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

0097107

11-AMRC-0155

JUN 09 2011

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

Dear Ms. Hedges:

TRANSMITTAL OF APPROVED WASTE SITE RECLASSIFICATION FORM AND SUPPORTING DOCUMENTATION FOR 100-H-51:4, 100-H MAIN GATE STORM DRAIN, REVISION 0

Dear Ms. Hedges:

Attached for your use is the approved Waste Site Reclassification Form No. 2009-026 and supporting "Remaining Sites Verification Package for the 100-H-51:4, 100-H Main Gate Storm Drain," Revision 0. If you have questions, please contact me or your staff may contact Joanne Chance, of my staff, at (509) 376-0811.

Sincerely,

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

AMRC:JCC

Attachment

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

cc w/o attach:
R. D. Cantwell, WCH
S. L. Feaster, WCH
T. A. Harris, WCH
M. L. Proctor, WCH

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EDMC

100-HR-1

Date Submitted: 2/7/2011 Originator: M. L Proctor Phone: 372-9227	**WASTE SITE RECLASSIFICATION FORM** Operable Unit(s): 100-HR-1 Waste Site Code: 100-H-51:4 Type of Reclassification Action: Closed Out ☐ Interim Closed Out ☐ No Action ☒ RCRA Postclosure ☐ Rejected ☐ Consolidated ☐	Control Number: 2009-026

This form documents agreement among parties listed authorizing classification of the subject unit as Closed Out, Interim Closed Out, No Action, RCRA Postclosure, Rejected, or Consolidated. This form also authorizes backfill of the waste management unit, if appropriate, for Closed Out and Interim Closed Out units. Final removal from the NPL of No Action and Closed Out waste management units will occur at a future date.

Description of current waste site condition:

The 100-H-51:4, 100-H Main Gate Storm Drain subsite, part of the 100-HR-1 Operable Unit, consists of vitrified clay pipe suspected of being a storm drain connected to the 1720-H Patrol Headquarters, the 1709-H Fire Headquarters, and the 1701-H Badge House to a main discharge line that terminates at a concrete headwall approximately 0.6 m (2 ft) thick located at the 100-H-27, 100-H Area Patrol Headquarters Storm Runoff Ditch. The 100-H-51 waste site is included in 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, as a candidate site for confirmatory sampling. Confirmatory sampling of this site has been performed on October 6, 2010 in accordance with remedial action objectives and goals established by 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. The selected action involved (1) evaluating the site using available process information, (2) demonstrating through confirmatory sampling that cleanup goals have been achieved, and (3) proposing the site for reclassification to No Action.

Basis for reclassification:

In accordance with this evaluation, the confirmatory sampling results support a reclassification of the 100-H-51:4 subsite to No Action. The current site conditions achieve the remedial action goals established by the Remaining Sites ROD. The results of confirmatory sampling show that residual contaminant concentrations do not preclude any future uses (as bounded by the rural-residential scenario) and allow for unrestricted use of shallow-zone soils (i.e., surface to 4.6 m [15 ft] deep). The results also demonstrate that residual contaminant concentrations are protective of groundwater and the Columbia River. Site contamination did not extend into the deep-zone soils. Therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep-zone soil are not required. The basis for reclassification is described in detail in the *Remaining Sites Verification Package for the 100-H-51:4, 100-H Main Gate Storm Drain* (attached).

Regulator Comments:
Approval of this WSRF documents regulator agreement that the 100-H-51:4 waste site qualifies for "No Action" under this Interim Action ROD. In addition, Ecology has evaluated the data for this site against WAC 173-340 (2007) clean-up levels for direct contact, groundwater protection, and river protection. This evaluation is documented in the letter transmitting Ecology's approval of the site's interim reclassification to "No Action."

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.

M. S. French DOE Federal Project Director (printed)	R. Chris Smith for MSF Signature	5/11/11 Date
N. Menard Ecology Project Manager (printed)	Nina M. Menard Signature	5/26/11 Date
NA EPA Project Manager (printed)	Signature	Date

REMAINING SITES VERIFICATION PACKAGE FOR THE 100-H-51:4, 100-H MAIN GATE STORM DRAIN

Attachment to Waste Site Reclassification Form 2009-026

February 2011

REMAINING SITES VERIFICATION PACKAGE FOR THE 100-H-51:4, 100-H MAIN GATE STORM DRAIN

EXECUTIVE SUMMARY

The 100-H-51:4 subsite is one of four subsites associated with the 100-H-51, Potentially Contaminated Pipeline Segments waste site. The 100-H-51:4 subsite consists of a storm drain constructed of vitrified clay pipe that collected precipitation runoff from the 1720-H Patrol Headquarters, the 1709-H Fire Headquarters, and the 1701-H Badge House in a main discharge line that terminates at a concrete headwall approximately 0.6 m (2 ft) thick located at the 100-H-27, 100-H Area Patrol Headquarters Storm Runoff Ditch. The 100-H-27 waste site was classified in the Waste Information Data System (WIDS) as "Not Accepted" because it was determined to have received storm water only. The 100-H-51:4 subsite is located between the 1701-H Building and the 100-H-27 storm runoff ditch. Additionally, the 100-H-51:4 pipeline runs parallel to and approximately 11 m (36 ft) north of the former location of the 1607-H3 septic system.

Confirmatory sampling was performed on October 7, 2010 to determine if remedial action would be required. The results indicated that the waste site achieved compliance with the remedial action objectives (RAOs) and remedial action goals (RAGs) for the 100-H-51:4 subsite; therefore, remediation was not necessary. A summary of the cleanup evaluation for the soil analysis against the applicable RAGs is presented in Table ES-1. The results of the confirmatory sampling are used to make reclassification decisions for the 100-H-51:4 subsite in accordance with the TPA-MP-14 procedure in the *Tri-Party Agreement Handbook Management Procedures* (DOE-RL 2007).

A reclassification to No Action for the 100-H-51:4 subsite is supported based on site history, process knowledge, field observations, and comparison of residual contaminant concentrations against RAGs. The current site conditions achieve the RAOs and the corresponding RAGs established in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE-RL 2009) 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 contaminant levels remaining in the soil are protective of groundwater and the Columbia River. The 100-H-51:4 subsite did not extend into the deep zone. Institutional controls to prevent uncontrolled drilling or excavation into the deep zone of the site are not required.

Table ES-1. Summary of Remedial Action Goals for the 100-H-51:4 Subsite. (2 Pages)

Regulatory Requirement	Remedial Action Goals	Results	Remedial Action Objectives Attained?
Direct Exposure-Radionuclides	Attain 15 mrem/yr dose rate above background over 1,000 years.	Radionuclides were not COPCs for the 100-H-51:4 subsite.	NA
Direct Exposure-Nonradionuclides	Attain individual COPC RAGs.	Cadmium is present at concentrations above direct exposure RAGs, however, based on a site-specific risk assessment presented in Appendix B of this RSVP: *100-H-51:4, 100-H Main Gate Storm Drain, Site-Specific Risk Assessment for Cadmium,* 0100H-CA-V0147, Rev. 1 , it was determined that the hazard quotient (1.63×10^{-3}) and incremental cancer risk (4.07×10^{-8}) for cadmium are less than their respective regulatory limits and therefore attain the RAGs and RAOs stated in the RDR/RAWP (DOE-RL 2009).	Yes
Risk Requirements-Nonradionuclides	Attain hazard quotient of <1 for noncarcinogens.	The hazard quotients for individual nonradionuclide COPCs are <1.	Yes
	Attain cumulative hazard quotient of <1 for noncarcinogens.	The cumulative hazard quotient for all sampling areas (1.9×10^{-1}) is <1.	
	Attain excess cancer risk of $<1 \times 10^{-6}$ for individual carcinogens.	Excess cancer risk values for individual nonradionuclide COPCs are $<1 \times 10^{-6}$.	
	Attain a total excess cancer risk of $<1 \times 10^{-5}$ for carcinogens.	The total excess carcinogenic risk for all sampling areas (1.3×10^{-6}) is $<1 \times 10^{-5}$.	
Groundwater/River Protection – Radionuclides	Attain single COC/COPC groundwater and river protection RAGs.	Radionuclides were not COPCs for the 100-H-51:4 subsite.	NA
	Attain national primary drinking water regulations [a]: 4 mrem/yr (beta/gamma) dose rate to target receptor/organs.		
	Meet drinking water standards for alpha emitters: the more stringent of 15 pCi/L MCL or 1/25th of the derived concentration guide from DOE Order 5400.5 [b].		
	Meet total uranium standard of 21.2 pCi/L [c].		

Table ES-1. Summary of Remedial Action Goals for the 100-H-51:4 Subsite. (2 Pages)

Regulatory Requirement	Remedial Action Goals	Results	Remedial Action Objectives Attained?
Groundwater/River Protection – Nonradionuclides	Attain individual nonradionuclide groundwater and river cleanup requirements.	Barium, cadmium, total chromium, copper, lead, zinc, mercury, silver, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and benzo(a)pyrene are present at concentrations above soil RAGs for groundwater and/or Columbia River protection. However, based on RESRAD modeling discussed in Appendix C of the RDR/RAWP (DOE-RL 2009), it is predicted that these constituents will not reach groundwater (and thus the Columbia River) within 1,000 years [d].	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).

[d] RESRAD modeling predicts that the residual concentrations of barium, cadmium, total chromium, copper, lead, zinc, silver, mercury, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and benzo(a)pyrene will not migrate through the 10.8 m (35.4 ft) thick vadose zone to reach groundwater in 1,000 years. Based on evaluation of the constituent with the lowest soil-partitioning distribution coefficient (K_d) value, copper with a K_d value of 22 mL/g, none of these constituents are predicted to migrate more than 3.0 m (10 ft) vertically in 1,000 years. Therefore, residual concentrations of these constituents are predicted to be protective of groundwater and the Columbia River.

COC = contaminant of concern
COPC = contaminant of potential concern
MCL = maximum contaminant level
RAG = remedial action goal
RDR/RAWP = *Remedial Design Report/Remedial Action Work Plan for the 100 Area*
RESRAD = RESidual RADioactivity (dose model)

Soil cleanup levels were established in the Remaining Sites ROD (EPA 1999) based in part on a limited ecological risk assessment. Although not required by the Remaining Sites ROD, comparison of the verification sample results and confirmatory sample results for areas that did not require remediation against ecological risk screening levels has been made for the site contaminants of concern, contaminants of potential concern, and other constituents and is presented in Appendix A. *Washington Administrative Code* 173-340 (2007) ecological screening levels were exceeded for barium, boron, cadmium, mercury, vanadium, and zinc.
U.S. Environmental Protection Agency ecological soil screening levels were exceeded for antimony, cadmium, copper, lead, 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 antimony, manganese, and vanadium are below Hanford Site 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 the Columbia River corridor portion of the Hanford Site.

REMAINING SITES VERIFICATION PACKAGE FOR THE 100-H-51:4, 100-H MAIN GATE STORM DRAIN

STATEMENT OF PROTECTIVENESS

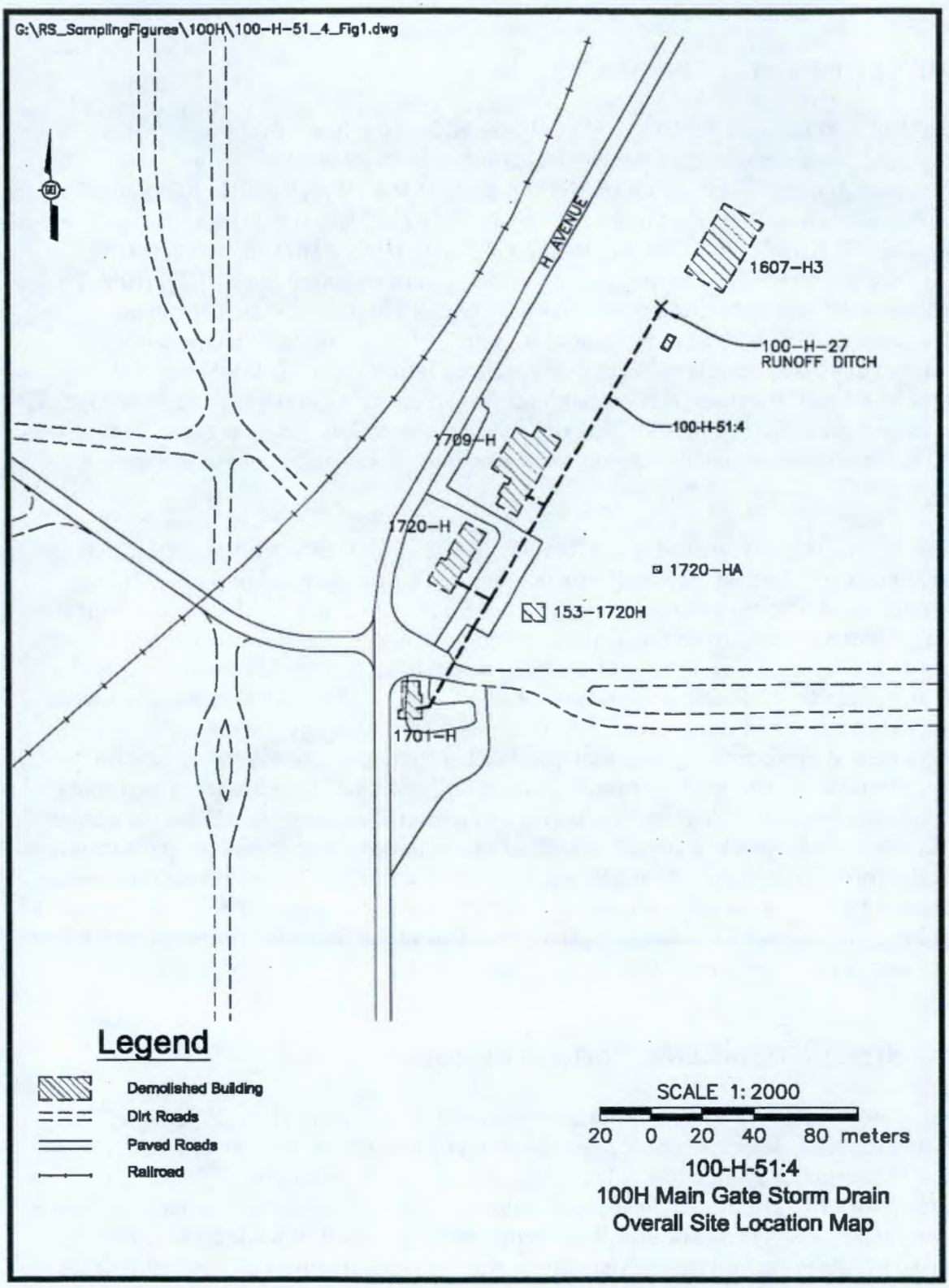
This report demonstrates that the 100-H-51:4, 100-H Main Gate Storm Drain subsite meets the objectives for reclassification to No Action as established in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP) (DOE-RL 2009) and the *Interim Action Record of Decision for the 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. This site does not extend into the deep zone. Institutional controls to prevent uncontrolled drilling or excavation into the deep zone of the site are not required.

