cumulative Excess Cancer Risk:** | | | | | **2.6E-07** |

Notes:

[a] = From WCH (2014).

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

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

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

-- = not applicable

RAG = remedial action goal

## CONCLUSION:

The calculations in Table 1 demonstrate that the 100-D-81 waste site meets the requirements for the direct contact hazard quotient and carcinogenic (excess cancer) risk as identified in the RDR/RAWP (DOE-RL 2009a) and SAP (DOE-RL 2009b). The direct contact hazard quotient and carcinogenic (excess cancer) risk calculations are for use in the RSVP for this site.

Acrobat 8.0

# CALCULATION COVER SHEET

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

Area: 100-D

Discipline: Environmental *Calculation No: 0100D-CA-V0578

Subject: 100-D-81 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<br>Sheets = 3<br>Total = 4 | J. D. Skoglie | R. J. Nielson | T. Q. Howell | S. G. Wilkinson | 1/6/15 |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

## SUMMARY OF REVISION

| | |
|---|---|
| | |
| | |
| | |

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

Washington Closure Hanford CALCULATION SHEET

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Originator: | J. D. Skoglie | Date: | 12/11/2014 | Calc. No.: | 0100D-CA-V0578 | Rev.: | 0 |
| Project: | 100-D Area Closure Operations | Job No: | 14655 | Checked: | R. J. Nielson | Date: | 12/11/2014 |
| Subject: | 100-D-81 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-D-81 waste site. In accordance with the remedial action goals (RAGs) in the remedial design report/remedial action work plan (RDR/RAWP) (DOE-RL 2009), 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) BHI, 2005, *100 Area Analogous Sites RESRAD Evaluation*, Calculation No. 0100X-CA-V0050 Rev 0, Bechtel Hanford, Inc., Richland, Washington.

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

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

4) WCH, 2014, *100-D-81 Waste Site Cleanup Verification 95% UCL Calculations*, 0100D-CA-V0576, Rev. 0, 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 (BHI 2005).

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 (BHI 2005) and compare it to the excess cancer risk of $<1 \times 10^{-6}$ (DOE-RL 2009).

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

Washington Closure Hanford CALCULATION SHEET

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Originator: | J. D. Skoglie | Date: | 12/10/2014 | Calc. No.: | 0100D-CA-V0578 | Rev.: | 0 |
| Project: | 100-D Area Closure Operations | Job No: | 14655 | Checked: | R. J. Nielson | Date: | 12/10/2014 |
| Subject: | 100-D-81 Waste Site Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater | | | | | Sheet No. 2 of 3 | |

## METHODOLOGY:

The 100-D-81 waste site is comprised of one decision unit for verification sampling; the excavation area. Hazard quotient and carcinogenic risk calculations for potential impact to groundwater at the 100-D-81 waste site were conservatively calculated for the entire waste site using the greater of the statistical or maximum value for each analyte in all decision units from the 95% UCL calculation (WCH 2014). Based on this model and a vadose zone of approximately 24.5 m (81 ft) thick, a $K_d$ of 3.1 or greater is required to show no predicted migration to groundwater in 1,000 years. Of the contaminants of potential concern (COPCs) for this site, boron and hexavalent chromium are included because no Washington State or Hanford background value has been established and the distribution coefficients are less than that necessary to show no migration to groundwater in 1,000 years using the generic site RESRAD model (BHI 2005). All other site nonradionuclide COPCs were not detected, quantified below background levels, or have a $K_d$ greater than or equal to 3.1. 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 (mg/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 mg (conversion factor). This is based on the "100 times rule" of WAC 173-340-740(3)(a)(ii)(A) (1996). For example, the statistical value for boron of 1.5 mg/kg, divided by the noncarcinogenic RAG value of 320 mg/kg is $4.7 \times 10^{-3}$. 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-D-81 waste site is $8.7 \times 10^{-2}$. 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. The 100-D-81 waste site did not have any detected COPCs above a Washington State or Hanford Site background or with a $K_d$ less than 3.1 mL/g with a carcinogenic RAG. Therefore, the requirement of $<1 \times 10^{-6}$ is met. The cumulative excess cancer risk requirement of $<1 \times 10^{-5}$ is also met.

4) 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."

## RESULTS:

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

Washington Closure Hanford CALCULATION SHEET

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Originator: | J. D. Skoglie | Date: | 12/11/2014 | Calc. No.: | 0100D-CA-V0578 | Rev.: | 0 |
| Project: | 100-D Area Closure Operations | Job No: | 14655 | Checked: | R. J. Nielson | Date: | 12/11/2014 |
| Subject: | 100-D-81 Waste Site Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater | | | | | Sheet No. 3 of 3 | |

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

Table 1 shows the results of the calculations.

