CVP-2006-00006
Rev. 0

# Cleanup Verification Package for the 618-8 Burial Ground

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

**August 2006**

# EXECUTIVE SUMMARY

This cleanup verification package documents completion of remedial action for the 618-8 Burial Ground, also referred to as the Solid Waste Burial Ground No. 8, 318-8, and the Early Solid Waste Burial Ground. This site is located in the 300-FF-2 Operable Unit in the 600 Area of the Hanford Site in southeastern Washington State. During its period of operation from 1943 to 1954, the 618-8 site is speculated to have been used to bury uranium-contaminated waste derived from fuel manufacturing, and construction debris from the remodeling of the 313 Building.

Site excavation and waste disposal are complete, and the exposed surfaces have been sampled and analyzed to verify attainment of the remedial action goals. Results of the sampling, laboratory analyses, and data evaluations for the 618-8 site indicate that all remedial action objectives and goals for direct exposure, protection of groundwater, and protection of the Columbia River have been met for industrial land use (Table ES-1).

Because residual soil concentrations indicated that cleanup levels for more stringent land uses may have been achieved for the 618-8 site, a supplemental evaluation was performed against unrestricted land-use cleanup objectives established in the *Explanation of Significant Differences for the 300-FF-2 Operable Unit Record of Decision* (EPA 2004). Results of the evaluation (Table ES-2) demonstrate 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). This site does not have a deep zone; therefore, no deep zone institutional controls are required.

The site meets cleanup standards and has been reclassified as "interim closed out" in accordance with the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1989) and the Waste Site Reclassification Guideline TPA-MP-14 (RL-TPA-90-0001) (DOE-RL 1998). A copy of the waste site reclassification form is included as Attachment ES-1.

## Table ES-1. Summary of Cleanup Verification Results for the 618-8 Waste Site - Industrial Land Use. (2 pages)

| Regulatory Requirement | Remedial Action Goals | Results | Remedial Action Objectives Attained? | Ref. |
|---|---|---|---|---|
| Direct Exposure – Radionuclides | 1. Attain 15 mrem/yr dose rate above background over 1,000 years. | 1. All individual radionuclide COC detections were below background. | Yes | a |
| Direct Exposure – Nonradionuclides | 1. Attain individual COC RAGs. | 1. All individual COC concentrations were below the direct exposure criteria. | Yes | a |
| Nonradionuclide Risk Requirements | 1. Attain hazard quotient of <1 for noncarcinogens. | 1,2. The hazard quotient for selenium, the sole nonradionuclide detected above background, is $2.1 \times 10^{-3}$, which is less than 1. Because selenium is the sole nonradionuclide detected above background, the cumulative hazard quotient is also <1. | Yes | a |
| | 2. Attain cumulative hazard quotient of <1 for noncarcinogens. | | | |
| | 3. Attain excess cancer risk of $<1 \times 10^{-5}$ for individual carcinogens. | 3,4. Excess cancer risk values were not calculated because all nonradionuclide carcinogenic COCs (arsenic and cadmium) were detected below statistical background levels. | | |
| | 4. Attain a total excess cancer risk of $<1 \times 10^{-5}$ for carcinogens. | | | |
| Groundwater/River Protection – Radionuclides | 1. Attain single-COC groundwater and river protection RAGs. | 1. All individual radionuclide COC detections were below background. | Yes | a |
| | 2. Attain National Primary Drinking Water Standards: 4 mrem/yr (beta/gamma) dose rate to target receptor/organs. | 2. All individual radionuclide COC detections were below background. | | |
| | 3. Meet drinking water standards for alpha emitters: the more stringent of the 15 pCi/L MCL or 1/25th of the derived concentration guide per DOE Order 5400.5. | 3. All individual radionuclide COC detections were below background. | | |
| | 4. Meet total uranium standard of 21.2 pCi/L.[b] | 4. Uranium statistical values are below background for this site. | NA | |
| Groundwater/River Protection – Nonradionuclides | 1. Attain individual nonradionuclide groundwater and river cleanup requirements. | 1. Soil cleanup levels for groundwater and river protection have been attained. | Yes | a |

## Table ES-1. Summary of Cleanup Verification Results for the 618-8 Waste Site - Industrial Land Use. (2 pages)

| Regulatory Requirement | Remedial Action Goals | Results | Remedial Action Objectives Attained? | Ref. |
|---|---|---|---|---|
| Other supporting Information | 1. 618-8 Burial Ground Sample Design (Appendix C) | | | c |
| | 2. Closeout Plan for the 618-8 Burial Ground | | | d |

[a] *618-8 Burial Ground Cleanup Verification 95% UCL Calculations*, 0600X-CA-V0058, Washington Closure Hanford, Richland, Washington (Appendix C).
[b] The EPA has promulgated a drinking water MCL of 30 µg/L for total uranium (40 CFR 141.66). Based on the isotopic distribution of uranium on the Hanford Site, the 30 µg/L MCL corresponds to 21.2 pCi/L. Concentration-to-activity calculations are documented in the *Calculation of Total Uranium Activity Corresponding to a Maximum Contaminant Level for Total Uranium of 30 Micrograms per Liter in Groundwater* calculation brief (BHI 2001).
[c] *618-8 Shallow Zone Sampling Plan,* 0300X-CA-V0067, Washington Closure Hanford, Richland, Washington.
[d] *Closeout Plan for the 618-8 Burial Ground*, CCN 126068, Washington Closure Hanford, Richland, Washington (WCH 2006b).
COC = contaminant of concern
NA = not applicable
RAG = remedial action goal
MCL = maximum contaminant level (drinking water standard)
UCL = upper confidence limit

## Table ES-2. Summary of Cleanup Verification Results for the 618-8 Waste Site - Unrestricted Land Use. (2 Pages)

| Regulatory Requirement | Remedial Action Goals | Results | Remedial Action Objectives Attained? | Ref. |
|---|---|---|---|---|
| Direct Exposure – Radionuclides | 1. Attain 15 mrem/yr dose rate above background over 1,000 years. | 1. All individual radionuclide COC detections were below background. | Yes | a |
| Direct Exposure – Nonradionuclides | 1. Attain individual COC RAGs. | 1. All individual COC concentrations were below the direct exposure criteria. | Yes | a |
| Nonradionuclide Risk Requirements | 1. Attain hazard quotient of <1 for noncarcinogens. | 1,2. The hazard quotient for selenium, the sole nonradionuclide detected above background, is $2.1 \times 10^{-3}$, which is less than 1. Because selenium is the sole nonradionuclide detected above background, the cumulative hazard quotient is also <1. | Yes | a |
| | 2. Attain cumulative hazard quotient of <1 for noncarcinogens. | | | |
| | 3. Attain excess cancer risk of $<1 \times 10^{-6}$ for individual carcinogens. | 3,4. Excess cancer risk values were not calculated because all nonradionuclide carcinogenic COCs (arsenic and cadmium) were detected below statistical background levels. | | |
| | 4. Attain a total excess cancer risk of $<1 \times 10^{-5}$ for carcinogens. | | | |
| Groundwater/River Protection – Radionuclides | 1. Attain single-COC groundwater and river protection RAGs. | 1. All individual radionuclide COC detections were below background. | Yes | a |

## Table ES-2. Summary of Cleanup Verification Results for the 618-8 Waste Site - Unrestricted Land Use. (2 Pages)

| Regulatory Requirement | Remedial Action Goals | Results | Remedial Action Objectives Attained? | Ref. |
|---|---|---|---|---|
| | 2. Attain National Primary Drinking Water Standards: 4 mrem/yr (beta/gamma) dose rate to target receptor/organs. | 2. All individual radionuclide COC detections were below background. | | |
| | 3. Meet drinking water standards for alpha emitters: the more stringent of the 15 pCi/L MCL or 1/25th of the derived concentration guide per DOE Order 5400.5. | 3. All individual radionuclide COC detections were below background. | | |
| | 4. Meet total uranium standard of 21.2 pCi/L.[b] | 4. Uranium statistical values are below background for this site. | NA | |
| Groundwater/River Protection – Nonradionuclides | 1. Attain individual nonradionuclide groundwater and river cleanup requirements. | 1. Soil cleanup levels for groundwater and river protection have been attained. | Yes | a |
| Other supporting Information | 1. 618-8 Burial Ground Sample Design (Appendix C) | | | c |
| | 2. Closeout Plan for the 618-8 Burial Ground | | | d |

[a] *618-8 Burial Ground Cleanup Verification 95% UCL Calculations*, 0600X-CA-V0058, Washington Closure Hanford, Richland, Washington (Appendix C).
[b] The EPA has promulgated a drinking water MCL of 30 µg/L for total uranium (40 CFR 141.66). Based on the isotopic distribution of uranium on the Hanford Site, the 30 µg/L MCL corresponds to 21.2 pCi/L. Concentration-to-activity calculations are documented in the *Calculation of Total Uranium Activity Corresponding to a Maximum Contaminant Level for Total Uranium of 30 Micrograms per Liter in Groundwater* calculation brief (BHI 2001).
[c] *618-8 Shallow Zone Sampling Plan,* 0300X-CA-V0067, Washington Closure Hanford, Richland, Washington.
[d] *Closeout Plan for the 618-8 Burial Ground*, CCN 126068, Washington Closure Hanford, Richland, Washington (WCH 2006a).
COC = contaminant of concern
NA = not applicable
RAG = remedial action goal
MCL = maximum contaminant level (drinking water standard)
UCL = upper confidence limit

# Attachment ES-1
# Waste Site Reclassification Form

| | | |
|---|---|---|
| **Date Submitted:** 7/10/06<br><br>**Originator:** L. M. Dittmer<br><br>**Phone:** 372-9664 | **Operable Unit(s):** 300-FF-2<br><br>**Waste Site ID:** 618-8<br><br>**Type of Reclassification Action:**<br>Rejected ☐<br>Closed Out ☐<br>Interim Closed Out ☒<br>No Action ☐ | **Control Number:** 2006-036<br><br>**Lead Agency:** EPA |

This form documents agreement among the parties listed below authorizing classification of the subject unit as rejected, closed out, or no action and authorizing backfill of the site, if appropriate. Final removal from the National Priorities List of no action or closed-out sites will occur at a future date.

**Description of current waste site condition:**

Remedial actions at this site have been performed in accordance with remedial action objectives and goals established by the U.S. Environmental Protection Agency and the U.S. Department of Energy, Richland Operations Office, in concurrence with the Washington State Department of Ecology. The selected remedial action involved (1) excavating the site to the extent required to meet specified soil cleanup levels, (2) disposing of contaminated excavation materials at the Environmental Restoration Disposal Facility in the 200 Area of the Hanford Site, and (3) backfilling the site with clean soil to adjacent grade elevations.