Soil cleanup levels were established in the Remaining Sites ROD (EPA 1999) based in part on a limited ecological risk assessment. Although not required by the Remaining Sites ROD, comparison of the verification sample results and confirmatory sample results for areas that did not require remediation against ecological risk screening levels has been made for the site contaminants of concern, contaminants of potential concern, and other constituents and is presented in Appendix A. *Washington Administrative Code* 173-340 (2007) ecological screening levels were exceeded for barium, boron, cadmium, mercury, vanadium, and zinc. U.S. Environmental Protection Agency ecological soil screening levels were exceeded for antimony, cadmium, copper, lead, 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 antimony, manganese, and vanadium are below Hanford Site 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 the Columbia River corridor portion of the Hanford Site.

GENERAL SITE INFORMATION AND BACKGROUND

The 100-H-51:4 subsite is one of four subsites associated with the 100-H-51, Potentially Contaminated Pipeline Segments waste site. The 100-H-51:4 subsite consists of a storm drain constructed of vitrified clay pipe that collected precipitation runoff from the 1720-H Patrol Headquarters, the 1709-H Fire Headquarters, and the 1701-H Badge House in a main discharge line that terminates at a concrete headwall approximately 0.6 m (2 ft) thick located at the 100-H-27, 100-H Area Patrol Headquarters Storm Runoff Ditch (Figure 1). The 100-H-27 waste site was classified in the Waste Information Data System (WIDS) as "Not Accepted" because it

Figure 1. 100-H-51:4, 100-H Main Gate Storm Drain Location Map.



was determined to only have received storm water. The 100-H-51:4 subsite is located between the 1701-H Building and the 100-H-27 storm runoff ditch (Figure 1). Additionally, the 100-H-51:4 pipeline runs parallel and approximately 11 m (36 ft) north of the former location of the 1607-H3 septic system (Figure 2). Small portions of lateral pipelines associated with the 100-H-51:4, 100-H Main Gate Storm Drain waste site were removed during the 1607-H3 waste site remediation. Remedial action at the 1607-H3 waste site was performed between October 13 and November 10, 2009.

The primary operational period of the 100-H-51:4 storm drain coincides with the operation of the 105-H Reactor from 1949 through 1965. The 1701-H, 1720-H, and 1709-H buildings were decommissioned in 1974 (UNI 1974). The 100-H-51:4 storm drain discharged at a headwall located at the 100-H-27, 100-H Area Patrol Headquarters Storm Runoff Ditch. All of the buildings associated with the 100-H-51:4 storm drain have been removed to grade.

Site Visit

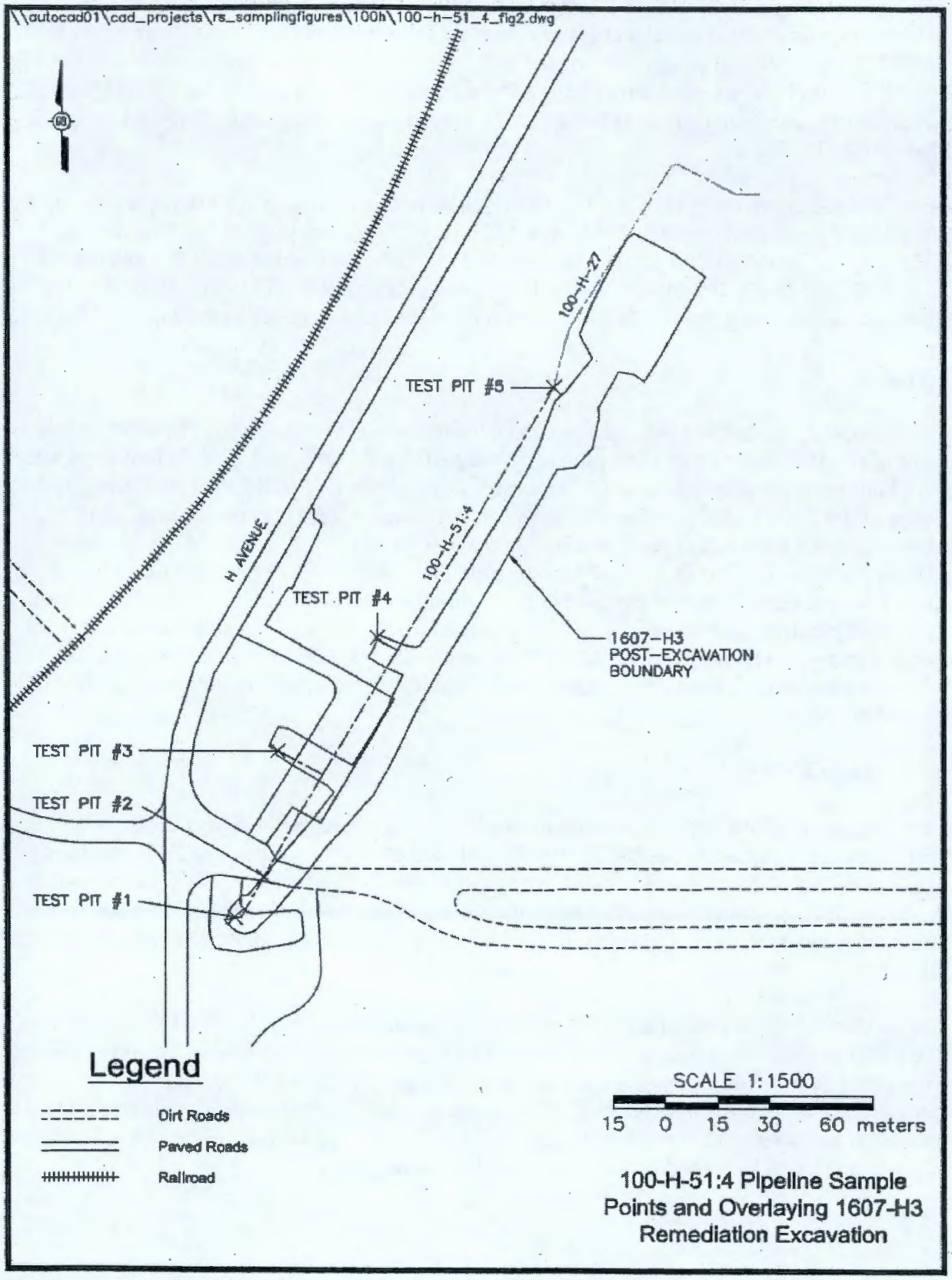
A site visit of the 100-H-51:4 subsite was conducted on December 11, 2009. The short lateral sections of the 100-H-51:4 pipelines running to the 1701-H, 1709-H, and 1720-H buildings were removed during excavation of the 1607-H3 waste site remediation (WCH 2009a). Little evidence of the 100-H-51:4 pipeline segments could be seen in the excavation banks. The pipeline segments were left in place within the foundations of the buildings and can be seen exposed at the building foundations within the 1607-H3 waste site excavation. The interior of the pipelines was observed to be exposed at the building foundation walls for visual inspection and potential pipeline content sampling. These potential sample locations at these locations are shown in Figure 2. The headwall at the northern end of the 100-H-51:4 pipeline and related 100-H-27 drainage ditch have been backfilled to support safe transportation around the 1607-H3 waste site excavation.

Ecological and Cultural

Ecological and cultural resources reviews to support the 100-H Area fiscal year 2009 confirmatory sampling activities (WCH 2009b) included evaluation of the 100-H-51 waste site. At the time of the ecological and cultural reviews, the 100-H-51 waste site WIDS description consisted of three potentially contaminated pipeline segments (WCH 2009b). Currently, four pipeline segments have been identified for the 100-H-51 waste site, including the 100-H-51:4 storm drain.

A new ecological and cultural resources review was completed on July 21, 2010 to account for all the pipeline segments associated with the 100-H-51 waste sites. Existing roads were to be used as much as possible when accessing the site to reduce the spread of noxious weeds and minimize impacts to existing vegetation. This waste site was previously disturbed during the construction and operation of the 100-H Area (WCH 2009b). In addition, this area has been previously disturbed by remediation of the 1607-H3 waste site.

Figure 2. 100-H-51:4 Subsite Test Pit Locations.



The workers were advised to watch for nesting activity if the sampling was to be performed between March 15 and July 15. No nests or nesting activity were observed or impacted during confirmatory sampling on October 6th. Although no impacts to cultural resources were anticipated, all workers were directed to watch for cultural materials (e.g., bones, stone tools, mussel shells, cans, and bottles) during all work activities. No ecologically or culturally significant materials were encountered during confirmatory sampling.

Geophysical Survey

A geophysical survey was performed at the 1607-H3 waste site in January 2006 (WCH 2005). This survey covers the adjacent northern end of the 100-H-51:4 subsite near the headwall and the 1607-H3 septic tank and drain field. Additional geophysical data was collected prior to sampling activities for the excavation permit purposes (Figure 3). No specific underground features were observed for 100-H-51:4 waste site during geophysical survey.

CONFIRMATORY SAMPLING SUMMARY

A focused sample collected from the excavated test pit 5 was used to evaluate the 100-H-51:4 subsite. The samples collected are summarized in Table 1. The pipeline was found 3 ft bgs, encased in 0.91- by 0.61-m (3- by 2-ft) concrete chunk. The pipe was found to be filled with rodent bedding and soil. A focused sample was collected from the contents of the pipeline. An additional focused sample and a duplicate were collected from the silty soils underlying the pipeline. No samples were collected from test pits 1 through 4 because the pipeline was not visible from the sidewalls of the 1607-H3 excavation. Also, test pit 5 was downstream from all other proposed test pits and thus received discharge from all other test pit areas. Test pit 5 was the only sampling location that was not impacted by the 1607-H3 excavation. Figure 2 shows all the proposed test pit locations on the 1607-H3 post-excavation boundary.

Field surveys for radiological contamination and volatile organic compounds (VOCs) were conducted during sampling. No radiological activity or VOCs were detected. Confirmatory sampling determined that environmental contamination was not present at this waste site. Based on confirmatory sampling at the 100-H-51:4 subsite, remedial action was determined to be unnecessary, and the confirmatory sampling data has been used to document this waste site for reclassification as a No Action site. Tables 1 and 2 identify the location and analyses for confirmatory sampling. No anomalous features were identified during confirmatory sampling. Confirmatory sampling results are presented in Appendix B.

Figure 3. Geophysical Interpretation Map of the 100-H-51:4 Waste Site.