**Table 1. Hazard Quotient and Excess Cancer Risk Results for the 100-D-81 Waste Site.**

| Contaminants of Potential Concern[a] | Statistical Value[a] (mg/kg) | Noncarcinogen RAG[b] (mg/kg) | Hazard Quotient | Carcinogen RAG[b] (mg/kg) | Carcinogen Risk |
|---|---|---|---|---|---|
| ***Metals*** | | | | | |
| Boron | 1.5 | 320 | 4.7E-03 | -- | -- |
| Hexavalent chromium | 0.394 | 4.8 | 8.2E-02 | -- | -- |
| ***Totals*** | | | | | |
| **Cumulative Hazard Quotient:** | | | **8.7E-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-D-81 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 2009).

# APPENDIX C

# 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 site-specific data quality objectives found in the *100 Area Remedial Action Sampling and Analysis Plan* (SAP) (DOE-RL 2009).

A review of the sample design (WCH 2014b), the field logbook (WCH 2014a), and applicable analytical data packages has been performed as part of this DQA. All samples were collected and analyzed per the sample design.

To ensure quality data, the SAP data assurance requirements and the data validation procedures for chemical analysis (BHI 2000) are used as appropriate. This review involves evaluation of the data to determine if they are of the right type, quality, and quantity to support the intended use (i.e., closeout decisions). The DQA completes the data life cycle (i.e., planning, implementation, and assessment) that was initiated by the data quality objectives process (EPA 2006).

Verification data from samples collected at the 100-D-81 waste site were provided by the laboratory in one sample delivery group (SDG): SDG JP0872. SDG JP0872 was submitted for third-party validation. No major deficiencies were identified in the analytical data set. Minor deficiencies are discussed for the 100-D-81 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 JP0872

This SDG comprises 13 statistical soil samples (J1V113 through J1V119, J1V120 through J1V125) collected from the excavation area. This SDG includes one field duplicate pair (J1V112/J1V125). All samples were analyzed for inductively coupled plasma (ICP) metals, mercury, hexavalent chromium, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAH), and diesel range total petroleum hydrocarbons (TPH-Dx). Additionally, a field equipment blank was prepared and included with SDG JP0872. The field equipment blank was analyzed for ICP metals and mercury. SDG JP0872 was submitted for third-party validation. Minor deficiencies are as follows:

In the ICP metals analysis, the analyte silver was detected in the laboratory method blank (MB). Third-party validation qualified the silver results in samples J1V121, J1V122, and J1V126 as nondetected and estimated with "UJ" flags. Nondetected and estimated data are usable for decision-making purposes.

In the ICP metals analysis, the analyte zinc was detected in the MB. Third-party validation qualified the zinc results in sample J1V126 as nondetected and estimated with "UJ" flags. Nondetected and estimated data are usable for decision-making purposes.

In the ICP metals analysis, matrix spike recoveries for antimony (67%) and silicon (17%) are outside quality control (QC) limits. Third-party validation qualified all antimony and silicon results in SDG JP0872 as estimated with "J" flags. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, the laboratory control sample recovery for silicon (8%) is outside QC limits. Third-party validation has qualified all silicon results in SDG JP0872 as estimated with "J" flags. Estimated data are usable for decision-making purposes.

In the TPH-Dx analysis, hydrocarbons in the C10-C28 and C10-C36 ranges were detected in the MB. Third-party validation qualified the C10-C28 and the C10-C36 results in samples J1V115, J1V116, J1V117, J1V120, J1V122, J1V123, and J1V125 as estimated with "J" flags. Estimated data are usable for decision-making purposes.

## FIELD QUALITY ASSURANCE/QUALITY CONTROL

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

Field quality assurance (QA)/QC measures are used to assess potential sources of error and cross contamination of samples that could bias results. Field QA/QC samples, listed in the field 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 |
|---|---|---|
| Excavation Area | J1V122 | J1V125 |

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 TDL) 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.

The RPD evaluation for the 100-D-81 data set did not find any deficiencies.

A secondary check of the data variability is used when one or both of the samples being evaluated (main and duplicate) is less than five times the TDL, including undetected analytes (Appendix B). In these cases, a control limit of ±2 times the TDL is used to indicate that a visual check of the data is required by the reviewer. The secondary check did not flag any data for specific review.

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-D-81 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 100-D-81 subsite concludes that the reviewed data are of the right type, quality, and quantity to support the intended use. The analytical data were found acceptable for decision-making purposes.

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

## REFERENCES

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

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

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

WCH, 2014a, *100D Field Remediation Miscellaneous Sampling Activities*, Logbook EL-1662-03, pp. 48-50, Washington Closure Hanford, Richland, Washington.

WCH, 2014b, *Work Instruction for Verification Sampling of the 100-D-81; 100D Burn Areas and Other Stained Areas*, 0100D-WI-G0146, Rev. 0, Washington Closure Hanford, Richland, Washington.