**Basis for reclassification:**

The 618-8 waste site has been remediated to meet the cleanup standards specified in the *Interim Action Record of Decision for the 300-FF-2 Operable Unit,* U.S. Environmental Protection Agency, Region 10, Seattle, Washington. Remedial actions were performed to support future industrial land use and to protect groundwater and the Columbia River. Further, the residual contaminant concentrations achieved 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). This site has no deep zone; therefore, no deep zone institutional controls are required. The basis for reclassification is described in detail in the *Cleanup Verification Package for the 618-8 Burial Ground* (CVP-2006-00006), Washington Closure Hanford, Richland, Washington.

| | | |
|---|---|---|
| D. C. Smith<br>DOE-RL Project Manager | Signature | 8/7/06<br>Date |
| NA<br>Ecology Project Manager | Signature | Date |
| A. L. Boyd<br>EPA Project Manager | A. L. Boyd<br>Signature | 8/7/06<br>Date |

## CONTENTS

## APPENDICES



## FIGURES



## TABLES

## ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| COC | contaminant of concern |
| CVP | cleanup verification package |
| DQA | data quality assessment |
| EPA | U.S. Environmental Protection Agency |
| ERDF | Environmental Restoration Disposal Facility |
| GPR | ground-penetrating radar |
| MTCA | *Model Toxics Control Act* |
| RAG | remedial action goal |
| RAO | remedial action objective |
| RDR/RAWP | remedial design report/remedial action work plan |
| RESRAD | RESidual RADioactivity (dose assessment model) |
| ROD | record of decision |
| SAP | sampling and analysis plan |
| UCL | upper confidence limit |
| WAC | *Washington Administrative Code* |

# 1.0 INTRODUCTION

This cleanup verification package (CVP) documents that the 618-8 waste site was remediated in accordance with the *Interim Action Record of Decision for the 300-FF-2 Operable Unit, Hanford Site, Benton County, Washington* (ROD) (EPA 2001). Remedial action objectives (RAOs) and remedial action goals (RAGs) for this site are documented in the ROD (EPA 2001) and the *Remedial Design Report/Remedial Action Work Plan for the 300 Area* (RDR/RAWP) (DOE-RL 2004a). The ROD provides the U.S. Department of Energy, Richland Operations Office, the authority, guidance, and objectives to conduct this remedial action.

The remedy specified in the ROD for the 618-8 waste site included (1) excavating the site to the extent required to meet specified soil cleanup levels, (2) disposing of contaminated excavation materials at the Environmental Restoration Disposal Facility (ERDF) in the 200 Area of the Hanford Site, and (3) backfilling the site with clean soil to average adjacent grade elevation. Excavation was driven by RAOs for direct exposure, protection of groundwater, and protection of the Columbia River. For the respective points of compliance, RAGs summarized in Table 1 were established for the contaminants of concern (COCs) in the RDR/RAWP (DOE-RL 2004b). Preliminary waste site COCs were identified in the *300 Area Remedial Action Sampling and Analysis Plan* (SAP) (DOE-RL 2004a). Following excavation of the site, final COCs were identified in the *Closeout Plan for the 618-8 Burial Ground* (WCH 2006a) and are presented in Table 1.

**Table 1. Summary of Remedial Action Goals – Industrial Land Use. (2 Pages)**

| Contaminants of Concern | Soil Cleanup Level for Direct Exposure[a] (pCi/g) | Soil Cleanup Level for Groundwater Protection[b] (pCi/g) | Soil Cleanup Level for River Protection (pCi/g) |
|---|---|---|---|
| ***Radionuclides*** | | | |
| Uranium-233/234 | 169[c] | 129[d] | 129[d] |
| Uranium-235 | 17[c] | 13[d] | 13[d] |
| Uranium-238 | 165[c] | 125[d] | 125[d] |
| **Contaminants of Concern** | **Soil Cleanup Level for Direct Exposure (mg/kg)** | **Soil Cleanup Level for Groundwater Protection[b] (mg/kg)** | **Soil Cleanup Level for River Protection[b] (mg/kg)** |
| ***Nonradionuclides*** | | | |
| Arsenic | 58[e] | NA[f] | NA[f] |
| Barium | 4,900[e] | NA[f] | NA[f] |
| Cadmium | 139[e] | NA[f] | NA[f] |

**Table 1. Summary of Remedial Action Goals – Industrial Land Use.
(2 Pages)**

| Contaminants of Concern | Soil Cleanup Level for Direct Exposure (mg/kg) | Soil Cleanup Level for Groundwater Protection[b] (mg/kg) | Soil Cleanup Level for River Protection[b] (mg/kg) |
|---|---|---|---|
| ***Nonradionuclides (cont.)*** | | | |
| Chromium | >1,000,000 | NA[f] | NA[f] |
| Lead | 1,000 | NA[f] | NA[f] |
| Selenium | 400 | 5[g] | 1[h] |
| Silver[i] | 400 | 8 | 0.73 |
| Uranium (total) | 505[j] | 385[j] | 385[j] |

[a] Listed values represent a 15 mrem/yr dose for the industrial exposure scenario.
[b] Groundwater protection values represent soil concentrations that will be protective of groundwater. River protection values represent soil concentrations that will not cause applicable river cleanup standards to be exceeded as contaminants migrate through the soil column to the river. Listed values are calculated by RESRAD, based on applicable river cleanup standards in the RDR/RAWP (DOE-RL 2004b).
[c] Direct exposure lookup values for uranium isotopes calculated using secular equilibrium isotopic ratios and the selected soil cleanup level for total uranium under the industrial exposure-scenario (350 pCi/g), as provided in the RDR/RAWP (DOE-RL 2004b).
[d] Soil lookup values for the protection of groundwater and the Columbia River for uranium isotopes calculated using secular equilibrium isotopic ratios and the selected soil cleanup level for total uranium under the industrial exposure-scenario (267 pCi/g), as provided in the RDR/RAWP (DOE-RL 2004b).
[e] Cleanup limit based on the inhalation exposure pathway per WAC 173-340-750(4)(b)(ii)(a) or (b).
[f] The RESRAD model predicts that the constituent will not reach groundwater within 1,000 years based on a generic site profile (4.6 m [15 ft] contaminated zone and 6m [19.6 ft] uncontaminated zone).
[g] Soil RAG for groundwater protection calculated from WAC 173-303-740(3)(a)(ii)(A), 1996 ("100 times rule") and the MCL (40 CFR 141).
[h] Soil RAG for river protection calculated from WAC 173-340-740(3)(a)(ii)(A), 1996 ("100 time rule") and a dilution attenuation factor of 2, using the ambient water quality criteria provided in WAC 173-201A-040, 1995.
[i] No value is provided for this constituent in the RDR/RAWP (DOE-RL 2004b); values for silver are determined based on WAC 173-340-740, 1996.
[j] Based on the calculated isotopic distribution of uranium in the 300 Area and cleanup levels of 350 pCi/g and 267 pCi/g for total uranium, the corresponding uranium concentration is 505 mg/kg and 385 mg/kg, respectively (BHI 2002) for the 300-FF-2 Operable Unit sites.

MCL = maximum contamination level (drinking water standard)
NA = not applicable
RAG = remedial action goal
RDR/RAWP = remedial design report/remedial action work plan
RESRAD = RESidual RADioactivity (dose assessment model)
WAC = *Washington Administrative Code*

Soil cleanup levels were established in the interim action ROD based on a limited ecological risk assessment. Although not required by the interim action ROD, a comparison against ecological risk screening levels has been made for the site COCs. Screening values were not exceeded for the COCs for this site, with the exception of selenium. Exceedance of screening values does not necessarily indicate the existence of risk to ecological receptors. It is believed that the presence of selenium at this site does not pose a risk to ecological receptors because the statistical concentration of selenium is within the range of natural site background (Ecology 1994). A baseline risk

assessment for the river corridor portion of the Hanford Site began in 2004, which includes a more complete quantitative ecological risk assessment. That baseline risk assessment will be used as part of the final closeout decision for this site.

## 2.0 SITE DESCRIPTION AND SUPPORTING INFORMATION

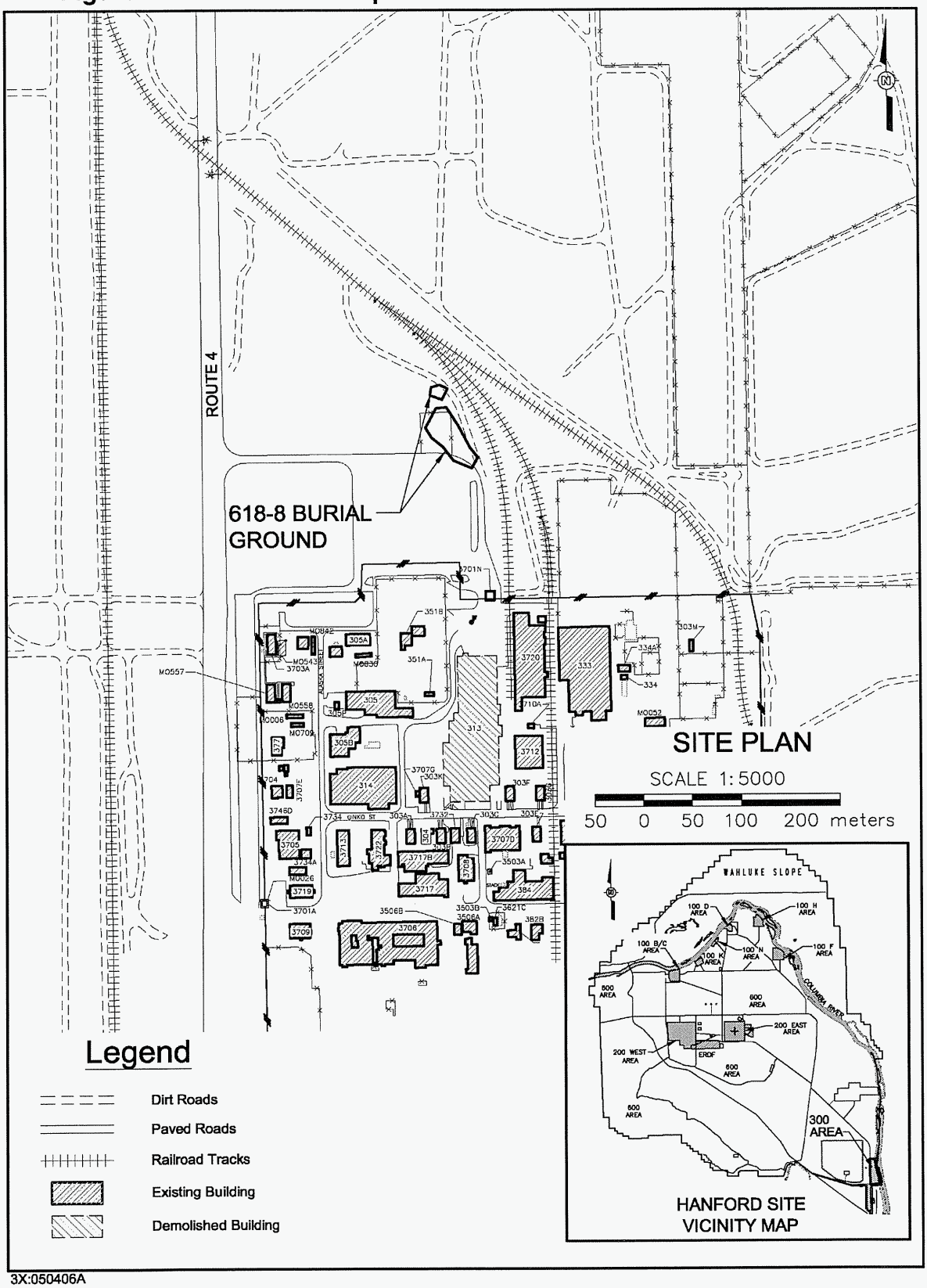
The 618-8 waste site is part of the 300-FF-2 Operable Unit in the 300 Area. The site was reportedly located north of the 300 Area, beneath a portion of the 300 Area North Parking Lot (in the vicinity of Washington State Plane coordinates E 593820, N 116410), and in an area immediately north of the parking lot (in the vicinity of Washington State Plane coordinates E 593820, N 116480) (Figure 1). The burial ground was reported to be a rectangular shaped area approximately 183 m (600 ft) long by 31 m (100 ft) wide. The waste site was believed to include the area under the parking lot, because when the North Parking Lot was constructed (sometime in the early 1950s), brass medallions were placed in the asphalt to delineate the presence of an Underground Contaminated Material Area. The waste site was also believed to include the area north of the parking lot because this area was delineated by "post and chain" boundary markers with signs identifying it as an Underground Contaminated Material Area (WCH 2006a).