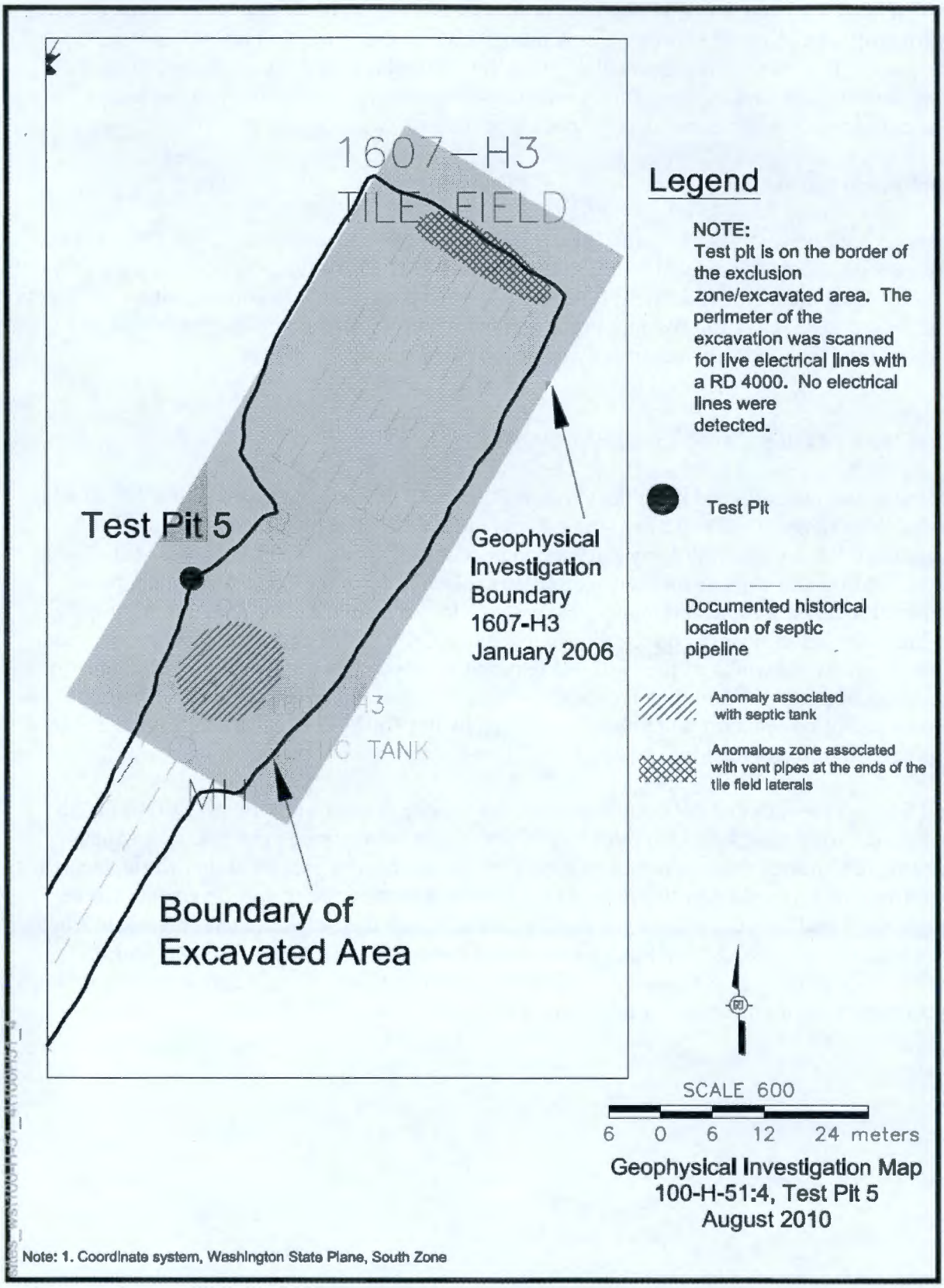


Table 1. 100-H-51:4 Confirmatory Sampling Summary Table.

Sample Location	Sample Media	HEIS Number	Washington State Plane Coordinates		Sample Analysis
			Northing (m)	Easting (m)	
Test pit 5 pipeline contents (3 ft bgs)	Pipeline contents (soil and rodent bedding)	J1C367	151843.1	577774.7	ICP metals [a], mercury, PAH, SVOA,
Test pit 5 pipeline underlying soil	Underlying Soil	J1C357	151843.1	577774.7	
Duplicate of J1C375	Underlying soil	J1C376	151843.1	577774.7	
Equipment blank	Silica sand	J1C374	NA	NA	ICP metals [a], mercury, SVOA, PAH

[a] Sample analysis for ICP metals included antimony, arsenic, barium, beryllium, boron, cadmium, chromium (total), cobalt, copper, lead, manganese, molybdenum, nickel, selenium, silver, vanadium, and zinc.

bgs = below ground surface
HEIS = Hanford Environmental Information System
ICP = inductively coupled plasma
NA = not applicable
PAH = polycyclic aromatic hydrocarbons
SVOA = semivolatile organic analysis

Table 2. 100-H-51:4 Laboratory Analytical Methods.

Analytical Method	Contaminant of Potential Concern
ICP metals [a] – EPA Method 6010	Expanded list [a]
Mercury – EPA Method 7471	Mercury
PAH – EPA Method 8310 [b]	Polycyclic aromatic hydrocarbons
SVOA – EPA Method 8270	Semivolatile organic compounds

[a] Analysis was performed for the expanded list of ICP metals including antimony, arsenic, barium, beryllium, boron, cadmium, chromium (total), cobalt, copper, lead, manganese, molybdenum, nickel, selenium, silver, vanadium, and zinc.
[b] Because method 8310 is specifically meant to analyze for PAHs, data from this method will be used preferentially over method 8270 for site evaluation of the PAH analytes.

EPA = U.S. Environmental Protection Agency
ICP = inductively coupled plasma
PAH = polycyclic aromatic hydrocarbons
SVOA = semivolatile organic analysis

Contaminants of Potential Concern

The 100-H-51:4 subsite is not listed in the 100 Area RDR/RAWP (DOE-RL 2009). Therefore, the waste site contaminants of potential concern (COPCs) were determined based on potential waste sources and information from physically connected, or similar, waste sites.

The COPCs for the 100-H-51:4 subsite were identified using historical information and process knowledge for the nonradiological area and buildings that the storm drain supported. Therefore, COPCs include lead, mercury, polycyclic aromatic hydrocarbons (PAH), and semivolatile organic compounds (SVOCs). Analysis for the expanded inductively coupled plasma (ICP)

metals including antimony, arsenic, barium, beryllium, boron, cadmium, total chromium, cobalt, copper, manganese, molybdenum, nickel, selenium, silver, vanadium, and zinc was performed. Radionuclides are not COPCs at this site.

If oil-stained soils or evidence of burning had been observed, a sample of the suspect soil would have been collected and analyzed for all site COPCs. In addition, analysis for total petroleum hydrocarbons (TPH) would have been performed on these samples.

Confirmatory Sample Results

Confirmatory samples were analyzed using U.S. Environmental Protection Agency-approved analytical methods. Evaluation of the sample data was performed by direct comparison of the maximum detected value for each COPC against the remedial action goals (RAGs). If no detections for a given COPC were reported in the data set, then no comparisons were performed for that COPC.

Comparisons of the maximum underlying soil sample results for COPCs and the site RAGs for 100-H-51:4 are presented in Table 3. Table 4 presents comparisons of the maximum sample results for COPCs and the site RAGs for the 100-H-51:4 other solid sample, collected from pipeline contents. Contaminants that were not detected by laboratory analysis are excluded from these tables. Calculated cleanup levels for aluminum, calcium, iron, magnesium, potassium, silicon, and sodium are not presented in the RDR/RAWP (DOE-RL 2009). Parameters to calculate cleanup levels for these constituents are not presented in the Cleanup Levels and Risk Calculations (CLARC) Database (Ecology 2009) under *Washington Administrative Code* (WAC) 173-340-740(3) or other reference databases; therefore, these constituents are not considered COPCs and are not included in the tables. The laboratory-reported data results for all constituents are stored in the Environmental Restoration (ENRE) project-specific database prior to provision to the Hanford Environmental Information System (HEIS) and are presented as an attachment to the direct contact hazard quotient and relative percent different (RPD) calculation in Appendix B.

Table 3. Comparison of Maximum Contaminant Concentrations to Remedial Action Goals for the 100-H-51:4 Confirmatory Sampling Underlying Soil Data. (2 Pages)

COPC	Maximum Result (mg/kg)	Remedial Action Goals[a] (mg/kg)			Does the Maximum Result Exceed RAGs?	Do the Results Pass RESRAD Modeling?
		Direct Exposure	Soil Cleanup Level for Groundwater Protection	Soil Cleanup Level for River Protection		
Arsenic	5.94 (<BG)	20[b]	20[b]	20[b]	No	--
Barium	112 (<BG)	5,600	200	400	No	--
Beryllium	0.345 (<BG)	10.4[c]	1.51[b]	1.51[b]	No	--
Boron[d]	1.65	7,200	320	--[e]	No	--
Cadmium[f]	0.81 (=BG)	13.9[c]	0.81[b]	0.81[b]	No	--
Chromium (total)	13.5 (<BG)	80,000	18.5[b]	18.5[b]	No	--
Cobalt	7.45 (<BG)	24	15.7[b]	--[e]	No	--

Table 3. Comparison of Maximum Contaminant Concentrations to Remedial Action Goals for the 100-H-51:4 Confirmatory Sampling Underlying Soil Data. (2 Pages)

COPC	Maximum Result (mg/kg)	Remedial Action Goals [a] (mg/kg)			Does the Maximum Result Exceed RAGs?	Do the Results Pass RESRAD Modeling?
		Direct Exposure	Soil Cleanup Level for Groundwater Protection	Soil Cleanup Level for River Protection		
Copper	14.7 (<BG)	2,960	59.2	22.0 [b]	No	--
Lead	6.47 (<BG)	353	10.2 [b]	10.2 [b]	No	--
Manganese	504 (<BG)	3,760	512 [b]	512 [b]	No	--
Mercury	0.045 (<BG)	24	0.33 [b]	0.33 [b]	No	--
Molybdenum [d]	0.401	400	8	-- [e]	No	--
Nickel	12.6 (<BG)	1,600	19.1 [b]	27.4	No	--
Selenium	0.276 (<BG)	400	5	1	No	--
Vanadium	46.3 (<BG)	560	85.1 [b]	-- [e]	No	--
Zinc	79.1	24,000	480	67.8 [b]	Yes	Yes [g]
Acenaphthene	0.00274	4,800	96	129	No	--
Benzo(a)anthracene	0.00188	1.37	0.015 [h]	0.015 [h]	No	--
Benzo(a)pyrene	0.0049	0.137	0.015 [h]	0.015 [h]	No	--
Benzo(b)fluoranthene	0.0057	1.37	0.015 [h]	0.015 [h]	No	--
Benzo(ghi)perylene [i]	0.00406	2,400	48	192	No	--
Benzo(k)fluoranthene	0.00219	1.37	0.015 [h]	0.015 [h]	No	--
Chrysene	0.00104	13.7	0.12	0.1 [h]	No	--
Fluoranthene	0.00128	3,200	64	18.0	No	--

[a] RAGs obtained from the RDR/RAWP (DOE-RL 2009) unless otherwise noted.
[b] Where cleanup levels are less than background, cleanup levels default to background per WAC 173-340-700(4)(d)(1996). The arsenic cleanup level of 20 mg/kg has been agreed to by the Tri-Party Agreement Project Managers as discussed in Section 2.1.2.1 of the RDR/RAWP (DOE-RL 2009).
[c] Carcinogenic cleanup level calculated based on the inhalation exposure pathway per WAC 173-340-750(3) (1996) (Method B for air quality) and an airborne particulate mass loading rate of 0.0001 g/m^3 (*Hanford Guidance for Radiological Cleanup* [WDOH 1997]).
[d] No Hanford Site-specific or Washington State background value available.
[e] No parameters (bioconcentration factors or AWQC values) are available from the Cleanup Levels and Risk Calculations Database (Ecology 2009) 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; it was not evaluated during background study. Value used is from *Natural Background Soil Metals Concentrations in Washington State* (Ecology 1994).
[g] Based on RESRAD modeling discussed in Appendix C of the RDR/RAWP (DOE-RL 2009), the residual concentrations of zinc are not expected to migrate more than 2 m (6.6 ft) vertically in 1,000 years (based on the distribution coefficient of zinc of 30 mL/g). The vadose zone underlying the soil below the site at the deepest test pit location is approximately 10.8 m (35.4 ft) thick. Therefore, residual concentrations of zinc are predicted to be protective of groundwater and the Columbia River.
[h] Where cleanup levels are less than RDLs, cleanup levels default to RDLs per WAC 173-340-707(2) (Ecology 1996).
[i] Toxicity data for this chemical is not available. Cleanup levels are based on surrogate chemicals: Contaminant: Benzo(ghi)perylene; surrogate: pyrene.

-- = not applicable
AWQC = ambient water quality criteria
BG = background
COPC = contaminant of potential concern
Ecology = Washington State Department of Ecology
RAG = remedial action goal
RDL = required detection limit
RDR/RAWP = *Remedial Design Report/Remedial Action Work Plan for the 100 Area*
RESRAD = RESidual RADioactivity (dose model)
WAC = *Washington Administrative Code*

Table 4. Comparison of Maximum Contaminant Concentrations to Remedial Action Goals for the 100-H-51:4 Confirmatory Sampling Pipeline Contents Other Solid Data. (2 Pages)

COPC	Maximum Result (mg/kg)	Remedial Action Goals [a] (mg/kg)			Does the Maximum Result Exceed RAGs?	Do the Results Pass RESRAD Modeling?
		Direct Exposure	Soil Cleanup Level for Groundwater Protection	Soil Cleanup Level for River Protection		
Antimony	0.948 (<BG)	32	5 [b]	5 [b]	No	--
Arsenic	4.09 (<BG)	20 [b]	20 [b]	20 [b]	No	--
Barium	287	5,600	200	400	Yes	Yes [c]
Beryllium	0.249 (<BG)	10.4 [d]	1.51 [b]	1.51 [b]	No	--
Boron [e]	2.72	7,200	320	-- [f]	No	--
Cadmium [g]	18.2	13.9 [d]	0.81 [b]	0.81 [b]	Yes	Yes [c, j]
Chromium (total)	19.3	80,000	18.5 [b]	18.5 [b]	Yes	Yes [c]
Cobalt	4.89 (<BG)	24	15.7 [b]	-- [f]	No	--
Copper	49.4	2,960	59.2	22.0 [b]	Yes	Yes [c]
Lead	32.8	353	10.2 [b]	10.2 [b]	Yes	Yes [c]
Manganese	207 (<BG)	3,760	512 [b]	512 [b]	No	--
Mercury	2.52	24	0.33 [b]	0.33 [b]	Yes	Yes [c]
Molybdenum [e]	1.17	400	8	-- [f]	No	--
Nickel	10.8 (<BG)	1,600	19.1 [b]	27.4	No	--
Silver	1.79	400	8	0.73 [b]	Yes	Yes [c]
Vanadium	43.6 (<BG)	560	85.1 [b]	-- [f]	No	--
Zinc	231	24,000	480	67.8 [b]	Yes	Yes [c]
Acenaphthene	0.102	4,800	96	129	No	--
Acenaphthylene [h]	0.0125	4,800	96	129	No	--
Anthracene	0.00806	24,000	240	1,920	No	--
Benzo(a)anthracene	0.0545	1.37	0.015 [i]	0.015 [i]	Yes	Yes [c]
Benzo(a)pyrene	0.108	0.137	0.015 [i]	0.015 [i]	Yes	Yes [c]
Benzo(b)fluoranthene	0.274	1.37	0.015 [i]	0.015 [i]	Yes	Yes [c]
Benzo(ghi)perylene [h]	0.228	2,400	48	192	No	--
Benzo(k)fluoranthene	0.0932	1.37	0.015 [i]	0.015 [i]	Yes	Yes [c]
Chrysene	0.0298	13.7	0.12	0.1 [i]	No	--
Dibenz[a,h]anthracene	0.0281	1.37	0.03 [i]	0.03 [i]	No	--
Fluoranthene	0.178	3,200	64	18.0	No	--
Fluorene	0.00431	3,200	64	260	No	--
Indeno(1,2,3-cd) pyrene	0.219	1.37	0.33 [i]	0.33 [i]	No	--

Table 4. Comparison of Maximum Contaminant Concentrations to Remedial Action Goals for the 100-H-51:4 Confirmatory Sampling Pipeline Contents Other Solid Data. (2 Pages)

COPC	Maximum Result (mg/kg)	Remedial Action Goals [a] (mg/kg)			Does the Maximum Result Exceed RAGs?	Do the Results Pass RESRAD Modeling?
		Direct Exposure	Soil Cleanup Level for Groundwater Protection	Soil Cleanup Level for River Protection		
Phenanthrene [h]	0.0146	24,000	240	1,920	No	--

[a] RAGs obtained from the RDR/RAWP (DOE-RL 2009) unless otherwise noted.
[b] Where cleanup levels are less than background, cleanup levels default to background per WAC 173-340-700(4)(d)(1996). The arsenic cleanup level of 20 mg/kg has been agreed to by the Tri-Party Agreement Project Managers as discussed in Section 2.1.2.1 of the RDR/RAWP (DOE-RL 2009).
[c] Based on RESRAD modeling discussed in Appendix C of the RDR/RAWP (DOE-RL 2009), the residual concentrations of barium, cadmium, total chromium, copper, lead, mercury, silver, zinc, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene and benzo(a)pyrene are not expected to migrate more than 3.0 m (10 ft) vertically in 1,000 years (based on the constituent with the lowest distribution coefficient (K_d), copper with a K_d of 22 mL/g). The vadose zone underlying the soil below the site at the deepest test pit location is approximately 10.8 m (35.4 ft) thick. Therefore, residual concentrations of these constituents are predicted to be protective of groundwater and the Columbia River.
[d] Carcinogenic cleanup level calculated based on the inhalation exposure pathway per WAC 173-340-750(3), 1996 (Method B for air quality) and an airborne particulate mass loading rate of 0.0001 g/m^3 (*Hanford Guidance for Radiological Cleanup* [WDOH 1997]).
[e] No Hanford Site-specific or Washington State background value available.
[f] No parameters (bioconcentration factors or AWQC values) are available from the Cleanup Levels and Risk Calculations Database (Ecology 2009) or other databases to calculate cleanup levels (WAC 173-340-730(3)(a)(iii) [1996] [Method B for surface waters]).
[g] Hanford Site-specific background value is not available; it was not evaluated during background study. Value used is from *Natural Background Soil Metals Concentrations in Washington State* (Ecology 1994).
[h] Toxicity data for this chemical is not available. Cleanup levels are based on surrogate chemicals: Contaminant: acenaphthylene, surrogate: acenaphthene; contaminant: benzo(ghi)perylene, surrogate: pyrene; contaminant: phenanthrene, surrogate: anthracene.
[i] Where cleanup levels are less than RDLs, cleanup levels default to RDLs per WAC 173-340-707(2) (Ecology 1996).
[j] Cadmium is present at concentrations above direct exposure RAGs; however, based on a site-specific risk assessment presented in Appendix B of this RSVP, it was determined that the hazard quotient (1.63×10^{-3}) and incremental cancer risk (4.07×10^{-8}) for cadmium are less than their respective regulatory limits and therefore attain the RAGs and RAOs stated in the RDR/RAWP for the 100 Area.

-- = not applicable
AWQC = ambient water quality criteria
BG = background
COPC = contaminant of potential concern
Ecology = Washington State Department of Ecology
RAG = remedial action goal
RAO = remedial action objective
RDL = required detection limit
RDR/RAWP = *Remedial Design Report/Remedial Action Work Plan for the 100 Area*
RESRAD = RESidual RADioactivity (dose model)
RSVP = remaining sites verification package
TPH = total petroleum hydrocarbons
WAC = *Washington Administrative Code*

CONFIRMATORY SAMPLES DATA EVALUATION

This section demonstrates that remedial actions at the 100-H-51:4 subsite have achieved the applicable remedial action objectives (RAOs) by meeting the RAGs and determining that groundwater and the river are protected.

Table 3 compares the confirmatory sample results for the underlying soil to the applicable soil RAGs for direct exposure, protection of groundwater, and protection of the Columbia River. All results are below rural-residential scenario direct exposure, groundwater protection, and Columbia River protection soil RAGs at the 100-H-51:4 subsite, with the exception of zinc, which exceeded the soil RAG for river protection. The thickness of the vadose zone beneath the bottom of the waste site excavation is approximately 10.8 m (35.4 ft) thick. Data were not collected on the vertical extent of contamination, but given the soil-partitioning coefficient (K_d) for zinc of 30 mL/g, zinc is not predicted to migrate more than 2 m (6.6 ft) vertically in 1,000 years, as discussed in Appendix C of the RDR/RAWP (DOE-RL 2009). Therefore, residual soil

concentrations of zinc are predicted to be protective of groundwater and the Columbia River. All other COPCs were either not detected or were quantified below the RAGs.

Evaluation of the results of confirmatory sampling of the pipeline contents (other solid sample listed in Table 4) indicates that cadmium exceeds direct exposure cleanup level. However, a site-specific risk assessment for cadmium in the 100-H-51:4 pipeline has determined that the hazard quotient (1.63×10^{-3}) and incremental cancer risk (4.07×10^{-8}) are less than their respective regulatory limits (a hazard quotient of 1.0 and an incremental cancer risk of 1.0×10^{-6}) and therefore attain the RAGs and RAOs stated in the RDR/RAWP for the 100 Area (see the site-specific risk assessment for cadmium in Appendix B of this remaining sites verification package: *100-H-51:4, 100-H Main Gate Storm Drain, Site-Specific Risk Assessment for Cadmium,* 0100H-CA-V0147, Rev. 1).

Also in Table 4, barium, cadmium, total chromium, copper, lead, silver, zinc, mercury, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and benzo(a)pyrene were quantified at concentrations exceeding soil RAGs for groundwater and river protection. Data were not collected on the vertical extent of these contaminants, but given the lowest soil-partitioning coefficient for these constituents (22 mL/g for copper); they are not predicted to migrate more than 3 m (10 ft) vertically in 1,000 years, as discussed in Appendix C of the RDR/RAWP (DOE-RL 2009). The vadose zone underlying the 100-H-51:4 subsite is approximately 10.8 m (35.4 ft) thick; therefore, residual concentrations of these constituents are predicted to be protective of groundwater. The only pathway for contaminant migration to the Columbia River is via groundwater; therefore, residual concentrations of these constituents are also predicted to be protective of the Columbia River. All other cleanup confirmatory data values are less than the applicable RAGs.

Assessment of the risk requirements for the 100-H-51:4 subsite was determined by calculation of the hazard quotient and excess carcinogenic risk values for direct contact (Appendix B). 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 1×10^{-6}, and a cumulative carcinogenic risk of less than 1×10^{-5}. For the 100-H-51:4 subsite, 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 values. The calculations indicated that all individual hazard quotients for noncarcinogenic constituents are less than 1.0. The cumulative direct contact hazard quotient for the 100-H-51:4 subsite is 1.9×10^{-1}. All individual carcinogen risk values for carcinogenic constituents are less than 1×10^{-6}. The cumulative direct contact excess cancer risk is 1.3×10^{-6}, which is less than the nonradionuclide risk requirement of 1×10^{-5}. Therefore, nonradionuclide risk requirements are met.

Because the vadose zone underlying the 100-H-51:4 subsite below test pit 5 (the location where barium, cadmium, total chromium, copper, lead, silver, zinc, mercury, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and benzo(a)pyrene were detected above RAGs) is approximately 10.8 m (35.4 ft) thick, constituents with a K_d of 7.2 or greater are protective of groundwater. Therefore, boron, acenaphthene, and acenaphthylene are the only constituents requiring a groundwater hazard quotient calculation (Appendix B). The cumulative

noncarcinogenic hazard quotient is 6.5×10^{-2}, which is less than the requirement of 1.0. No carcinogenic constituents met the criteria for evaluation of a groundwater hazard quotient.

A three-part test evaluation was performed for focused sampling results. Table 4 presents the maximum value associated with each detected constituent. Maximum results for barium, cadmium, total chromium, copper, lead, silver, zinc, mercury, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and benzo(a)pyrene exceed soil RAGs for groundwater and/or river protection. Because the data set for each focused sample consists of one sample, greater than 10% of the data for these analytes also exceed the same RAG values. Maximum result for cadmium, copper, lead, mercury, silver, zinc, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and benzo(a)pyrene also exceed more than twice the lowest RAG value (for groundwater and river protection). As discussed previously, these constituents are not predicted to migrate more than 3 m (10 ft) vertically in 1,000 years, per RESidual RADioactivity modeling discussed in Appendix C of the RDR/RAWP (DOE-RL 2009).

DATA QUALITY ASSESSMENT

A data quality assessment (DQA) was performed to compare the confirmatory sampling approach (WCH 2010b), the field logbook (WCH 2010a), and resulting analytical data with the sampling and data quality requirements specified by the project objectives and performance specifications.

The DQA for the 100-H-51:4 subsite established that the data are of the right type, quality, and quantity to support site closeout decisions within specified error tolerances. The evaluation verified that the sample design was sufficient for the purpose of clean site confirmation. The confirmatory sample analytical data are stored in the ENRE project-specific database for data evaluation prior to archival in the HEIS and are provided as an attachment to the direct contact hazard quotient RPD calculation in Appendix B. The detailed DQA is presented in Appendix C.

SUMMARY FOR NO ACTION DETERMINATION

The 100-H-51:4 subsite has been evaluated in accordance with the Remaining Sites ROD (EPA 1999) and the RDR/RAWP (DOE-RL 2009). Confirmatory sampling was performed, and the analytical results indicate that the residual concentrations of COPCs at this site meet the remedial action goals for direct exposure, groundwater protection, and river protection. In accordance with this evaluation, the confirmatory sampling results support a reclassification of the 100-H-51:4 subsite to No Action.

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, 2007, *Tri-Party Agreement Handbook Management Procedures,* RL-TPA-90-0001, Guideline Number TPA-MP-14, "Maintenance of the Waste Information Data System (WIDS)," Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

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.

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, 2009, Cleanup Levels and Risk Calculations (CLARC) Database, Washington State Department of Ecology, Olympia, Washington, https://fortress.wa.gov/ecy/clarc.CLARCHome.aspx.

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.

UNI, 1974, "Final Status Report Hanford Site Housekeeping and Cleanup Program For 100-H Area," UNI-7231974, external letter to P. A. Craig, U.S. Atomic Energy Commission, from A. R. Maguire, United Nuclear Industries, Richland, Washington, July 23.

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

WCH, 2005, "Results of Geophysical Investigations at 100 D Area Remaining Sites 100-D-9, 100-D-14, and 1607-D1," CCN 122373 to L. M. Dittmer from W. K. Hudson and T. H. Mitchell, Washington Closure Hanford, Inc., Richland, Washington, October 24.

WCH, 2009a, *100 H Area, 100 H Burial Grounds and Remaining Sites 1607-H-3 Post Excavation Survey,* H-1-91297, Sheet 01, Rev. 0, Washington Closure Hanford, Richland, Washington.

WCH, 2009b, "Ecological and Cultural Resources Reviews for Sampling and Characterization of the 100-H-39, 100-H 40, 100-H-41, 100-H-42, 100-H-43, 100-H-44, 100-H-45, 100-H-46, 100-H-47, 100-H-48, 100-H-49, 100-H-50, 100-H-51, 100-H-52, and 100-H-55 Waste Sites in the 100-H Area (09-ER-017)," CCN 144924 to M. W. Perrott from T. E. Marceau, Washington Closure Hanford, Richland, Washington, June 3.

WCH, 2010a, *100 Area Confirmatory Sampling*, Logbook EL-1649, pp. 14-15, Washington Closure Hanford, Richland, Washington.

WCH, 2010b, *Work Instruction for Confirmatory Sampling of 100-D-70, 184-DA Steam Generating Plant Dry Well*, 0100D-WI-G0077, Rev. 0, Washington Closure Hanford, Richland, Washington.

WDOH, 1997, *Hanford Guidance for Radiological Cleanup*, WDOH/320-015, Rev. 1, Washington State Department of Health, Olympia, Washington.