Information on dates of operation and burial ground inventory are limited. However, it has been speculated that the segment located under the parking lot may have been used in 1943 and 1944 to bury uranium-contaminated waste derived from uranium fuel manufacturing. The area north of the parking lot was speculated to have been used in the mid 1950s to bury uranium-contaminated waste and construction debris from the 1954 remodeling of the 313 Building (WCH 2006a).

Early characterization investigations at the 618-8 Burial Ground included a series of *in situ* gamma spectral measurements, performed in September 1980. These measurements were performed to determine the nature and extent of radiological contamination at the waste site. Results of the investigation indicated that the radiological contamination was found primarily within established "post and chain" boundaries associated with the area located north of the parking lot. The radiological contamination identified in this investigation consisted exclusively of uranium isotopes, primarily uranium-235 and uranium-238.

Additional characterization included geophysical, ground-penetrating radar (GPR) surveys performed in 1987. These GPR surveys identified two distinct areas containing substantial amounts of buried waste in the areas located north of the parking lot (inside the area previously delineated by the "post and chain" boundaries). The GPR surveys could not identify a traditional trench configuration or evidence of buried waste under the area delineated by the medallions in the parking lot. Subsequent test excavations and trenching performed at the parking lot area did not expose any evidence of buried waste or debris in that area. A total of eight soil samples were collected from soil

**Figure 1. Hanford Site Map and Location of the 618-8 Burial Ground.**




3X:050406A

removed during the trenching and test excavations (WCH 2006b). These samples were analyzed for *Resource Conservation and Recovery Act of 1976* metals and a wide range of radionuclides. Analytical results showed all results were either undetected or detected below lookup values. As a result, the area under the parking lot was not excavated further. Results of the parking lot test pit/trenching investigation are documented in WCH (2006b).

# 3.0 REMEDIAL ACTION FIELD ACTIVITIES

## 3.1 EXCAVATION AND DISPOSAL

Remedial action activities at the 618-8 waste site began on November 1, 2004, and were completed on November 8, 2004. Remediation involved excavation and staging of clean overburden material and removal of contaminated soil to the extent required to satisfy the RAOs and corresponding RAGs. Excavated material consisted of soil and a wide variety of construction-type debris. Some land disposal restricted materials (primarily three metal drums) were identified and separated from the bulk soil and debris during excavation and sorting operations. Sorting and sampling of the excavated soil and debris was performed in a designated staging pile area. The staging pile area used for the 618-8 waste site also supported the 618-2 and 618-3 Burial Ground excavations and will be closed out with the 618-2 waste site. Subsequent to sorting and receipt of sampling results, the "released" material was loaded into ERDF containers and transported to the ERDF for disposal. Segregated land disposal restricted materials were subsequently loaded out and transported to the ERDF under a separate waste profile. In December 2004, load-out operations at the 618-8 Burial Ground staging piles were suspended, due to the discovery of plutonium-contaminated waste at the 618-2 Burial Ground. As part of mitigation actions to stabilize excavated waste and debris from 618-2 Burial Ground, a soil cover was placed on all stockpiled material from the 618-8 Burial Ground.

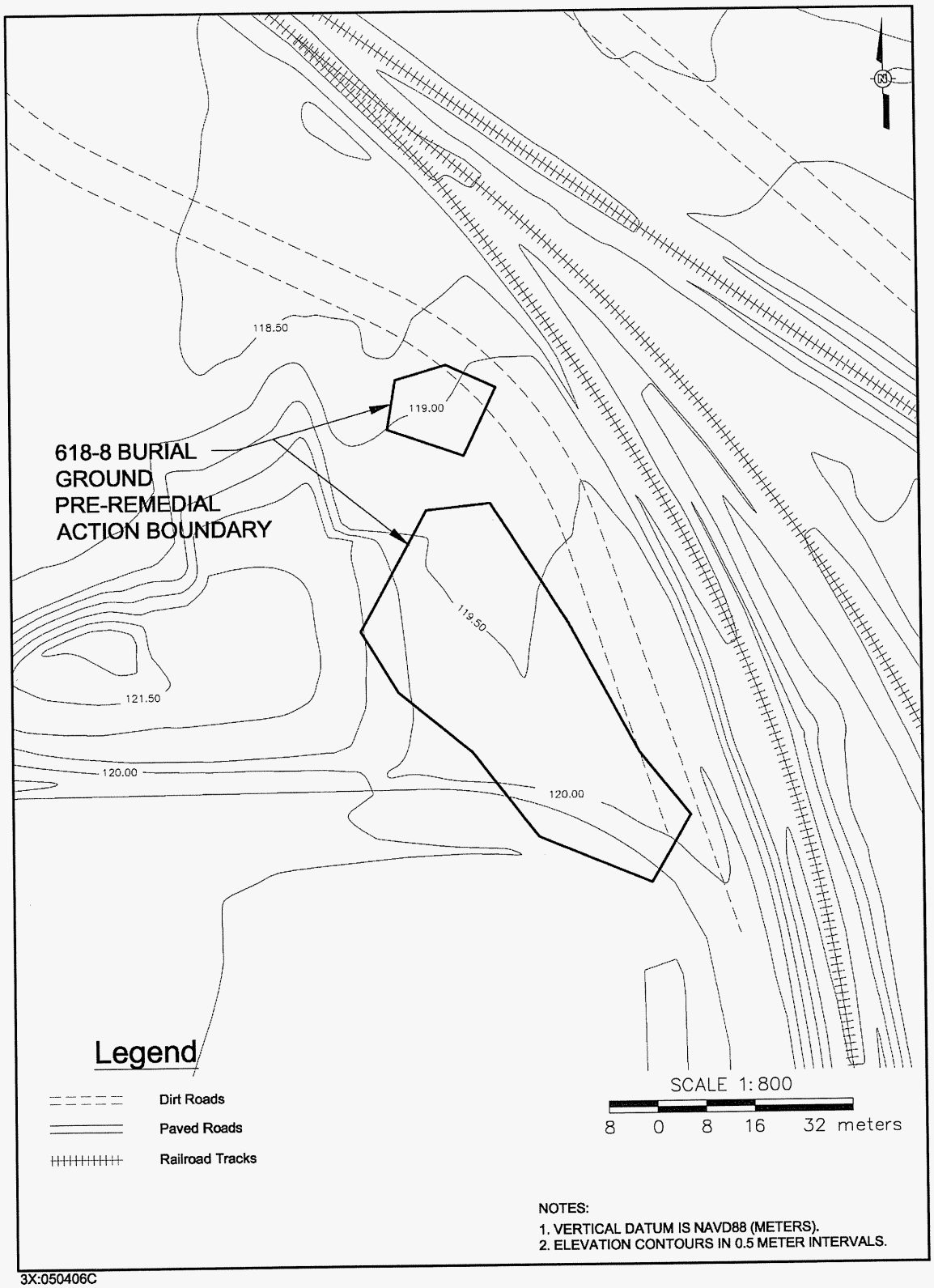
Load-out of the 618-8 stockpiled material resumed on September 1, 2005, and was completed on September 13, 2005. Approximately 6,462 metric tons (7,125 U.S. tons) of material from the site was removed and disposed at the ERDF. Pre- and post-remediation topographic maps are shown in Figures 2 and 3.

There was no indication of bulk liquid waste disposal observed during excavation of the 618-8 waste site.

## 3.2 FIELD SCREENING

Post-excavation radiological surveys of the 618-8 waste site floor were performed in December 2005. The field radiological measurements survey results did not identify any residual radiological contamination above background levels. The radiological survey maps are included as Figures 4 and 5.