APPENDIX A

ECOLOGICAL RISK COMPARISON TABLE

Maximum Contaminant Concentrations that Exceed Ecological Screening Levels for the 100-H-51:4 Subsite [a].

Hazardous Substance		2001 WAC 173-340 Table 749-3			EPA Ecological Soil Screening Levels [b]				Maximum Result
		Plants	Soil Biota	Wildlife	Plants	Soil Biota	Avian [c]	Mammalian [c]	
	Background	Metals (mg/kg)							
Antimony	5	5	--	--	--	78	--	0.27	0.948 (<BG)
Barium	132	500	--	102	--	330	--	2,000	287
Boron	--	0.5	--	--	--	--	--	--	2.72
Cadmium (total)	0.81	4	20	14	32	140	0.77	0.36	18.2
Copper	22	100	50	217	70	80	28	49	49.4
Lead	10.2	50	500	118	120	1,700	11	56	32.8
Manganese	512	1,100 [d]	--	1,500	220	450	4,300	4,000	504 (<BG)
Mercury	0.33	0.3	0.1	5.5	--	--	--	--	2.52
Vanadium	85.1	2	--	--	--	--	7.8	280	46.3 (<BG)
Zinc	67.8	86 [d]	200	360	160	120	46	79	231

[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] 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.

-- = not applicable

BG = background

WAC = *Washington Administrative Code*

APPENDIX B

CALCULATIONS

APPENDIX B

CALCULATION BRIEFS

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

100-H-51:4, 100-H Main Gate Storm Drain, RPD and Direct Contact Hazard Quotient and Carcinogenic Risk Calculation, 0100H-CA-V0149, Rev. 0, Washington Closure Hanford, Richland, Washington.

100-H-51:4, 100-H Main Gate Storm Drain, Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater, 0100H-CA-V0155, Rev. 0, Washington Closure Hanford, Richland, Washington.

100-H-51:4, 100-H Main Gate Storm Drain, Site-Specific Risk Assessment for Cadmium, 0100H-CA-V0147, Rev. 1, Washington Closure Hanford, Richland, Washington.

Acrobat 8.0

CALCULATION COVER SHEET

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

Area: 100-H

Discipline: Environmental Calculation No: 0100H-CA-V0149

Subject: 100-H-51:4 RPD and Direct Contact Hazard Quotient and Carcinogenic Risk Calculation

Computer Program: Excel Program No: Excel 2003

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

Committed Calculation ☒ Preliminary ☐ Superseded ☐ Voided ☐

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover = 1 Summary = 6 Attachment 1 = 3 Total = 10	J. D. Skoglie	T. E. Queen	B. L. Vedder	D. F. Obenauer	2/8/11

SUMMARY OF REVISION

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

DE01-437.03

Washington Closure Hanford, Inc. CALCULATION SHEET

Originator:	J. D. Skoglie	Date:	1/18/2011	Calc. No.:	0100H-CA-V0149	Rev.:	0
Project:	100-H Area Field Remediation	Job No:	14655	Checked:	T. E. Queen	Date:	1/18/2011
Subject:	100-H-51:4 RPD and Direct Contact Hazard Quotient and Carcinogenic Risk Calculations					Sheet No.	1 of 6

PURPOSE:

Provide documentation to support the calculation of the direct contact hazard quotient (HQ) and excess carcinogenic risk for the 100-H-51:4 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.

Also, calculate the relative percent difference (RPD) for primary-duplicate sample pairs from 100-H-51:4 confirmatory sampling, as necessary.

GIVEN/REFERENCES:

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

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

3) EPA, 1994, *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*, EPA 540/R-94/013, U.S. Environmental Protection Agency, Washington, D.C.

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

5) WCH, 2010, *100-H-51:4 Site-Specific Risk Assessment for Cadmium*, 0100H-CA-V0147, Washington Closure Hanford, Inc., Richland, Washington.

6) WCH, 2011, *Remaining Sites Verification Package for the 100-H-51:4, 100-H Main Gate Storm Drain*, Attachment to Waste Site Reclassification Form 2009-026, Washington Closure Hanford, Inc., Richland, Washington.

SOLUTION:

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

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

Washington Closure Hanford, Inc. CALCULATION SHEET

Originator:	J. D. Skoglie	Date:	1/19/2011	Calc. No.:	0100H-CA-V0149	Rev.:	0
Project:	100-H Area Field Remediation	Job No:	14655	Checked:	T. E. Queen	Date:	1/19/2011
Subject:	100-H-51:4 RPD and Direct Contact Hazard Quotient and Carcinogenic Risk Calculations					Sheet No. 2 of 6	

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

5) Use data from WCH (2011) to perform the RPD calculations for primary-duplicate sample pairs, as required.

METHODOLOGY:

The 100-H-51:4 confirmatory sampling results are from one test pit where one soil sample and one pipe content sample were collected. A duplicate sample was collected from the soil under the pipe. The direct contact hazard quotient and carcinogenic risk calculations for the 100-H-51:4 waste site were conservatively calculated for the entire waste site using the greatest of the maximum sample results (WCH 2011). Of the contaminants of potential concern (COPCs) for this site, barium, cadmium, copper, mercury, silver, total chromium, and zinc require HQ and risk calculations because these analytes were detected above background values. The site-specific risk assessment for cadmium in the 100-H-51:4 pipeline has determined that the hazard quotient (1.63×10^{-3}) and incremental cancer risk (4.07×10^{-8}) are less than their respective regulatory limits (a hazard quotient of 1.0 and an incremental cancer risk of 1.0×10^{-6}) and therefore attain the remedial action goals and remedial action objectives stated in the RDR/RAWP for the 100 Area. Boron, molybdenum, and the detected polycyclic aromatic hydrocarbons require HQ and risk calculations because these analytes were detected and a Washington State or Hanford Site background value is not available. Lead was quantitated at a concentration above Hanford Site background; however, lead is not included in the calculation based on modeling of child blood levels, which is fundamentally different from the oral reference dose and cancer slope factors used to calculate typical cleanup levels and associated HQs and cancer risks. All other site nonradionuclide COPCs were not detected or were quantified below background levels. An example of the HQ and risk calculations is presented below:

1) For example, the maximum value for boron is 2.72 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 3.8×10^{-4}. Comparing this value, and all other individual values, to the requirement of <1.0, this criterion is met.

2) After the HQ calculation is completed for the appropriate analytes, the cumulative HQ can be obtained by summing the individual values. To avoid errors due to intermediate rounding, the individual HQ values prior to rounding are used for this calculation. The sum of the HQ values is 1.9×10^{-1}. Comparing this value to the requirement of <1.0, this criterion is met.

3) To calculate the excess cancer risk, the maximum or statistical value is divided by the carcinogenic RAG value, then multiplied by 1.0×10^{-6}. For example, the maximum value for benzo(a)anthracene is 0.0545 mg/kg, divided by 1.37 mg/kg, and multiplied as indicated, is 4.0×10^{-8}. Comparing this value, and all other individual values, to the requirement of $<1 \times 10^{-6}$, this criterion is met.

Washington Closure Hanford, Inc. CALCULATION SHEET

Originator:	J. D. Skoglie	Date:	1/24/2011	Calc. No.:	0100H-CA-V0149	Rev.:	0
Project:	100-H Area Field Remediation	Job No:	14655	Checked:	T. E. Queen	Date:	1/24/2011
Subject:	100-H-51:4 RPD and Direct Contact Hazard Quotient and Carcinogenic Risk Calculations					Sheet No. 3 of 6	

4) After these calculations are completed for the carcinogenic analytes, the cumulative excess cancer risk can be obtained by summing the individual values. To avoid errors due to intermediate rounding, the individual cancer risk values prior to rounding are used for this calculation. The sum of the excess cancer risk values is 1.3×10^{-6}. Comparing this value to the requirement of $<1 \times 10^{-5}$, this criterion is met.

5) The RPD is calculated when both the primary value and the duplicate value for a given analyte are above detection limits and are greater than 5 times the target detection limit (TDL). The TDL is a laboratory detection limit pre-determined for each analytical method and is listed for certain analytes in Table II-1 of the SAP (DOE-RL 2009b). Other analytes will have their own pre-determined constituents and will have their own TDLs based on the laboratory and method used. Where direct evaluation of the attached sample data showed that a given analyte was not detected in the primary and/or duplicate sample, further evaluation of the RPD value was not performed. The RPD calculations use the following formula:

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

where, M = main sample value D = duplicate sample value

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. This assessment is provided in the data quality assessment section of the RSVP.

For quality assurance/quality control (QA/QC) duplicate RPD calculations, a value less than 30% indicates the data compare favorably. For regulatory splits, a threshold of 35% is used (EPA 1994). If the RPD is greater than 30% (or 35% for regulatory split data), further investigation regarding the usability of the data is performed. No split samples were collected for cleanup verification of the subject site. Additional discussion is provided in the data quality assessment section of the applicable RSVP (WCH 2011), as necessary.

RESULTS:

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

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

5) The evaluation of the QA/QC duplicate RPD calculations is performed within the data quality assessment section of the RSVP.

Table 2 shows the results of the RPD calculations for the 100-H-51:4 waste site.

Washington Closure Hanford, Inc. CALCULATION SHEET

Originator:	J. D. Skoglie	Date:	1/19/2011	Calc. No.:	100H-CA-V0149	Rev.:	0
Project:	100-H Area Field Remediation	Job No:	14655	Checked:	T. E. Queen	Date:	1/19/2011
Subject:	100-H-51:4 RPD and Direct Contact Hazard Quotient and Carcinogenic Risk Calculations					Sheet No. 4 of 6	

Table 1. Direct Contact HQ and Excess Cancer Risk Results for the 100-H-51:4 Waste Site.

Contaminants of Potential Concern	Maximum Value[a] (mg/kg)	Noncarcinogen RAG[b] (mg/kg)	Hazard Quotient	Carcinogen RAG[b] (mg/kg)	Carcinogen Risk
Metals					
Barium	287	5,600	5.1E-02	--	--
Boron	2.72	7,200	3.8E-04	--	--
Cadmium[c]	18.2	--	1.6E-03	--	4.1E-08
Chromium, total	19.3	80,000	2.4E-04	--	--
Copper	49.4	2,960	1.7E-02	--	--
Lead[d]	32.8	353	--	--	--
Mercury	2.52	24	1.1E-01	--	--
Molybdenum	1.17	400	2.9E-03	--	--
Silver	1.79	400	4.5E-03	--	--
Zinc	231	24,000	9.6E-03	--	--
Polycyclic Aromatic Hydrocarbons					
Acenapthene	0.102	4,800	2.1E-05	--	--
Acenaphthylene[e]	0.0125	4,800	2.6E-06	--	--
Anthracene	0.00806	24,000	3.4E-07	--	--
Benzo(a)anthracene	0.0545	--	--	1.37	4.0E-08
Benzo(a)pyrene	0.108	--	--	0.137	7.9E-07
Benzo(b)fluoranthene	0.274	--	--	1.37	2.0E-07
Benzo(k)fluoranthene	0.0932	--	--	1.37	6.8E-08
Benzo(ghi)perylene[e]	0.228	2,400	9.5E-05	--	--
Chrysene	0.0298	--	--	13.7	2.2E-09
Dibenz(a,h)anthracene	0.0281	--	--	1.37	2.1E-08
Fluoranthene	0.178	3,200	5.6E-05	--	--
Fluorene	0.00431	3,200	1.3E-06	--	--
Indeno(1,2,3-cd)pyrene	0.219	--	--	1.37	1.6E-07
Phenanthrene[e]	0.0146	24,000	6.1E-07	--	--
Totals					
Cumulative Hazard Quotient:			**1.9E-01**		
Cumulative Excess Cancer Risk:					**1.3E-06**

Notes:

[a] = From WCH (2011).

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

[c] = Site-specific risk assessment for cadmium (WCH 2010) calculated hazard quotient to be 1.63×10^{-3} and incremental cancer risk of 4.07×10^{-8} mg/kg

[d] = Value for the noncarcinogenic RAG calculated using Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children, EPA/540/R 93/081, Publication No. 9285.7, U.S. Environmental Protection Agency, Washington, D.C.

[e] = Toxicity data for these chemicals are not available. The cleanup levels are based on use of surrogate chemicals.

acenaphthylene surrogate: acenaphthene

benzo(g,h,i)perylene surrogate: pyrene

phenanthrene surrogate: anthracene

-- = not applicable

RAG = remedial action goal

Washington Closure Hanford, Inc. CALCULATION SHEET

Originator:	J. D. Skoglie	Date:	1/18/2011	Calc. No.:	0100H-CA-V0149	Rev.:	0
Project:	100-H Area Field Remediation	Job No:	14655	Checked:	T. E. Queen	Date:	1/18/2011
Subject:	100-H-51:4 RPD and Direct Contact Hazard Quotient and Carcinogenic Risk Calculations					Sheet No. 5 of 6	

Table 2. Relative Percent Difference Calculations for the 100-H-51:4 Waste Site. (2 Pages)

100-H-51:4 Duplicate Analysis

Sampling Area	HEIS Number	Sample Date	Aluminum			Arsenic			Barium			Beryllium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
Soil Under Pipe	J1C375	10/7/10	9900		4.50	5.94		0.901	112		0.450	0.345		0.180
Duplicate of J1C375	J1C376	10/7/10	9300		4.22	3.57		0.845	93.8		0.422	0.313		0.169

Analysis:

TDL		5	10	2	0.2
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	Yes (calc RPD)	No-Stop (acceptable)	Yes (calc RPD)	No-Stop (acceptable)
	RPD	6.3%		17.7%	
	Difference > 2 TDL?	Not applicable	No - acceptable	Not applicable	No - acceptable

Sampling Area	HEIS Number	Sample Date	Boron			Cadmium			Calcium			Chromium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
Soil Under Pipe	J1C375	10/7/10	1.65	B	1.80	0.810		0.180	4040		90.1	13.5		0.180
Duplicate of J1C375	J1C376	10/7/10	1.55	B	1.69	0.742		0.169	3590		84.5	12.5		0.169

Analysis:

TDL		2	0.2	100	1
Duplicate Analysis	Both > PQL?	No-Stop (acceptable)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?		No-Stop (acceptable)	Yes (calc RPD)	Yes (calc RPD)
	RPD			11.8%	7.7%
	Difference > 2 TDL?	No - acceptable	No - acceptable	Not applicable	Not applicable

Sampling Area	HEIS Number	Sample Date	Cobalt			Copper			Iron			Lead		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
Soil Under Pipe	J1C375	10/7/10	7.45		1.80	14.7		0.901	23200		18.0	6.47		0.450
Duplicate of J1C375	J1C376	10/7/10	6.68		1.69	13.2		0.845	19900		16.9	5.80		0.422

Analysis:

TDL		2	1	5	5
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	No-Stop (acceptable)	Yes (calc RPD)	Yes (calc RPD)	No-Stop (acceptable)
	RPD		10.8%	15.3%	
	Difference > 2 TDL?	No - acceptable	Not applicable	Not applicable	No - acceptable

Sampling Area	HEIS Number	Sample Date	Magnesium			Manganese			Mercury			Molybdenum		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
Soil Under Pipe	J1C375	10/7/10	4030		67.6	504	J	4.50	0.0200	JB	0.0260	0.394	B	1.80
Duplicate of J1C375	J1C376	10/7/10	3760		63.4	237	J	4.22	0.0447	J	0.0267	0.401	B	1.69

Analysis:

TDL		75	5	0.2	2
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)	No-Stop (acceptable)	No-Stop (acceptable)
	Both >5xTDL?	Yes (calc RPD)	Yes (calc RPD)		
	RPD	6.9%	72.1%		
	Difference > 2 TDL?	Not applicable	Not applicable	No - acceptable	No - acceptable

Sampling Area	HEIS Number	Sample Date	Nickel			Potassium			Selenium			Silicon		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
Soil Under Pipe	J1C375	10/7/10	12.6		3.60	1680		360	0.274		0.270	759		1.80
Duplicate of J1C375	J1C376	10/7/10	11.5		3.38	1570		338	0.276		0.253	631		1.69

Analysis:

TDL		4	400	1	2
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	Yes (calc RPD)
	RPD				18.4%
	Difference > 2 TDL?	No - acceptable	No - acceptable	No - acceptable	Not applicable

Note: Gray cells indicate not applicable.

B = estimated result. Result is less than the RL but greater than the MDL.
D = analyte reported from a dilution
J = estimated result.
HEIS = Hanford Environmental Information System

PQL = practical quantitation limit.
Q = qualifier
RPD = relative percent difference.
TDL = target detection limit

Washington Closure Hanford, Inc. CALCULATION SHEET

Originator:	J. D. Skoglie	Date:	1/18/2011	Calc. No.:	0100H-CA-V0149	Rev.:	0
Project:	100-H Area Field Remediation	Job No:	14655	Checked:	T. E. Queen	Date:	1/18/2011
Subject:	100-H-51:4 RPD and Direct Contact Hazard Quotient and Carcinogenic Risk Calculations					Sheet No. 6 of 6	

Table 2. Relative Percent Difference Calculations for the 100-H-51:4 Waste Site. (2 Pages)

100-H-51:4 Duplicate Analysis

Sampling Area	HEIS Number	Sample Date	Sodium			Vanadium			Zinc			Benzo(a)pyrene		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	ug/kg	Q	PQL
Soil Under Pipe	J1C375	10/7/10	291		45.0	46.3		2.25	79.1		9.01	4.90	J	2.74
Duplicate of J1C375	J1C376	10/7/10	277		42.2	43.2		2.11	77.7		8.45	1.68	J	3.61

Analysis:

TDL		50	2.5	1	15
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)	No-Stop (acceptable)
	Both >5xTDL?	Yes (calc RPD)	Yes (calc RPD)	Yes (calc RPD)	
	RPD	4.9%	6.9%	1.8%	
	Difference > 2 TDL?	Not applicable	Not applicable	Not applicable	No - acceptable

Sampling Area	HEIS Number	Sample Date	Benzo(b)fluoranthene			Benzo(ghi)perylene			Fluoranthene		
			ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
Soil Under Pipe	J1C375	10/7/10	5.70	J	2.74	4.06	J	2.74	1.28	J	2.74
Duplicate of J1C375	J1C376	10/7/10	1.56	J	3.61	2.60	J	3.61	1.27	J	3.61

Analysis:

TDL		15	15	15
Duplicate Analysis	Both > PQL?	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)
	Both >5xTDL?			
	RPD			
	Difference > 2 TDL?	No - acceptable	No - acceptable	No - acceptable

CONCLUSION:

The calculations in Tables 1 and 2 demonstrate that the 100-H-51:4 waste site meets the requirements for the hazard quotients and carcinogenic (excess cancer) risk and RPDs, respectively, as identified in the RDR/RAWP (DOE-RL 2009a) and SAP (DOE-RL 2009b). The hazard quotients and carcinogenic (excess cancer) risk and RPD calculations are for use in the RSVP for this site.

Acrobat 8.0

CALCULATION COVER SHEET

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

Area: 100-HR-1

Discipline: Environmental *Calculation No: 0100H-CA-V0155

Subject: 100-H-51:4 Waste Site Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater

Computer Program: Excel Program No: Excel 2003

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

Committed Calculation ☒ Preliminary ☐ Superseded ☐ Voided ☐

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover = 1 Sheets = 3 Total = 4	I. B. Berezovskiy	T. E. Queen	J. D. Skoglie	D. F. Obenauer	1/31/11

SUMMARY OF REVISION

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

Attachment 1. 100-H-51:4 Waste Site Confirmatory Sample Results (Metals).

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
Soil Under Pipe	J1C375	10/7/10	9900		4.50	0.540	UJ	0.540	5.94		0.901	112		0.450	0.345		0.180
Duplicate of J1C375	J1C376	10/7/10	9300		4.22	0.507	UJ	0.507	3.57		0.845	93.8		0.422	0.313		0.169
Pipe Contents	J1C367	10/7/10	8100		5.00	0.948		0.600	4.09		1.00	287		0.500	0.249		0.200
Equipment Blank	J1C374	10/7/10	189		3.38	0.406	UJ	0.406	0.676	U	0.676	1.89		0.338	0.135	U	0.135

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
Soil Under Pipe	J1C375	10/7/10	1.65	B	1.80	0.810		0.180	4040		90.1	13.5		0.180	7.45		1.80
Duplicate of J1C375	J1C376	10/7/10	1.55	B	1.69	0.742		0.169	3590		84.5	12.5		0.169	6.68		1.69
Pipe Contents	J1C367	10/7/10	2.72		2.00	18.2		0.200	4120		100	19.3		0.200	4.89		2.00
Equipment Blank	J1C374	10/7/10	1.35	U	1.35	0.135	U	0.135	50.1	B	67.6	0.142		0.135	1.35	U	1.35

Sample Location	HEIS Number	Sample Date	Copper			Iron			Lead			Magnesium			Manganese		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
Soil Under Pipe	J1C375	10/7/10	14.7		0.901	23200		18.0	6.47		0.450	4030		67.6	504	J	4.50
Duplicate of J1C375	J1C376	10/7/10	13.2		0.845	19900		16.9	5.80		0.422	3760		63.4	237	J	4.22
Pipe Contents	J1C367	10/7/10	49.4		1.00	16500		20.0	32.8		0.500	3780		75.0	207		5.00
Equipment Blank	J1C374	10/7/10	0.676	U	0.676	221		13.5	0.412		0.338	27.6	B	50.7	4.72	J	3.38

Sample Location	HEIS Number	Sample Date	Mercury			Molybdenum			Nickel			Potassium			Selenium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
Soil Under Pipe	J1C375	10/7/10	0.0200	JB	0.0260	0.394	B	1.80	12.6		3.60	1680		360	0.274		0.270
Duplicate of J1C375	J1C376	10/7/10	0.0447	J	0.0267	0.401	B	1.69	11.5		3.38	1570		338	0.276		0.253
Pipe Contents	J1C367	10/7/10	2.52		0.164	1.17	B	2.00	10.8		4.00	1610		400	0.300	U	0.300
Equipment Blank	J1C374	10/7/10	0.0250	U	0.0250	1.35	U	1.35	2.71	U	2.71	42.6	B	271	0.203	U	0.203

Sample Location	HEIS Number	Sample Date	Silicon			Silver			Sodium			Vanadium			Zinc		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
Soil Under Pipe	J1C375	10/7/10	759		1.80	0.180	U	0.180	291		45.0	46.3		2.25	79.1		9.01
Duplicate of J1C375	J1C376	10/7/10	631		1.69	0.169	U	0.169	277		42.2	43.2		2.11	77.7		8.45
Pipe Contents	J1C367	10/7/10	904		2.00	1.79		0.200	212		50.0	43.6		2.50	231		10.0
Equipment Blank	J1C374	10/7/10	188		1.35	0.135	U	0.135	33.8	U	33.8	0.312	B	1.69	0.868	B	6.76

Acronyms and notes apply to all of the tables in this attachment.
Gray cells indicate not applicable.
Note: Data qualified with B, C, and/or J are considered acceptable values.
B = blank contamination (organic constituents) = Estimated (inorganic)
D = result reported from a dilution
HEIS=Hanford Environmental Information System
J = estimated
PQL = practical quantitation limit
Q = qualifier
U = undetected

Attachment	1	Sheet No.	1 of 3
Originator	J. D. Skoglie	Date	1/18/11
Checked	T. E. Queen	Date	1/18/11
Calc. No.	0100H-CA-V0149	Rev. No.	0

Attachment 1. 100-H-51:4 Waste Site Confirmatory Sample Results (Organics).

CONSTITUENT	Soil Under Pipe - J1C375, 10/7/10			Duplicate of J1C375 - J1C376, 10/7/10			Pipe Contents - J1C367, 10/7/10			Equipment Blank - J1C374, 10/7/10		
	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
Polycyclic Aromatic Hydrocarbons												
Acenaphthene	2.74	J	2.74	3.61	U	3.61	102		3.26			
Acenaphthylene	3.65	U	2.74	3.61	U	3.61	12.5		3.26			
Anthracene	3.65	U	2.74	3.61	U	3.61	8.06		3.26			
Benzo(a)anthracene	1.88	J	2.74	3.61	UJ	3.61	54.5		3.26			
Benzo(a)pyrene	4.90	J	2.74	1.68	J	3.61	108		3.26			
Benzo(b)fluoranthene	5.70	J	2.74	1.56	J	3.61	274		3.26			
Benzo(ghi)perylene	4.06	J	2.74	2.60	J	3.61	228		3.26			
Benzo(k)fluoranthene	2.19	J	2.74	3.61	U	3.61	93.2		3.26			
Chrysene	1.04	J	2.74	3.61	U	3.61	29.8		3.26			
Dibenz[a,h]anthracene	3.65	U	2.74	3.61	U	3.61	28.1		3.26			
Fluoranthene	1.28	J	2.74	1.27	J	3.61	178		3.26			
Fluorene	3.65	U	2.74	3.61	U	3.61	4.31		3.26			
Indeno(1,2,3-cd)pyrene	3.65	U	2.74	3.61	U	3.61	219		3.26			
Naphthalene	3.65	U	2.74	3.61	U	3.61	3.26	U	3.26			
Phenanthrene	3.65	U	2.74	3.61	U	3.61	14.6		3.26			
Pyrene	3.65	U	2.74	3.61	U	3.61	3.26	U	3.26			
Semi Volatile Organics												
1,2,4-Trichlorobenzene	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
1,2-Dichlorobenzene	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
1,3-Dichlorobenzene	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
1,4-Dichlorobenzene	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
2,4,5-Trichlorophenol	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
2,4,6-Trichlorophenol	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
2,4-Dichlorophenol	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
2,4-Dimethylphenol	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
2,4-Dinitrophenol	1770	UJ	1770	16000	UJD	16000	1600	U	1600	1810	UJ	1810
2,4-Dinitrotoluene	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
2,6-Dinitrotoluene	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
2-Chloronaphthalene	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
2-Chlorophenol	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
2-Methylnaphthalene	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
2-Methylphenol (cresol, o-)	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
2-Nitroaniline	1770	UJ	1770	16000	UJD	16000	1600	U	1600	1810	UJ	1810
2-Nitrophenol	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
3+4 Methylphenol (cresol, m+p)	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
3,3'-Dichlorobenzidine	709	UJ	709	6410	UJD	6410	641	U	641	723	UJ	723
3-Nitroaniline	1770	UJ	1770	16000	UJD	16000	1600	U	1600	1810	UJ	1810
4,6-Dinitro-2-methylphenol	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
4-Bromophenylphenyl ether	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
4-Chloro-3-methylphenol	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
4-Chloroaniline	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
4-Chlorophenylphenyl ether	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
4-Nitroaniline	1770	UJ	1770	16000	UJD	16000	1600	U	1600	1810	UJ	1810
4-Nitrophenol	1770	UJ	1770	16000	UJD	16000	1600	U	1600	1810	UJ	1810
Acenaphthene	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
Acenaphthylene	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361

Attachment	1	Sheet No.	2 of 3
Originator	J. D. Skoglie	Date	1/18/11
Checked	T. E. Queen	Date	1/18/11
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Attachment 1. 100-H-51:4 Waste Site Confirmatory Sample Results (Organics).