**Figure 2. Pre-Remediation Topographic Plan for the Western Portion of the 618-8 Waste Site.**




3X:050406C

**Figure 3. Post-Remediation Topographic Plan for the Western Portion of the 618-8 Waste Site.**

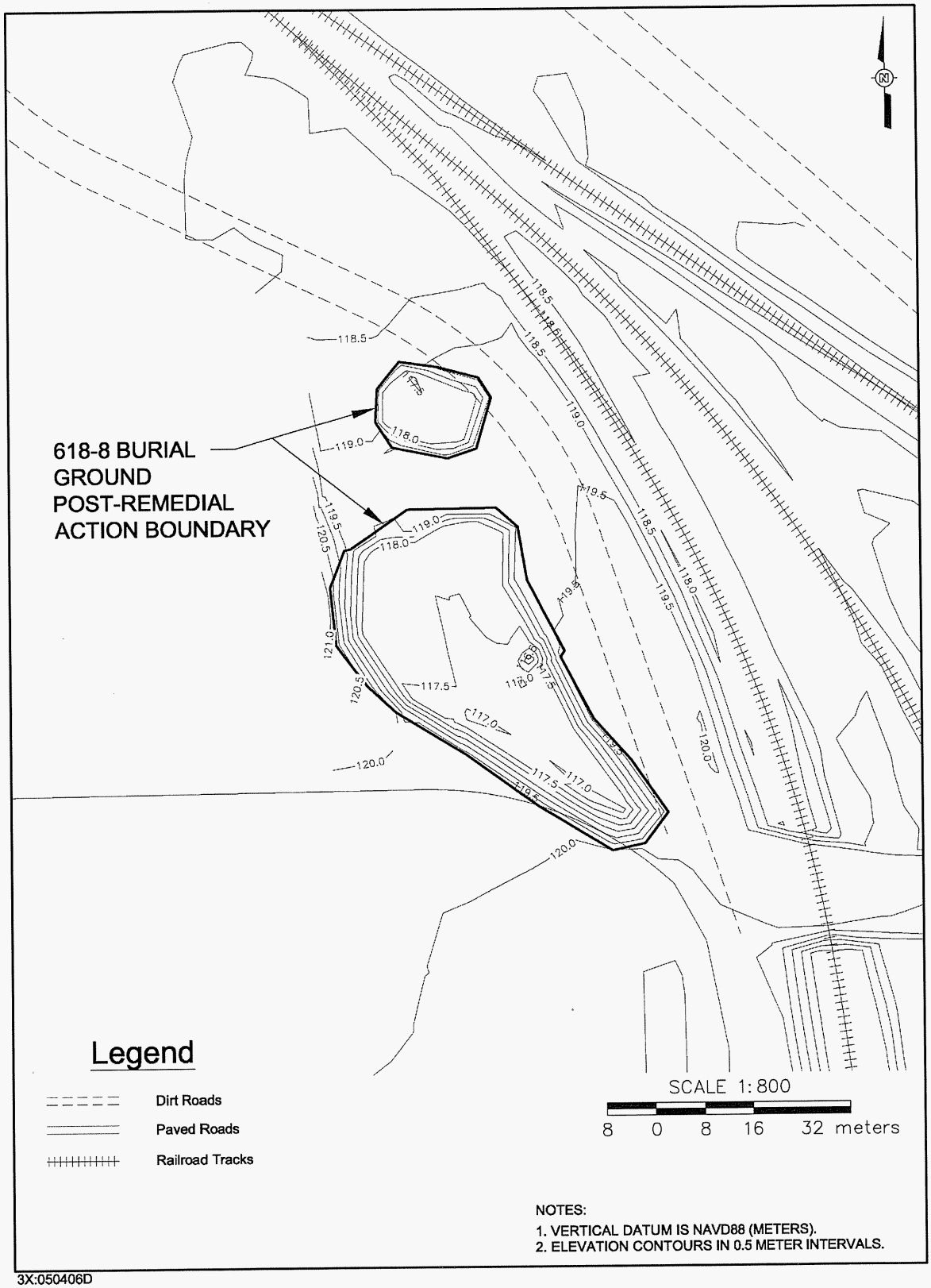


**Figure 4. 618-8 Burial Ground Radiological Survey Results.**

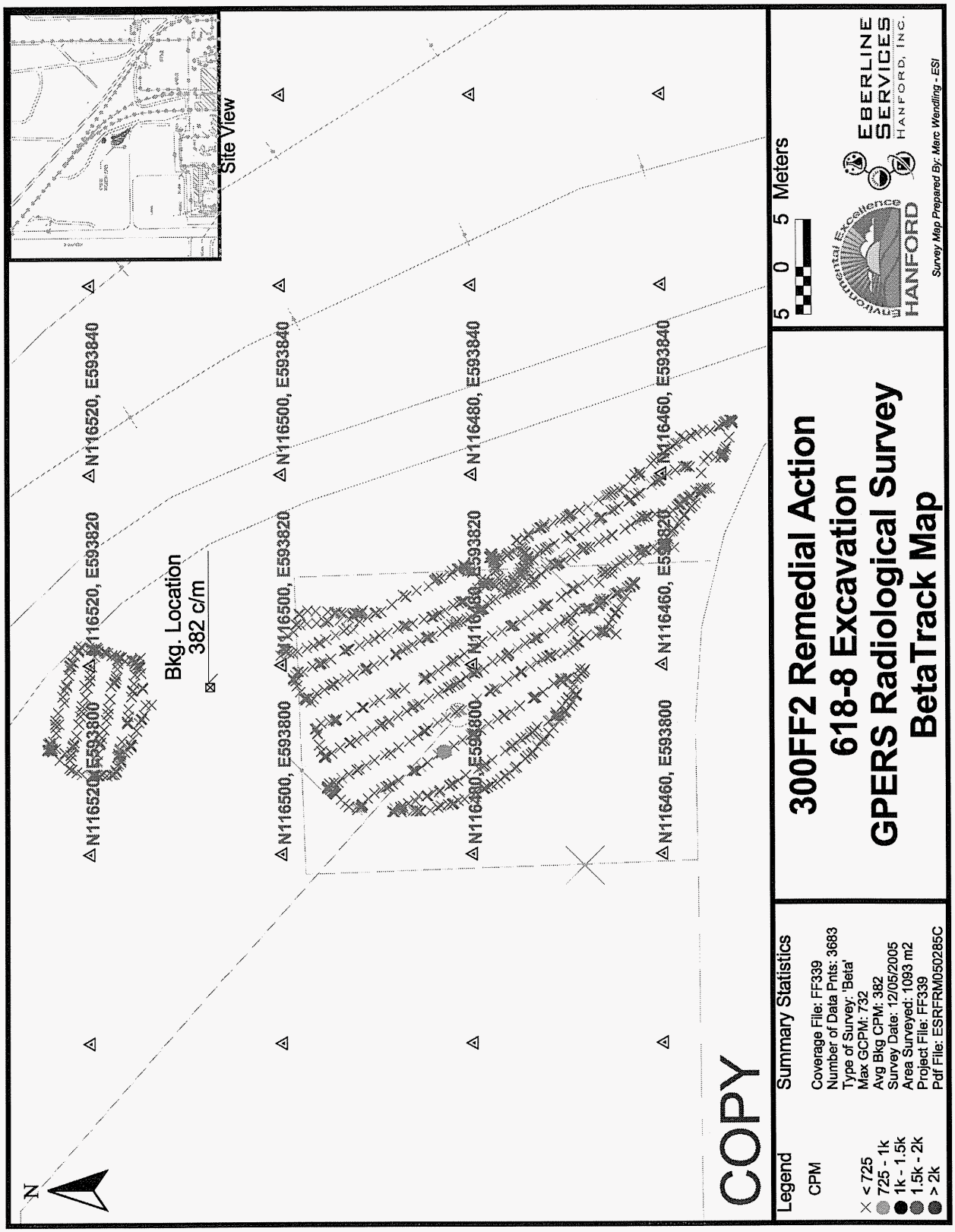
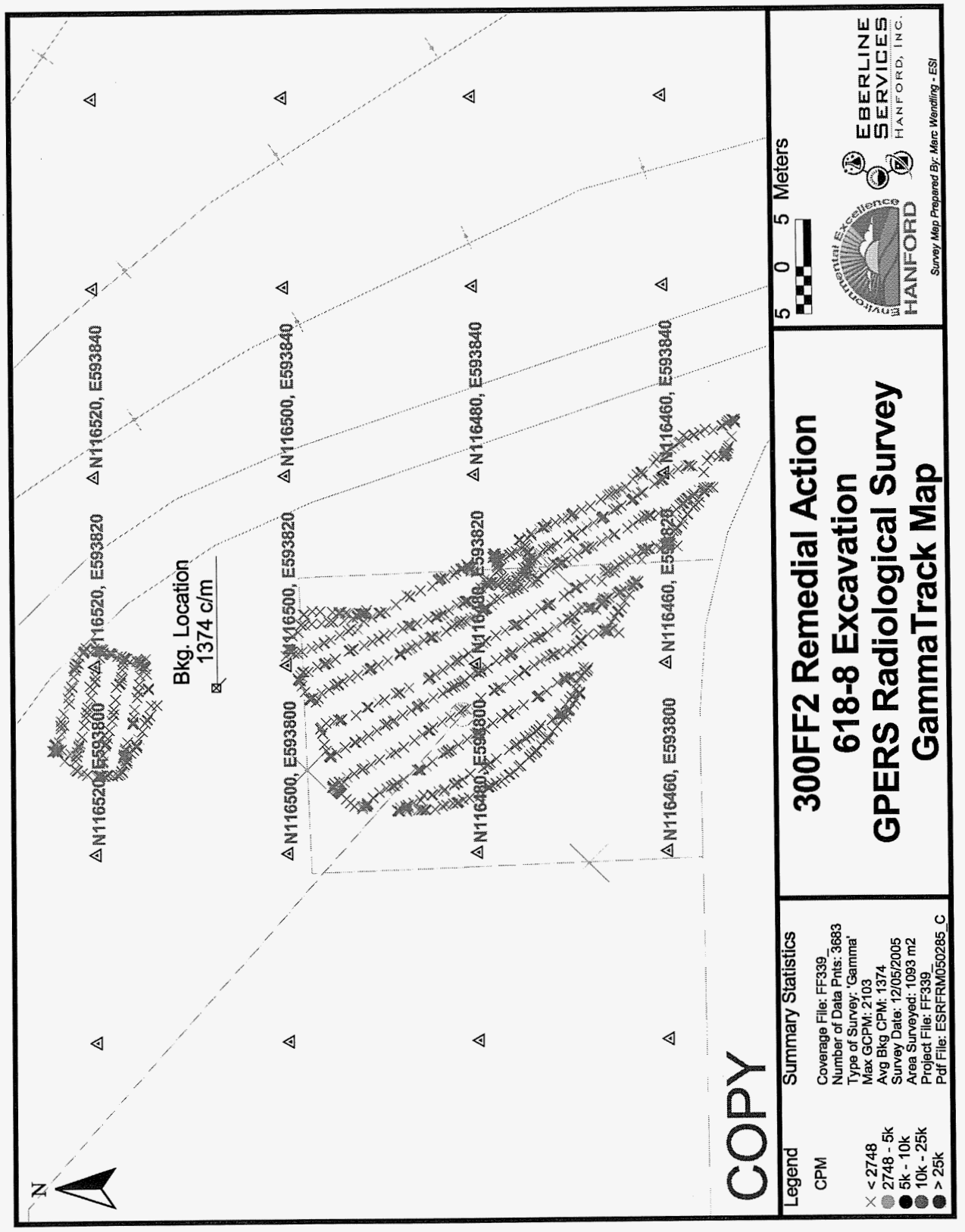


**Figure 5. 618-8 Burial Ground Radiological Survey Results.**



## 3.3 CLEANUP VERIFICATION SAMPLING AND ANALYSIS

Final cleanup verification sampling was conducted on January 31, 2006. The verification samples were submitted to offsite laboratories for analysis using approved U.S. Environmental Protection Agency analytical methods as required per the SAP (DOE-RL 2004a). Each verification sample was composed of a composite sample formed by combining soil collected at the required number of randomly selected locations within each sampling area (excluding the quality assurance/quality control samples).

The 618-8 waste site excavation has only a shallow zone decision unit, as shown on the sample design figure (Appendix C), inclusive of the excavation sidewalls and floors. Direct exposure, groundwater protection, and river protection RAGs are all applicable to shallow zone soils (i.e., soils within 4.6 m [15 ft] of the ground surface). Based on the size of the remediation footprint, the 618-8 shallow zone decision unit is comprised of one decision subunit, divided into four sampling areas (DOE-RL 2004a). All sampling areas were further divided into 16 sampling nodes, each as shown in the sample design methodology and sample location figures presented in the calculation brief in Appendix C. The analytical results for the samples were used for the purposes of statistical calculations, as described in the cleanup verification calculation brief (Appendix C).

# 4.0 CLEANUP VERIFICATION DATA EVALUATION

This section presents the evaluation and modeling of the 618-8 cleanup verification data for comparison with the data quality criteria and RAGs.

## 4.1 DATA QUALITY ASSESSMENT PROCESS

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

The DQA for the 618-8 waste site determined that the data are of the right type, quality, and quantity to support site verification decisions within specified error tolerances. All analytical data were found to be acceptable for decision-making purposes. The evaluation also verified that the sample design was sufficient to support clean site verification. The analytical data are stored in the Environmental Restoration database prior to being transferred to the Hanford Environmental Information System and are summarized in Appendix A. The detailed DQA is presented in Appendix B.

## 4.2 CONTAMINANTS OF CONCERN 95% UPPER CONFIDENCE LIMIT

The primary statistical calculation to support cleanup verification is the 95% upper confidence limit (UCL) on the arithmetic mean of the data. The 95% UCL values for each COC are computed for the decision unit. Prior to calculating the 95% UCL, the individual sample results are reviewed and, as appropriate, adjusted per the SAP (DOE-RL 2004a). This process is summarized below.

### 4.2.1 Radionuclides

For radionuclides, the laboratory-reported value is used in the calculation of the 95% UCL. In cases where the laboratory does not report a value for data qualified with a "U" (i.e., less than the detection limit), one-half of the minimum detectable activity is used in the calculation of the 95% UCL.

### 4.2.2 Nonradionuclides

For nonradionuclides, a value equal to one-half the practical quantitation limit is used for data flagged with a "U" (i.e., less than the detection limit) in the calculation of the 95% UCL, as required by *Washington Administrative Code* (WAC) 173-340-740[7][g]. If greater than half of the sample results for a given nonradionuclide COC are below detection, the statistical value is set equal to the maximum concentration detected (i.e., versus computing a 95% UCL).

Statistical calculations for 618-8 verification data are presented in the 95% UCL calculation brief (Appendix C), with results shown in Table 2. The columns on the left side of Table 2 are the COCs and the 95% statistical values before subtraction of background. The third column of Table 2 presents the background, and the last column presents the statistical values adjusted for background, if appropriate, which becomes the cleanup verification data set used for evaluation against RAGs. All of the COCs for the 618-8 site were detected below background in the verification samples, with the exception of selenium, which was detected slightly above background. Individual sample cleanup verification results are presented in Appendix A.

**Table 2. Cleanup Verification Data Set. (2 Pages)**

| COCs | 95% UCL Statistical Values[a] | Hanford Site Background | Shallow Zone Cleanup Verification Data Set[b] |
|---|---|---|---|
| ***Radionuclide Concentration (pCi/g)*** | | | |
| Uranium-233/234 | 1.04 | 1.1[c] | 0 (< BG) |
| Uranium-235 | 0.228 U | 0.11[c] | 0.118 U |
| Uranium-238 | 0.643 | 1.1[c] | 0 (< BG) |

**Table 2. Cleanup Verification Data Set. (2 Pages)**

| COCs | 95% UCL Statistical Values[a] | Hanford Site Background | Shallow Zone Cleanup Verification Data Set[b] |
|---|---|---|---|
| *Nonradionuclide Concentration (mg/kg)* | | | |
| Arsenic | 3.7 | 6.5 | 3.7 |
| Barium | 93.3 | 132 | 93.3 |
| Cadmium | 0.07 U | 0.81[c] | 0.07 U |
| Chromium | 11.8 | 18.5 | 11.8 |
| Lead | 4.8 | 10.2 | 4.8 |
| Selenium | 0.83 | 0.78[c] | 0.83 |
| Silver | 0.15 U | 0.73 | 0.15 U |
| Uranium (total) | 1.7 | 3.21 | 1.7 |

[a] Laboratory data, including the minimum detectable activity or practical quantitation limit for the individual cleanup verification samples, are included in Appendix A and the 95% UCL calculation brief in Appendix C.
[b] For shallow zone decision units, background is subtracted only for naturally occurring radionuclides (e.g., uranium). Nonradionuclide background levels are considered in direct evaluation of the cleanup verification data set.
[c] *Hanford Site Background: Part 2, Soil Background for Radionuclides* (DOE-RL 1996).
[d] Hanford Site-specific background not available. Value is from Ecology publication 94-11 (Ecology 1994).
BG = background COC = contaminant of concern
U = undetected (in all samples) UCL = upper confidence limit

## 4.3 SITE-SPECIFIC CLEANUP VERIFICATION MODEL

A site-specific vadose zone model was not developed for the 618-8 waste site. For the statistical cleanup verification data set, all COCs were either undetected, or the statistical values were determined to be below statistical background levels, with the exception of selenium, which was detected slightly above background, as shown in Table 2.

## 4.4 RESRAD MODELING

A site-specific RESidual RADioactivity (RESRAD) model was not developed for the 618-8 waste site, because the statistical values for radionuclides were determined to be below the statistical background levels as reported in *Hanford Site Background: Part 2, Soil Background for Radionuclides* (DOE-RL 1996).

# 5.0 EVALUATION OF REMEDIAL ACTION GOAL ATTAINMENT FOR INDUSTRIAL LAND USE

This section demonstrates that remedial action at the 618-8 waste site has achieved the applicable RAGs developed to support industrial land use. Sections 5.1, 5.2, and 5.3 address attainment of direct exposure RAGs, groundwater protection RAGs, and Columbia River protection RAGs, respectively. Section 5.4 documents application of the

WAC 173-340-740(7)(e) three-part test, which is required for nonradionuclide COCs only.

## 5.1 DIRECT EXPOSURE SOIL REMEDIAL ACTION GOALS ATTAINED

### 5.1.1 Radionuclides

**5.1.1.1 Direct Comparison to RAGs.** Radionuclide COCs were either not detected or detected below background levels for the statistical verification data set at the 618-8 waste site, as shown in Table 2. All applicable RAGs have been met.

**5.1.1.2 Radionuclide Risk.** Radionuclide COCs were either not detected or detected below background levels for the statistical verification data set at the 618-8 waste site, as shown in Table 2.

### 5.1.2 Nonradionuclides

**5.1.2.1 Direct Comparison to RAGs.** All nonradionuclide COCs in the statistical verification data set were either not detected or detected below background levels, with the exception of selenium, which was detected slightly above background, as shown in Table 2. Table 3 compares the nonradionuclide cleanup verification statistical values for selenium, presented in Table 2, to the direct exposure RAG presented in Table 1. The statistical value is less than the corresponding RAG.

**Table 3. Attainment of Nonradionuclide Direct Exposure Standards – Industrial Land Use.**

| Nonradionuclides | RAG (mg/kg) | Shallow Zone Verification Data Set Values (mg/kg) | Direct Exposure RAG Attained?[a] |
|---|---|---|---|
| Selenium | 17,500 | 0.83 | Yes |

[a]Criterion is comparison to direct exposure RAG.
RAG = remedial action goal

**5.1.2.2 Noncarcinogenic Hazard Quotient RAG Attained.** For noncarcinogenic COCs, WAC 173-340-740(5)(a) and (b) specify the evaluation of the hazard quotient, which is given as daily intake divided by a reference dose. This evaluation is shown in the 95% UCL calculation brief (Appendix C). The calculated hazard quotient for statistical residual selenium concentrations (the only nonradionuclide COC detected above background) at the 618-8 waste site is $2.1 \times 10^{-3}$. This value is below the individual and cumulative RAGs (a hazard quotient of 1.0 in both cases).

**5.1.2.3 Carcinogenic Risk RAG Attained.** For individual nonradionuclide carcinogenic COCs, the WAC 173-340-745(4)(a)(iii) Method C cleanup limits are based

on an industrial land-use incremental cancer risk of $1 \times 10^{-5}$. The cumulative excess cancer risk for all nonradionuclide carcinogenic COCs must also be less than $1 \times 10^{-5}$ (WAC 173-340). Excess cancer risk was not calculated because the nonradionuclide carcinogenic COCs identified for the 618-8 waste site (arsenic and cadmium) were either not detected or detected below the statistical background levels.

## 5.2 GROUNDWATER REMEDIAL ACTION GOALS ATTAINED

### 5.2.1 Radionuclides

Radionuclide COCs were either not detected or detected below background levels for the statistical verification data set at the 618-8 waste site, as shown in Table 2. Therefore, the groundwater protection RAGs have been attained.

### 5.2.2 Nonradionuclides

All nonradionuclide COCs in the statistical verification data set were either not detected or detected below background levels, with the exception of selenium. Selenium was detected slightly above background, but below the applicable RAGs. Table 4 compares the nonradionuclide cleanup verification statistical values for selenium, presented in Table 2, to the soil RAG for groundwater protection presented in Table 1. Residual concentrations of selenium, the sole nonradionuclide COC detected above background for the 618-8 waste site, are less than the soil RAG for groundwater protection.

**Table 4. Attainment of Nonradionuclide Groundwater and River Protection Standards for the 618-8 Waste Site.**

| Contaminant of Concern | Cleanup Verification Data Set (mg/kg) | Soil RAG for Groundwater Protection (mg/kg) | Soil RAG for River Protection (mg/kg) | Cleanup Criteria Attained?[a] |
|---|---|---|---|---|
| Selenium | 0.83 | 5[b] | 1[c] | Yes |

[a] Criterion is comparison to soil RAGs for groundwater and river protection.
[b] Soil RAG for groundwater protection calculated from WAC 173-303-740(3)(a)(ii)(A), 1996 ("100 times rule") and the maximum contaminant level (drinking water standard) (40 CFR 141).
[c] Soil RAG for river protection calculated from WAC 173-340-740(3)(a)(ii)(A), 1996 ("100 time rule") and a dilution attenuation factor of 2, using the ambient water quality criteria provided in WAC 173-201A-040, 1995.
RAG = remedial action goal

## 5.3 COLUMBIA RIVER REMEDIAL ACTION GOALS ATTAINED

### 5.3.1 Radionuclides

Radionuclide COCs were either not detected or detected below background levels for the statistical verification data set at the 618-8 waste site, as shown in Table 2, therefore, the river protection RAGs have been attained.