CONSTITUENT	Soil Under Pipe - J1C375, 10/7/10			Duplicate of J1C375 - J1C376, 10/7/10			Pipe Contents - J1C367, 10/7/10			Equipment Blank - J1C374, 10/7/10		
	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
Semi Volatile Organics												
Anthracene	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
Benzo(a)anthracene	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
Benzo(a)pyrene	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
Benzo(b)fluoranthene	354	U	354	3210	UD	3210	320	U	320	361	U	361
Benzo(ghi)perylene	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
Benzo(k)fluoranthene	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
Bis(2-chloro-1-methylethyl)ether	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
Bis(2-Chloroethoxy)methane	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
Bis(2-chloroethyl) ether	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
Bis(2-ethylhexyl) phthalate	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
Butylbenzylphthalate	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
Carbazole	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
Chrysene	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
Di-n-butylphthalate	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
Di-n-octylphthalate	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
Dibenz[a,h]anthracene	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
Dibenzofuran	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
Diethyl phthalate	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
Dimethyl phthalate	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
Fluoranthene	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
Fluorene	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
Hexachlorobenzene	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
Hexachlorobutadiene	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
Hexachlorocyclopentadiene	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
Hexachloroethane	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
Indeno(1,2,3-cd)pyrene	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
Isophorone	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
N-Nitroso-di-n-dipropylamine	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
N-Nitrosodiphenylamine	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
Naphthalene	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
Nitrobenzene	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
Pentachlorophenol	1770	UJ	1770	16000	UJD	16000	1600	U	1600	1810	UJ	1810
Phenanthrene	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
Phenol	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361
Pyrene	354	UJ	354	3210	UJD	3210	320	U	320	361	UJ	361

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Acrobat 8.0

CALCULATION COVER SHEET

Project Title: Field Remediation **Job No. 14655**

Area: 100-H

Discipline: Environmental *Calculation No: 0100H-CA-V0147 Rev. 1

Subject: 100-H-51:4 Site-Specific Risk Assessment for Cadmium

Computer Program: Excel Program No: Microsoft Excel 2003

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

Committed Calculation ☒ Preliminary ☐ Superseded ☐ Voided ☐

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover – 1 pg Summary – 6 pg Total – 7 pages	S. W. Clark	M. W. Perrott	N/A	D. F. Obenauer	
1	Cover – 1 pg Summary – 6 pg Total – 7 pages	S. W. Clark	M. W. Perrott	N/A	D. F. Obenauer	1/31/11

SUMMARY OF REVISION

Rev. 1	The title "Incremental Cancer Risk from Soil Ingestion Pathway" was revised to "Incremental Noncarcinogenic Risk from the Soil Ingestion Pathway" on Sheet 4. Additional formatting was done to the tables.

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

Washington Closure Hanford CALCULATION SHEET

Originator:	S. W. Clark	Date:	1/27/11	Calc. No.:	0100H-CA-V0147	Rev.:	1
Project:	100-H Field Remediation	Job No:	14655	Checked:	M. W. Perrott	Date:	~~1/26/11~~ 1/27/11
Subject:	100-H-51:4 Site-Specific Risk Assessment for Cadmium					Sheet No.	1 of 6

PURPOSE:

Calculate the incremental cancer risk and hazard quotient from residual concentrations of cadmium at the 100-H-51:4 waste sub-site to evaluate the attainment of remedial action objectives.

GIVEN/REFERENCES:

1) Maximum residual concentration of cadmium of 18.2 mg/kg in sample number J1C367.
2) *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (100 Area RDR/RAWP), DOE/RL-96-17, Rev. 6, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
3) Equations for calculating contaminant intake from Appendix D of *Hanford Site Risk Assessment Methodology* (HSRAM), DOE/RL-91-45, Rev. 3, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
4) Use of area factors and occupancy factors to account for small waste site size and actual period of occupancy is from the *User's Manual for RESRAD Version 6*, ANL/EAD-4, Environmental Assessment Division, Argonne National Laboratory, Argonne, Illinois.

SOLUTION:

1) Table 1 shows the risk assessment input parameters used for this calculation.

Table 1. Risk Assessment Input Parameters.

Parameter	Units	Value	Citation
Area of contaminated zone	m^2	71.8	Interior area of 6 inch diameter pipeline 152.3 m long
Exposure duration, adult	years	24	HSRAM
Exposure duration, child	years	6	HSRAM
Fraction of time spent indoors	unitless	0.6	100 Area RDR/RAWP
Fraction of time spent outdoors (on site)	unitless	0.2	100 Area RDR/RAWP
Soil ingestion rate, adult	g/yr	36.5	HSRAM
Soil ingestion rate, child	g/yr	73	HSRAM
Inhalation rate	m^3/yr	7,300	100 Area RDR/RAWP
Mass dust loading for inhalation	g/m^3	0.0001	100 Area RDR/RAWP
Wind speed	m/s	3.4	100 Area RDR/RAWP
Body weight, adult	kg	70	HSRAM
Body weight, child	kg	16	HSRAM
Average lifetime	years	70	HSRAM

2) Table 2 shows the contaminant-specific risk assessment input parameters for the inhalation and soil ingestion pathways. Published values for the cancer slope factor for inhalation

Washington Closure Hanford CALCULATION SHEET

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Project:	100-H Field Remediation	Job No:	14655	Checked:	M. W. Perrott	Date:	~~1/26/11~~ 1/27/11
Subject:	100-H-51:4 Site-Specific Risk Assessment for Cadmium					Sheet No. 2 of 6	

(CSFi) and the noncarcinogenic reference dose for oral soil ingestion (RfDo) provide both carcinogenic risk and hazard quotient calculations for cadmium.

Table 2. Contaminant-Specific Risk Assessment Input Parameters

Contaminant	Pathway: Inhalation (Fugitive Dust)		Pathway: Soil Ingestion	
	RfDi[a] (mg/kg-d)	CSFi[b] (kg-d/mg)	RfDo[a] (mg/kg-d)	CSFo[b] (kg-d/mg)
Cadmium	N/A	6.30E+00	1.00E-03	N/A

[a] RfDi or RfDo = Noncarcinogenic Reference Dose for dust inhalation or soil ingestion. Obtained from the Ecology *Cleanup Levels and Risk Calculations (CLARC) Database* on the internet at <https://fortress.wa.gov/ecy/clarc/CLARCHome.aspx>.

[b] CSFi or CSFo = Cancer Slope Factor for dust inhalation or soil ingestion. Obtained from the Ecology *Cleanup Levels and Risk Calculations (CLARC) Database* on the internet at <https://fortress.wa.gov/ecy/clarc/CLARCHome.aspx>

N/A = Not Available

METHODOLOGY:

1) Incremental Cancer Risk:

The incremental cancer risk calculation is based upon the general formula:

ICR = (Daily Intake) CSF

Where CSF = the cancer slope factor with units of kg - day/mg. As applicable, the EPA provides separate values of the cancer slope factor for the inhalation and oral ingestion pathways (CSFi and CSFo, respectively). Cadmium only has a cancer slope factor for inhalation.

2) Hazard Quotient:

The hazard quotient calculation is based upon the general formula:

Hazard Quotient = (Daily Intake) / RfD

Where RfD = the reference dose with units of mg/ kg - day. As applicable, the EPA provides separate values of the reference dose for the inhalation and oral ingestion pathways (RfDi and RfDo, respectively). Cadmium only has a reference dose for soil ingestion.

3) Daily Intake for the Soil Ingestion Pathway:

Daily Intake for the soil ingestion pathway is calculated from the following formula from HSRAM Equation D-24, including the area factor and occupancy factor from the *User's Manual for RESRAD Version 6*:

$$DIS = \frac{C \times \left[\left(\frac{SI \times ED}{BW} \right)_{child} + \left(\frac{SI \times ED}{BW} \right)_{adult} \right] \times AFS \times OFS \times 0.001(kg/g)}{AL \times 365(d/yr)}$$

Washington Closure Hanford CALCULATION SHEET

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Where: C is contaminant concentration, (site-specific statistical value, mg/kg)

SI is Soil Ingestion Rate, (g/yr)

AFS is an area factor for soil ingestion: AFS = A/1000 for A < 1000 m^2

AFS = 1 for A > 1000 m^2

A is the area of the contaminated zone, m^2

OFS is the occupancy factor for soils: OFS = (IT) + (OT)

IT is the Indoor Time Factor (0.6)

OT is the Outdoor Time Factor (0.2)

OFS = 0.6 + 0.2 = 0.8

ED is exposure duration (yr) for adult or child

BW is body weight (kg) for adult or child

AL is average lifetime (yr) for adult or child

4) Daily Intake for the Inhalation Pathway:

Daily Intake for the inhalation pathway is calculated using the following formula from HSRAM Equation D-30, including the area factor and occupancy factor from the *User's Manual for RESRAD Version 6*:

$$DII = \frac{C \times IR \times ML \times ED \times AFI \times OFI \times 0.001(kg/g)}{BW \times AL \times 365(d/yr)}$$

Where: C is contaminant concentration, (site-specific statistical value, mg/kg)

BW is body weight (70 kg)

AL is average lifetime (70 yr)

IR is Inhalation Rate, (7,300 m^3/yr)

ML is Mass Loading, (0.0001 g/m^3)

ED is exposure duration (30 yr)

AFI is the site specific area factor for dust inhalation calculated from formula B.4 of the *User's Manual for RESRAD Version 6*:

$$AFI = \frac{a}{1 + b\left(\sqrt{A}\right)^c}$$

In this equation, A is the area of the contaminated zone in m^2 and a, b, c are least squares regression coefficients dependent upon the average wind speed as described in Table B.2 of the *User's Manual for RESRAD Version 6*. Calculation results are shown in the RESULTS section of this Calculation Summary.

OFI is the occupancy factor for inhalation: OFI = (IT x IDF) + (OT)

IT is the Indoor Time Factor (0.6)

IDF = Indoor dust filtration factor (0.4)

OT is the Outdoor Time Factor (0.2)

OFI = (0.6 x 0.4) + 0.2 = 0.44

Washington Closure Hanford CALCULATION SHEET

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Project:	100-H Field Remediation	Job No:	14655	Checked:	M. W. Perrott	Date:	~~1/26/11~~ 1/27/11
Subject:	100-H-51:4 Site-Specific Risk Assessment for Cadmium					Sheet No. 4 of 6	

RESULTS:
Calculations were performed using an Excel spreadsheet, incorporating the formulas shown in the METHODOLOGY section of this Calculation Summary.

1) Incremental Noncarcinogenic Risk from the Soil Ingestion Pathway:
The following Excel spreadsheet incorporates the formulas for calculation of noncarcinogenic risk (hazard quotient) from cadmium in the soil ingestion pathway:

Table 3. Excel Calculation of Noncarcinogenic Risk in the Soil Ingestion Pathway

	A	B	C	D	E	F	G	H
1	Area factor for soil ingestion pathway (AFS) is calculated per the *User's Manual for RESRAD Version 6.0*, Formula F.3:							
2	Area, m^2	AFS = 1 for Area > 1000 m^2; AFS = Area/1000 for Area < 1000 m^2						
3	71.8	0.0718	Generic waste site area					
4								
5	Soil Ingestion Intake = (C*((SIc*EDc/BWc)+(SIa*EDa/BWa))*AFS*OFS*UCF1)/(AL*UCF2)							
6	Variable	Value	Description					
7	C	18.2	mg/kg, Maximum concentration of Cadmium in pipeline scale					
8	SIc	73	g/yr, Childhood soil ingestion rate					
9	SIa	36.5	g/yr, Adult soil ingestion rate					
10	EDc	6	years, Childhood exposure duration					
11	EDa	24	years, Adult exposure duration					
12	BWc	16	kg, Child body weight					
13	BWa	70	kg, Adult body weight					
14	AFS	1	unitless area factor					
15	OFS	0.8	unitless occupancy factor					
16	UCF1	0.001	kg/g, Units conversion factor					
17	AL	70	years, Average lifetime					
18	UCF2	365	days/year, Units conversion factor					
19	RfDo	0.001	mg/kg-day, Reference dose for Cadmium					
20								
21	Calculated Ingestion Daily Intake = E24 = (B7*((B8*B10/B12)+(B9*B11/B13))*B14*B15*B16)/(B17*B18)							
22	Soil Ingestion Hazard Quotient = E25 = (E24/B19)							
23								
24	Calculated Ingestion Daily Intake =				1.63E-06	mg / kg - day		
25	Cadmium Soil Ingestion Hazard Quotient =				1.63E-03			

2) Incremental Cancer Risk from the Inhalation Pathway:
The following Excel spreadsheet incorporates the formulas for calculation of incremental cancer risk from cadmium in the inhalation pathway:

Washington Closure Hanford CALCULATION SHEET

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Table 4. Excel Calculation of Incremental Cancer Risk in the Inhalation Pathway