### 5.3.2 Nonradionuclides

All nonradionuclide COCs in the statistical verification data set, with the exception of selenium, were either not detected or detected below background levels and are, therefore, below applicable soil RAGs for protection of the Columbia River. Selenium was detected slightly above background. Residual concentrations of selenium are less than the applicable soil RAG for protection of the Columbia River (Table 4).

## 5.4 WAC 173-340 THREE-PART TEST FOR NONRADIONUCLIDES

Although performed for all nonradionuclide COCs in the 95% UCL calculation (Appendix C, the WAC 173-340-740(7)(e) three-part test is required only for nonradionuclide statistical verification data sets with detections above background. The three-part test consists of the following criteria: (1) the cleanup verification statistical value must be less than the cleanup level, (2) no single detection within the data set can exceed two times the cleanup criteria, and (3) the percentage of samples in the data set exceeding the cleanup criteria must be less than 10%.

Selenium was the only nonradionuclide detected above background in the statistical verification data set. Table 5 summarizes the results of the WAC 173-340-740[7][e] three-part test for the 618-8 cleanup verification nonradionuclide data set for selenium in comparison to the most restrictive applicable RAG. The table lists the most restrictive RAG (from Table 1), the maximum detected value, the total number of samples collected, and the percentage of samples exceeding the RAG. The final column of the table describes the result of applying the three criteria using the values listed in the preceding columns.

**Table 5. Application of the WAC 173-340 Three-Part Test.**

| Contaminant of Concern | Most Restrictive Applicable RAG[a] | Statistical Cleanup Verification Value (mg/kg)[b] | Maximum Detected Cleanup Verification Value (mg/kg)[c] | Total Number of Samples[d] | Percentage of Cleanup Verification Data Set Exceeding RAG[e] | Cleanup Criteria Attained? |
|---|---|---|---|---|---|---|
| Selenium | 1[f] | 0.83 | 0.85 | 4 | 0 | Yes |

[a] From Table 1, the most restrictive RAG is the soil RAG for protection of the Columbia River.
[b] Criterion is statistical value cannot exceed most restrictive applicable RAG.
[c] Criterion is no single detection can exceed two times the most restrictive applicable RAG.
[d] Total number of samples in the decision unit includes field duplicate samples, which are included in the evaluation as separate samples.
[e] Criterion is percentage of data set exceeding the most restrictive applicable RAG cannot exceed 10%.
[f] Soil RAG for river protection calculated from WAC 173-340-740(3)(a)(ii)(A), 1996 ("100 time rule") and a dilution attenuation factor of 2, using the ambient water quality criteria provided in WAC 173-201A-040, 1995.
RAG = remedial action goal
WAC = *Washington Administrative Code*

As demonstrated in Table 5, residual shallow zone concentrations of selenium (the sole nonradionuclide COC exceeding background) at the 618-8 site pass the three-part test in comparison to the most restrictive applicable RAG, therefore, the RAOs for protection of groundwater and the river have been attained.

## 6.0 EVALUATION OF REMEDIAL ACTION GOAL ATTAINMENT FOR UNRESTRICTED LAND USE

The information presented in the previous section demonstrates that the cleanup objectives established in the ROD (EPA 2001) for industrial land use have been achieved. In addition, residual soil concentrations indicated that cleanup levels for more stringent land uses may have been achieved for the 618-8 waste site. The information presented in this section evaluates the remedial action results against cleanup criteria established for unrestricted land use to be implemented at selected sites in the 300-FF-2 Operable Unit through the *Explanation of Significant Differences for the 300-FF-2 Operable Unit Record of Decision* (ESD) (EPA 2004).

The 300 Area unrestricted land-use scenario is represented by an individual in a rural-residential setting. The exposure pathways considered in estimating dose from radionuclides in soil are inhalation; soil ingestion; ingestion of crops, meat, fish, drinking water, and milk; and external gamma exposure. This individual is conservatively assumed to spend 80% of his/her lifetime onsite. It is assumed that drinking water and irrigation water are obtained from groundwater, as impacted by the waste site.

Unrestricted land-use cleanup levels for chemicals or nonradionuclides are based on WAC 173-340-740(3), which assumes that the exposure pathway for residual contamination will be from ingestion of contaminated soil. Soil cleanup levels are calculated using the equations provided by WAC 173-340-740(3) for carcinogens and for noncarcinogens. For both carcinogens and noncarcinogens, the calculations assume that a resident with an average body weight 16 kg (35 lb) over the period of exposure ingests soil at a rate of 200 mg/day (73 g/yr [2.6 oz/yr]), with a frequency of contact of 100% and a gastrointestinal absorption rate of 100%. For carcinogens, the calculation is based on achieving a lifetime cancer risk goal of 1 in 1,000,000 ($1 \times 10^{-6}$) for an exposure duration of 6 years and a lifetime of 75 years. For noncarcinogens, the calculation is based on achieving a hazard quotient of 1.

The key assumptions in the 300 Area unrestricted land-use scenario that affect groundwater protection are irrigation at agronomic rates (76 cm/yr [30 in./yr]), surface vegetation resulting in an evapotranspiration coefficient of 91%, and inclusion of drinking water ingestion as an exposure pathway. Details of this land-use scenario and associated RAGs are documented in the ESD (EPA 2004).

A comparison of the 618-8 waste site cleanup verification data set to the cleanup objectives for unrestricted land use as established in the ESD (EPA 2004) is presented in the following sections.

## 6.1 DIRECT EXPOSURE SOIL REMEDIAL ACTION GOALS ATTAINED

### 6.1.1 Radionuclides

**6.1.1.1 Direct Comparison to RAGs.** Radionuclide COCs were either not detected or detected below background levels for the statistical verification data set at the 618-8 waste site, as shown in Table 2. All applicable RAGs have been met.

**6.1.1.2 Radionuclide Risk.** Radionuclide COCs were either not detected or detected below background levels for the statistical verification data set at the 618-8 waste site, as shown in Table 2.

### 6.1.2 Nonradionuclides

**6.1.2.1 Direct Comparison to RAGs.** All nonradionuclide COCs in the statistical verification data set were either not detected or detected below background levels, with the exception of selenium, which was detected slightly above background, as shown in Table 2. Table 6 compares the nonradionuclide cleanup verification statistical values for selenium, presented in Table 2, to the direct exposure RAG presented in Table 1. The statistical value is less than the corresponding RAG.

**Table 6. Attainment of Nonradionuclide Direct Exposure Standards – Unrestricted Land Use.**

| Nonradionuclides | RAG (mg/kg) | Shallow Zone Verification Data Set Values (mg/kg) | Direct Exposure RAG Attained?[a] |
|---|---|---|---|
| Selenium | 400 | 0.83 | Yes |

[a]Criterion is comparison to direct exposure RAG.
RAG = remedial action goal

**6.1.2.2 Noncarcinogenic Hazard Quotient RAG Attained.** For noncarcinogenic COCs, WAC 173-340-740(5)(a) and (b) specify the evaluation of the hazard quotient, which is given as daily intake divided by a reference dose. This evaluation is shown in the 95% UCL calculation brief (Appendix C). The calculated hazard quotient for statistical residual selenium concentrations (the only nonradionuclide COC detected above background) at the 618-8 waste site is $2.1 \times 10^{-3}$. This value is below the individual and cumulative RAGs (a hazard quotient of 1.0 in both cases).

**6.1.2.3 Carcinogenic Risk RAG Attained.** For individual nonradionuclide carcinogenic COCs, the WAC 173-340-745(4)(a)(iii) Method B cleanup limits are based on an unrestricted land-use incremental cancer risk of $1 \times 10^{-6}$. The cumulative excess cancer risk for all nonradionuclide carcinogenic COCs must also be less than $1 \times 10^{-5}$ (WAC 173-340). Excess cancer risk was not calculated because the nonradionuclide carcinogenic COCs identified for the 618-8 waste site (arsenic and cadmium) were either not detected or detected below the statistical background levels.

## 6.2 GROUNDWATER REMEDIAL ACTION GOALS ATTAINED

### 6.2.1 Radionuclides

Radionuclide COCs were either not detected or detected below background levels for the statistical verification data set at the 618-8 waste site, as shown in Table 2. Therefore, the groundwater protection RAGs have been attained.

### 6.2.2 Nonradionuclides

All nonradionuclide COCs in the statistical verification data set were either not detected or detected below background levels, with the exception of selenium. Selenium was detected slightly above background, but below the applicable RAGs. Table 7 compares the nonradionuclide cleanup verification statistical values for selenium, presented in Table 2, to the soil RAG for groundwater protection presented in Table 1. Residual concentrations of selenium, the sole nonradionuclide COC detected above background for the 618-8 waste site, are less than the soil RAG for groundwater protection.

**Table 7. Attainment of Nonradionuclide Groundwater and River Protection Standards for the 618-8 Waste Site.**

| COC | Cleanup Verification Data Set (mg/kg) | Soil RAG for Groundwater Protection (mg/kg) | Soil RAG for River Protection (mg/kg) | Cleanup Criteria Attained? |
|---|---|---|---|---|
| Selenium | 0.83 | 5[a] | 1[b] | Yes |

[a] Soil RAG for groundwater protection calculated from WAC 173-303-740(3)(a)(ii)(A), 1996 ("100 times rule") and the maximum contaminant level (drinking water standard) (40 CFR 141).
[b] Soil RAG for river protection calculated from WAC 173-340-740(3)(a)(ii)(A), 1996 ("100 time rule") and a dilution attenuation factor of 2, using the ambient water quality criteria provided in WAC 173-201A-040, 1995.
RAG = remedial action goal

## 6.3 COLUMBIA RIVER REMEDIAL ACTION GOALS ATTAINED

### 6.3.1 Radionuclides

Radionuclide COCs were either not detected or detected below background levels for the statistical verification data set at the 618-8 waste site, as shown in Table 2, therefore, the river protection RAGs have been attained.

### 6.3.2 Nonradionuclides

All nonradionuclide COCs in the statistical verification data set, with the exception of selenium, were either not detected or detected below background levels and are, therefore, below applicable soil RAGs for protection of the Columbia River. Selenium was detected slightly above background. Residual concentrations of selenium are less than the applicable soil RAG for protection of the Columbia River (Table 7).

## 6.4 WAC 173-340 THREE-PART TEST FOR NONRADIONUCLIDES

Although performed for all nonradionuclide COCs in the 95% UCL calculation (Appendix C, the WAC 173-340-740(7)(e) three-part test is required only for nonradionuclide statistical verification data sets with detections above background. The three-part test consists of the following criteria: (1) the cleanup verification statistical value must be less than the cleanup level, (2) no single detection within the data set can exceed two times the cleanup criteria, and (3) the percentage of samples in the data set exceeding the cleanup criteria must be less than 10%.

Selenium was the only nonradionuclide detected above background in the statistical verification data set. Table 8 summarizes the results of the WAC 173-340-740[7][e] three-part test for the 618-8 cleanup verification nonradionuclide data set for selenium in comparison to the most restrictive applicable RAG. The table lists the most restrictive RAG (from Table 1), the maximum detected value, the total number of samples collected, and the percentage of samples exceeding the RAG. The final column of the table describes the result of applying the three criteria using the values listed in the preceding columns.

**Table 8. Application of the WAC 173-340 Three-Part Test.**

| Contaminant of Concern | Most Restrictive Applicable RAG[a] | Statistical Cleanup Verification Value (mg/kg)[b] | Maximum Detected Cleanup Verification Value (mg/kg)[c] | Total Number of Samples[d] | Percentage of Cleanup Verification Data Set Exceeding RAG[e] | Cleanup Criteria Attained? |
|---|---|---|---|---|---|---|
| Selenium | 1[f] | 0.83 | 0.85 | 4 | 0 | Yes |

[a] From Table 1, the most restrictive RAG is the soil RAG for protection of the Columbia River.
[b] Criterion is statistical value cannot exceed most restrictive applicable RAG.
[c] Criterion is no single detection can exceed two times the most restrictive applicable RAG.
[d] Total number of samples in the decision unit includes field duplicate samples, which are included in the evaluation as separate samples.
[e] Criterion is percentage of data set exceeding the most restrictive applicable RAG cannot exceed 10%.
[f] Soil RAG for river protection calculated from WAC 173-340-740(3)(a)(ii)(A), 1996 ("100 time rule") and a dilution attenuation factor of 2, using the ambient water quality criteria provided in WAC 173-201A-040, 1995.
RAG = remedial action goal
WAC = *Washington Administrative Code*

As demonstrated in Table 8, residual shallow zone concentrations of selenium (the sole nonradionuclide COC exceeding background) at the 618-8 site pass the three-part test in comparison to the most restrictive applicable RAG, therefore, the RAOs for protection of groundwater and the river have been attained.

## 7.0 STATEMENT OF PROTECTIVENESS

This CVP demonstrates that remedial action at the 618-8 waste site has achieved the RAOs and corresponding RAGs established for the industrial land-use scenario in the ROD (EPA 2001), EPA (2004), and the RDR/RAWP (DOE-RL 2004b). The contaminated materials from the site have been excavated and disposed at ERDF. The remaining soil at the 618-8 waste site has been sampled, analyzed, and evaluated. Results indicate that the site supports future land uses that can be represented (or bounded) by the industrial land-use scenario and poses no threat to groundwater or the Columbia River. Consequently, the 618-8 waste site is verified to be remediated in accordance with the ROD.

Because residual soil concentrations indicated that cleanup levels for more stringent land uses may have been achieved for the 618-8 waste site, a supplemental evaluation was performed against the unrestricted land-use RAGs established for the 300 Area in the ESD (EPA 2004). This evaluation demonstrated that the results of verification sampling do not preclude any future uses (as bounded by the rural-residential scenario) and allow unrestricted use of shallow zone soils. In consideration of this and because the site has no deep zone, no institutional controls are required at the 618-8 waste site.

## 8.0 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*, U.S. Department of Energy, Washington, D.C.

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

DOE-RL, 1998, *Tri-Party Agreement Handbook Management Procedures,* RL-TPA-90-0001, Guideline Number TPA-MP-14, "Maintenance of the Waste Information Data System (WIDS)," U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 2004a, *300 Area Sampling and Analysis Plan*, DOE/RL-2001-48, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 2004b, *Remedial Design Report/Remedial Action Work Plan for the 300 Area*, DOE/RL-2001-47, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order,* 2 vols., as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

Ecology, 1994, *Natural Background Soil Metals Concentrations in Washington State*, Publication 94-115, Washington State Department of Ecology, Olympia, Washington.

EPA, 2001, *Interim Action Record of Decision for the 300-FF-2 Operable Unit, Hanford Site, Benton County, Washington,* U.S. Environmental Protection Agency, Region 10, Seattle, Washington.

EPA, 2004, *Explanation of Significant Differences for the 300-FF-2 Operable Unit Record of Decision*, U.S. Environmental Protection Agency, Region 10, Seattle, Washington.

*Resource Conservation and Recovery Act of 1976*, 42 U.S.C. 6901 et seq.

WAC 173-201A, 1995, "Water Quality Standards for Surface Waters of the State of Washington," *Washington Administrative Code*.

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

WCH, 2006a, *Closeout Plan for the 618-8 Burial Ground,* CCN 126068, Washington Closure Hanford, Richland, Washington

WCH, 2006b, *Parking Lot Test Pit/Trenching Investigation for the 618-8 Burial Ground,* Interoffice Memorandum from L. M. Dittmer to M. J. Haass, CCN 124817, dated June 28, 2006, Washington Closure Hanford, Richland, Washington.

# APPENDIX A

# SUMMARY OF VERIFICATION SOIL SAMPLING AND ANALYTICAL RESULTS

## Table A-1. 618- 8 Verification Sampling Results.

| Sampling Area | HEIS Number | Sample Date | Silver | | | Arsenic | | | Barium | | | Cadmium | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| A1 | J11271 | 1/31/2006 | 0.15 | U | 0.15 | 3.4 | | 0.36 | 81.3 | | 0.02 | 0.07 | U | 0.07 |
| Duplicate of J11271 | J11272 | 1/31/2006 | 0.15 | U | 0.15 | 4.1 | | 0.36 | 79.4 | | 0.02 | 0.07 | U | 0.07 |
| A2 | J11273 | 1/31/2006 | 0.15 | U | 0.15 | 3.8 | | 0.34 | 97.6 | | 0.02 | 0.07 | U | 0.07 |
| A3 | J11274 | 1/31/2006 | 0.15 | U | 0.15 | 2.4 | | 0.36 | 87.0 | | 0.02 | 0.07 | U | 0.07 |
| A4 | J11275 | 1/31/2006 | 0.15 | U | 0.15 | 2.4 | | 0.36 | 69.1 | | 0.02 | 0.07 | U | 0.07 |
| Split of J11271 | J11277 | 1/31/2006 | 1.1 | U | 1.1 | 3.5 | | 1.1 | 94.9 | | 21.3 | 0.53 | U | 0.53 |

| Sampling Area | HEIS Number | Sample Date | Chromium | | | Lead | | | Selenium | | | Total Uranium | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| A1 | J11271 | 1/31/2006 | 10.4 | | 0.17 | 4.5 | | 0.33 | 0.81 | | 0.38 | 1.28 | | 0.017 |
| Duplicate of J11271 | J11272 | 1/31/2006 | 11.7 | | 0.17 | 4.2 | | 0.33 | 0.76 | | 0.38 | 1.13 | | 0.017 |
| A2 | J11273 | 1/31/2006 | 12.4 | | 0.17 | 5.1 | | 0.32 | 0.51 | | 0.21 | 1.67 | | 0.017 |
| A3 | J11274 | 1/31/2006 | 10.2 | | 0.17 | 4.4 | | 0.33 | 0.85 | | 0.38 | 1.72 | | 0.017 |
| A4 | J11275 | 1/31/2006 | 9.4 | | 0.17 | 3.9 | | 0.32 | 0.69 | | 0.38 | 1.35 | | 0.017 |
| Split of J11271 | J11277 | 1/31/2006 | 8.3 | | 1.1 | 3.9 | | 1.1 | 0.33 | B | 1.6 | 3.28 | | 0.020 |

| Sampling Area | HEIS Number | Sample Date | Uranium-233/234 | | | Uranium-235 | | | Uranium-238 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | pCi/g | Q | MDA | pCi/g | Q | MDA | pCi/g | Q | MDA |
| A1 | J11271 | 1/31/2006 | 0.540 | | 0.27 | 0 | U | 0.31 | 0.439 | | 0.26 |
| Duplicate of J11271 | J11272 | 1/31/2006 | 0.736 | | 0.26 | 0.081 | U | 0.31 | 0.401 | | 0.26 |
| A2 | J11273 | 1/31/2006 | 0.780 | | 0.35 | 0.056 | U | 0.42 | 0.734 | | 0.35 |
| A3 | J11274 | 1/31/2006 | 1.19 | | 0.40 | 0.314 | U | 0.48 | 0.363 | U | 0.40 |
| A4 | J11275 | 1/31/2006 | 0.778 | | 0.25 | 0.078 | U | 0.30 | 0.518 | | 0.25 |
| Split of J11271 | J11277 | 1/31/2006 | 1.14 | | 0.053 | 0.078 | | 0.030 | 1.10 | | 0.053 |

B = analyte found in method blank
HEIS = Hanford Environmental Information System
MDA = minimum detectable activity
PQL = practical quantitation limit
Q = qualifier
U = undetected

# APPENDIX B

# DATA QUALITY ASSESSMENT

# B1.0 DATA QUALITY ASSESSMENT FOR 618-8 BURIAL GROUND WASTE SITE

## B1.1 OVERVIEW

The data quality assessment (DQA) completes the data life cycle (i.e., planning, implementation, and assessment) that was initiated by the data quality objectives process. The DQA includes a review of the field logbook information (WCH 2006c) to verify sample location, date, and time. It also involves a scientific and statistical evaluation of the data to determine if they are of the right type, quality, and quantity to support their intended use for closeout decisions.

This DQA was performed in accordance with ENV-1, *Environmental Monitoring and Management*. Specific data quality objectives for the site are found in the *300 Area Remedial Action Sampling and Analysis Plan* (SAP) (DOE-RL 2004a). The DQA is based on the guidelines presented in *Guidance for Data Quality Assessment* (EPA 2000). Statistical tests used in this DQA were performed as specified in the SAP and the *Remedial Design Report/Remedial Action Work Plan for the 300 Area* (RDR/RAWP) (DOE-RL 2004b).