	A	B	C	D	E	F	G	H
1	Area factor for inhalation pathway is calculated per the *User's Manual for RESRAD Version 6.0*, Formula B.4, calculating least squares regression coefficients for a wind speed of 3.4 m/s per the *User's Manual for RESRAD Version 6.0*, Formula B.2:							
2	Coefficient a for 3.4 m/s Wind Speed = B7 = (B6-((A7-A6)/(A8-A6))*(B6-B8))							
3	Coefficient b for 3.4 m/s Wind Speed = C7 = (C6-((A7-A6)/(A8-A6))*(C6-C8))							
4	Coefficient c for 3.4 m/s Wind Speed = D7 = (D6-((A7-A6)/(A8-A6))*(D6-D8))							
5	Wind Speed, m/s	a	b	c				
6	2	1.6819	25.5076	-0.2278				
7	3.4	1.2627	28.3173	-0.2315				
8	5	0.7837	31.5283	-0.2358				
	Area Factor for Inhalation Pathway = AFI = (B7/(1 +C7(((SQRT(A10))^D7)))							
9	Area, m^2	AFI						
10	71.8	0.0659						
11								
12	Inhalation Intake = (C*IR*ML*ED*AFI*OFI*UCF1)/(BW*AL*UCF2)							
13	Variable	Value	Description					
14	C	18.2	mg/kg, Maximum concentration of Cadmium in soil					
15	IR	7,300	m^3/yr, Inhalation rate					
16	ML	0.0001	gm/m^3, Mass dust loading for inhalation					
17	ED	30	years, Exposure Duration					
18	AFI	0.659	unitless area factor					
19	OFI	0.44	unitless occupancy factor					
20	UCF1	0.001	kg/gm, Units conversion factor					
21	BW	70	kg, Body weight					
22	AL	70	years, Average lifetime					
23	UCF2	365	days/year, Units conversion factor					
24	CFSi	6.3	kg-day/mg, Cancer slope factor for Cadmium					
25								
26	Inhalation Daily Intake = E31 = (B14*B15*B16*B17*B18*B19*B20)/(B21*B22*B23)							
27	Inhalation Incremental Cancer Risk = E33 = (E31*B24)							
28								
29	Calculated Inhalation Daily Intake =				6.46E-09	mg/kg-day		
30	Cadmium Inhalation Incremental Cancer Risk =				4.07E-08			

CONCLUSIONS:

- Potential human health hazards associated with exposure to noncarcinogenic substances are evaluated by comparing the daily intake over a specified time period (the exposure duration; see Table 1) to a reference dose (the RfD; Table 2). This ratio is the hazard quotient which must be less than 1.0 or the possibility exists for systemic toxicity effects.

  The hazard quotient due to cadmium in the soil ingestion pathway is 1.63E-03 in Table 3 which is less than 1.0. Cadmium does not have a reference dose or hazard quotient in the inhalation pathway.

Washington Closure Hanford CALCULATION SHEET

Originator:	S. W. Clark	Date:	1/27/11	Calc. No.:	0100H-CA-V0147	Rev.:	1
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- The incremental cancer risk due to cadmium in the inhalation pathway is 4.07E-08 in Table 4 which is less than the excess cancer risk guideline of 1.0E-06 for individual carcinogens. Cadmium does not have an incremental cancer risk component in the soil ingestion pathway.

- The site-specific risk assessment for cadmium in the 100-H-51:4 pipeline has determined that the hazard quotient (1.63E-03) and incremental cancer risk (4.07E-08) are less than their respective regulatory limits (a hazard quotient of 1.0 and an incremental cancer risk of 1.0E-06) and therefore attain the remedial action goals and remedial action objectives stated in the RDR/RAWP for the 100 Area.

APPENDIX C

DATA QUALITY ASSESSMENT

APPENDIX C

DATA QUALITY ASSESSMENT

CONFIRMATORY SAMPLING

A data quality assessment (DQA) was performed to compare the confirmatory sampling approach and resulting analytical data with the sampling and data requirements specified in the site-specific sample design (WHC 2010b). 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 2010b), the field logbook (WCH 2010a), 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 Procedure 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).

Confirmatory sample data collected at the 100-H-51:4 subsite were provided by the laboratories in two sample delivery groups (SDGs): SDG K2447 and SDG K2448. SDG K2448 was submitted for third-party validation. No major deficiencies were identified in the analytical data set. Minor deficiencies are discussed as follows below. If no comments are made about a specific analysis, it should be assumed that no deficiencies affecting the quality of the data were found.

SDG K2448

This SDG comprises a field duplicate pair (J1C375/J1C376) of the soil collected from the 100-H-51:4 test pit 5, and one equipment blank (J1C374). These samples were analyzed for inductively coupled plasma (ICP) metals, mercury, polycyclic aromatic hydrocarbons (PAH), and semivolatile organic compounds (SVOCs). SDG K2448 was submitted for third-party validation. Minor deficiencies are as follows:

In the PAH analysis, a surrogate recovery in sample J1C375 was above the quality control (QC) criteria at 204%. The acenaphthene, fluoranthene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, and benzo(g,h,i)perylene results in sample J1C375 were qualified as estimated and flagged "J" by third-party validation. The data are useable for decision-making purposes.

In the PAH analysis, the matrix spike (MS) recovery for benzo(a)anthracene is below the QC criteria at 49%. Third-party validation considered the results for benzo(a)anthracene estimated and flagged "J". The data are useable for decision-making purposes.

In the SVOC analysis, the MS and matrix spike duplicate (MSD) results for 4-chloroanaline are below the QC criteria at 33% and 42%, respectively. The MS and MSD results for pentachlorophenol are below the QC criteria at 28% and 44%, respectively. The MS results for 1,2,4-trichloroethane (37%), 1,2-dichlorobenzene (44%), 1,3-dichlorobenzene (38%), 1,4-dichlorobenzene (39%), 2,4,5-trichlorophenol (46%), 2,4,6-trichlorophenol (44%), 2,4-dichlorophenol (41%), 2,4-dimethylphenol (39%), 2,4-dinitrophenol (47%), 2-methylnaphthalene (44%), 2-nitrophenol (40%), 3,3-dichlorobenzidine (43%), 4-chloro-3-methylphenol (43%), 4-nitroanaline (48%), 4-nitrophenol (31%), bis(2-chloroethoxy)methane (41%), bis(2-chloroethyl)ether (47%), bis(2-chloroisopropyl)ether (49%), hexachlorobutadiene (40%), hexachlorocyclopentadiene (28%), hexachloroethane (36%), isophorone (39%), naphthalene (41%), and nitrobenzene (40%) are all below the QC criteria. The laboratory control sample (LCS) recoveries for 2,4-dinitrophenol (17%), 4,6-dinitro-2-methylphenol (26%), 4-chloroanaline (43%), hexachlorocyclopentadiene (38%), and pentachlorophenol (14%) are below the QC criteria. Third-party validation considered the results for these SVOCs estimated and flagged "J." The data are useable for decision-making purposes.

In the SVOC analysis, the MS/MSD relative percent differences (RPDs) for all SVOC results except 4-chloroanaline and benzo(b)fluoranthene are above the QC limit of 30%. The results for all SVOCs in SDG K2448 except 4-chloroanaline and benzo(b)fluoranthene were considered estimated and flagged "J" by third-party validation. The data are useable for decision-making purposes.

In the ICP metals analysis, the MS recoveries were out of project acceptance criteria for six analytes (aluminum, iron, mercury, manganese, antimony, and silicon). For most constituents the spiking concentration was insignificant compared to the native concentration in the sample from which the MS was prepared. The deficiency in the MS is a reflection of the analytical variability of the native concentration rather than a measure of the recovery from the sample. Antimony and mercury did not have mismatched spike and native concentrations in the original MS. The original MS recovery for antimony and mercury were 46% and 137%, respectively. All antimony data for SDG K2448 and the detected mercury results (J1C375 and J1C376) were considered estimated and flagged "J" by third-party validation due to the MS recoveries outside the QC limits. Estimated data are useable for decision-making purposes.

In the ICP metals analysis, the RPD for manganese is above the QC limit of 30% at 47%. The manganese results were considered estimated and flagged "J" by third-party validation. The data are useable for decision-making purposes.

SDG K2447

This SDG comprises the pipe contents sample (J1C367) from the 100-H-51:4 test pit 5. This sample was analyzed for ICP metals, mercury, PAH, and SVOC. Minor deficiencies are as follows:

In the PAH analysis, the MS and MSD recoveries for benzo(b)fluoranthene are outside the QC criteria at 172% and 22%, respectively. The MSD recoveries for naphthalene (373%),

fluoranthene (26%), pyrene (716%), chrysene (660%), dibenz(a,h)anthracene (16%), and benzo(g,h,i)perylene (32%) are all outside the QC criteria. The results for these PAH may be considered estimated. The data are useable for decision-making purposes.

In the SVOC analysis, the MS and MSD results for 2,4-dinitrophenol, 3,3-dichlorobenzidine, 4-chloroanaline, 4-nitroanaline, 4-nitrophenol, hexachlorocyclopentadiene, pentachlorophenol, and 3-nitroanaline are all below the QC criteria at 0%. The MS and MSD for 4,6-dinitro-2-methylphenol are 29% and 31%, below the QC criteria. The MS and MSD results for hexachloroethane are below the QC criteria at 48% and 36%. The MSD results for 1,2,4-trichlorobenzene (47%), 1,2-dichlorobenzene and 1,3-dichlorobenzene (46%), 1,4-dichlorobenzene (45%), 2,4,5-trichlorophenol (49%), 2,4-dichlorophenol (46%), 2,4-dinitrotoluene (46%), 2-methylphenol (48%), 2-nitroanaline (0%), 2-nitrophenol (41%), 4-chloro-3-methylphenol (0%), bis(2-chloroethoxy)methane (46%), bis(2-chloroethyl)ether (44%), bis(2-chloroisopropyl)ether (49%), isophorone (36%), nitrobenzene (40%), and n-nitrosodi-n-propylamine (47%) are all below the QC criteria. The LCS recoveries for 2,4-dinitrophenol (17%), 4,6-dinitro-2-methylphenol (26%), 4-chloroanaline (43%), hexachlorocyclopentadiene (38%), and pentachlorophenol (14%) are below the QC criteria. The results for these SVOCs may be considered estimated. The data are useable for decision-making purposes.

In the SVOC analysis, the MS/MSD RPDs for 1,2-dichlorobenzene (32%), 2,4-dichlorophenol (30%), 2,4-dimethylphenol (34%), 2,4-dinitrotoluene (42%), 2-nitrophenol (30%), bis(2-chloroethoxy)methane (34%), butyl benzyl phthalate (34%), n-nitrosodiphenylamine (32%), and pyrene (31%) are above the QC limit of 30%. The results for these SVOCs in SDG K2447 may be considered estimated. The data are useable for decision-making purposes.

In the ICP metals analysis, the MS recoveries were out of project acceptance criteria for twelve analytes (aluminum, cadmium, calcium, chromium, copper, iron, magnesium, manganese, mercury, antimony, silicon, and zinc). For aluminum, iron, mercury, and silicon, the spiking concentration was insignificant compared to the native concentration in the sample from which the MS was prepared. The deficiency in the MS is a reflection of the analytical variability of the native concentration rather than a measure of the recovery from the sample. Antimony, cadmium, calcium, chromium, copper, magnesium, manganese, and zinc did not have mismatched spike and native concentrations in the original MS. The original MS recovery for antimony, cadmium, calcium, chromium, copper, magnesium, manganese, and zinc were 46%, 27%, 52%, 69%, 28%, 64%, 21%, and 19%. All antimony, cadmium, calcium, chromium, copper, magnesium, manganese, and zinc data for SDG K2447 may be considered estimated. Estimated data are useable for decision-making purposes.

In the ICP metals analysis, the RPD for silver is above the QC limit of 30% at 34%. The silver result may be considered estimated. The data is useable for decision-making purposes.

FIELD QUALITY ASSURANCE/QUALITY CONTROL

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

Field quality assurance/quality control (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 2010a), are the primary and duplicate samples (J1C375/J1C376). The main and QA/QC sample results are presented in Appendix B.

Field duplicate samples are collected to provide a relative measure of the degree of local heterogeneity in the sampling medium, unlike laboratory duplicates that are used to evaluate precision in the analytical process. The field duplicates are evaluated by computing the RPD of the sample/duplicate pair(s) for each contaminant of potential concern (COPC). RPDs are not calculated for analytes that are not detected in both the main and duplicate sample at more than 5 times the target detection limit. RPDs of analytes detected at low concentrations (less than 5 times the detection limit) are not considered to be indicative of the analytical system performance. The RPD calculation brief in Appendix B provides details on duplicate pair evaluation and RPD calculation.

The RPD calculated for manganese in the duplicate sample (J1C376) is above the acceptance criteria of 30% at 72.1%. A secondary check of the data variability is used when one or both of the samples being evaluated (main and duplicate) is less than 5 times the target detection limit (TDL), including undetected analytes. In these cases, a control limit of ± 2 times the TDL is used (Appendix B) to indicate that a visual check of the data is required by the reviewer. No data required this check. A visual inspection of all of the data is also performed. No additional major or minor deficiencies are noted. The data are useable 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-H-51:4 subsite confirmatory 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-H-51:4 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 confirmatory sample analytical data are stored in the Environmental Restoration (ENRE) project-specific database prior to being submitted for inclusion in the Hanford Environmental Information System (HEIS) database. The confirmatory 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, 2010a, *Miscellaneous Sampling*, Logbook EL-1601-04, pp. 95-96, Washington Closure Hanford, Richland, Washington.

WCH, 2010b, *Work Instruction for Confirmatory Sampling of the 100-H-51:4, 100-H Main Gate Storm Drain,* Work Instruction No. 0100H-WI-G0048, Rev. 0, Washington Closure Hanford, Richland, Washington.