Prior to performing statistical tests, the field logbook (WCH 2006c), sample designs (WCH 2006b), and sample analytical data are evaluated. A portion of the cleanup verification sample analytical data is validated for compliance requirements (DOE-RL 2004a). Data evaluation is performed to determine if the laboratory carried out all steps required by the SAP and the laboratory contract governing the conduct of analysis and reporting of the data. This evaluation also examines the available laboratory data to determine if an analyte is present or absent in a sample and the degree of overall uncertainty associated with that determination. Data validation is done in accordance with validation procedures (BHI 2000a, 2000b). After data evaluation and validation, the appropriate statistical analyses are performed on the adjusted raw analytical data (Appendix C) to determine statistical values for each contaminant. The cleanup verification sample analytical data are stored in the Environmental Restoration database prior to being transferred to the Hanford Environmental Information System and are summarized in Appendix A.

## B1.2 LABORATORY QUALITY MEASURES

All verification samples are subject to laboratory-specific quality assurance (QA) requirements, including instrument procurement, maintenance, calibration, and operation. Additional laboratory quality control (QC) checks are performed, as appropriate, for the analytical method at a rate of one per sample delivery group (SDG), or 1 in 20, whichever is more frequent. Laboratory internal QC checks include the following:

- Laboratory Contamination. Each analytical batch contains a laboratory (method) blank (material of similar composition as the samples with known/minimal contamination of the analytes of interest) carried through the complete analytical process. The method blank is used to evaluate false-positive results in samples, due to contamination during handling at the laboratory.

- Analytical Accuracy. For most analyses, a known quantity of representative analytes of interest (matrix spike/matrix spike duplicate [MS/MSD]) is added to a separate aliquot of a sample from the analytical batch. The recovery percentage of the added MS is used to evaluate analytical accuracy. For analyses not amenable to MS techniques (e.g., gamma energy analysis) or where analytical recovery is corrected via internal standards (e.g., alpha spectral analyses), accuracy is evaluated from recovery of the QC reference sample (e.g., laboratory control spike or blank spike sample).

- Analytical Precision. Separate aliquots removed from the same sample container (replicate samples) are analyzed for each analytical batch. The replicate sample results (evaluated as relative percent differences [RPDs]) are used to assess analytical precision.

- QC Reference Samples. A QC reference sample is prepared from an independent standard at a concentration other than that used for calibration, but within the calibration range. Reference samples provide an independent check on analytical technique and methodology.

Laboratories are also subject to periodic and random assessments of the laboratory performance, systems, and overall program. These assessments are performed by the Washington Closure Hanford QA group to ensure that the laboratories are performing within laboratory contract requirements.

## B1.3 DATA VALIDATION

After sampling was completed, all of the fixed-base laboratory data from SDG K0204 were submitted for third-party validation to Level C per ENV-1-2.12, "Data Package Validation." Level C validation procedures are specified in *Data Validation Procedure for Radiochemical Analysis* (BHI 2000b) and *Data Validation Procedure for Chemical Analysis* (BHI 2000a).

Use of Level C validation procedures was included in the review of the following items, as appropriate, for each analytical method:

- Sample holding times
- Method blanks
- MS/MSD recovery
- Surrogate recovery

- Sample replicates
- Associated batch laboratory control sample results
- Data package completeness
- Achievement of required (or contractual) detection limits (RDLs).

Data flagged by the validator as estimated (i.e., "J") indicate that the associated concentration is an estimate, but that the data may be used for decision-making purposes. Data flagged as below detection limits (i.e., "U") indicate the contaminant was analyzed for but not detected, and the concentration is below the minimum detectable activity (MDA) for radionuclides or the practical quantitation limit (PQL) (i.e., reporting limit) for nonradionuclides. For nonradionuclides, nondetects are reported at the PQL. For radionuclides, nondetects report the actual value obtained from analysis (positive or negative but less than the MDA) except for limited analyses where no value can be calculated. In these cases, the MDA is reported. This situation is applicable for sample results that are below detection limits. All other validated results are considered to be accurate within the standard errors associated with the methods.

The adequacy of laboratory QA/QC was evaluated for precision, accuracy, completeness, and RDLs pursuant to the SAP (DOE-RL 2004a). The organization performing the data validation reported that, of the data given formal validation, the laboratory met the standards for performance for precision (±30%), accuracy (±30%), and completeness (>90%). Comparison of the RDL with the respective MDA or PQL is discussed in Section B1.4.

The validated SDG K0204 contains six samples (J11271, J11272, J11273, J11274, J11275, J11276) from the 618-8 Burial Ground. Sample J11276 is the equipment blank and sample J11272 is a duplicate of sample J11271. A summary of deficiencies noted during validation follows.

- **Radionuclides.** The validation DQA noted no major deficiencies.

Total uranium was found in the equipment blank (J11276) at 0.496 mg/kg. The Hanford Site-specific background value for total uranium is 3.21 mg/kg. This result is probably carryover in the analytical equipment but does not represent a significant source of contamination. The field sample data are useable for decision making purposes.

- **Nonradionuclides.** The validation DQA noted no major deficiencies.

Barium and lead were found in the equipment blank (J11276) at 1.8 mg/kg and 0.72 mg/kg, respectively.

Third party validation did not qualify any of the data in SDG K0204.

## B1.4 LABORATORY DATA EVALUATION

The following paragraphs include a data evaluation of two verification sample SDGs for the 618-8 Burial Ground, SDG K0204 and SDG J00056. SDG K0204 consists of six total samples (J11271 to J11276) from the 618-8 site: four statistical samples, an equipment blank (J11276) and a field duplicate (J11272). SDG K0204 was also subjected to third party verification, as mentioned above. SDG J00056 consists of one split sample (J11277).

The context for assessing the data includes evaluating the sample data using the statistical methodology from the SAP (DOE-RL 2004a) (included in the calculation briefs in Appendix C) and a comparison of analytical results to the parameters as specified in the SAP. This section summarizes the results of the comparison and presents an evaluation of the affected data.

### MAJOR DEFICIENCIES

Any data anomaly that causes final data to be qualified as rejected (R flagged) is considered a major deficiency. No major deficiencies were identified in the data.

### MINOR DEFICIENCIES

**Sample Holding Times.** All of the method-specific holding times were met for all samples in the 618-8 data set.

**Method Blanks.** The method blank is used to evaluate false-positive results in samples due to contamination during handling at the laboratory.

**Radionuclides.** In the radionuclide analyses, low-level positive results were observed for uranium-233/234 at 0.035 pCi/g. The Hanford Site-specific background activity for uranium-233/234 is 1.1 pCi/g. Most radiological analytical techniques are counting methods. Due to the nature of this type of analysis, positive, but insignificant, results are not uncommon in the method blank and are not considered contamination.

**Nonradionuclides.** Barium was detected in the method blank at 0.09 mg/kg. The lowest applicable remedial action goal (RAG) for barium is the river protection RAG at 132 mg/kg. All of the nonradiological method blanks associated with 618-8 were found acceptable.

**MS/MSD Recoveries.** Recovery of spiked analytes in the MS/MSD pair is used to evaluate method efficiency and the effect of the matrix on an environmental sample.

**Radionuclides.** All MS/MSD recoveries for radionuclide analytes were within acceptance criteria.

**Nonradionuclides.** In the inductively coupled plasma metals analysis of SDG J00056, the percent recoveries for barium and chromium were 148% and 128%, respectively. The barium result is outside of the project-specific acceptance criteria of +/- 30%. The chromium result is outside of the laboratory acceptance criteria of +/- 20%, but is within the project-specific acceptance criteria. Both results are attributed to natural heterogeneity in the soil sample used as the matrix. The data are useable for the intended purpose.

**RDL Comparison.** Reported analytical detection levels for nondetected analytes were compared to the RDLs specified in the SAP (DOE-RL 2005a). When detected results were obtained, evaluation of detection limits was not performed. The data validation and supplemental data evaluation noted any analyses in which the detection limit (MDA or PQL) was above the SAP RDLs for nondetected analytes.

**Radionuclides.** All of the reported MDAs are sufficiently low for decision-making purposes. All values meet the site cleanup criteria as demonstrated in the calculation briefs (Appendix C) and discussed in this cleanup verification package.

**Nonradionuclides.** All of the reported method detection limits are less than applicable RAGs, and the data are of sufficient quality for decision-making purposes.

**Precision and Accuracy Evaluation.** Analytical accuracy and precision were evaluated by examination of the RPD of the main, duplicate, and split samples. Only the contaminants of concern (COCs) detected at five times the target detection limit (or greater) are used for data analysis with respect to accuracy and precision.

**Radionuclides.** RPDs for the radionuclide analytes were not calculated because an evaluation of the data shows none of the analytes were detected in both the main and duplicate (or split) sample at more than five times the target detection limit.

**Nonradionuclides.** RPDs for the nonradionuclide analytes barium and chromium were calculated for both the duplicate and split samples. In the duplicate sample analysis, both barium and chromium were within acceptance criteria with RPDs of 2.4% and 12%, respectively. The RPDs for the split sample analysis of barium and chromium were 15% and 22%, respectively. The acceptance criteria for split sample RPDs is 30%. It was previously discussed that barium and chromium also had high matrix spike recoveries. All of the sample extracts associated with these results were produced using field-collected materials. The natural heterogeneity of field collected soils and materials adds to elevated RPDs. This variability is expected and does not indicate a problem with the analytical system. RPDs of analytes detected at low concentrations (less than five times the detection limit) are also not considered to be indicative of the analytical system performance. The data are useable for decision-making purposes.

## B1.5 FIELD QUALITY ASSURANCE/QUALITY CONTROL

Field QA/QC measures were used to assess potential sources of error and cross-contamination of soil samples that could bias results. Field QA/QC samples listed in the field logbook (WCH 2006c) are summarized in Table B-1. All main and QA/QC sample results are presented in Appendix A.

**Table B-1. Summary of Field Quality Control Samples.**

| Equipment Blank | Main Sample | Duplicate | Split |
|---|---|---|---|
| J11276 | J11271 | J11272 | J11277 |

Field duplicate samples were 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 duplicate samples for each COC. Only analytes with values above five times the detection limits for both the main and duplicate samples are compared. The 95% upper confidence limit (UCL) calculation brief in Appendix C provides details on duplicate pair evaluation and RPD calculation. The data are suitable for the intended purpose of cleanup verification.

Split samples were collected to provide a relative measure of the degree of variability in the sampling, sample handling, and analytical techniques used by commercial laboratories. The field main and split samples are evaluated by computing the RPD of the split samples for each COC to determine the usability of the verification data. The U.S. Environmental Protection Agency Contract Laboratory Program duplicate sample comparison methodology, *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (EPA 1994), is used as an initial test of the data from the splits. Only analytes that had values above five times the contractual RDL for both the main and split sample were compared. The 95% UCL calculation brief in Appendix C provides details on split pair RPD calculation. These results are typical of the heterogeneity found in the sample matrices and do not indicate a problem in the analytical systems.

## B1.6 SUITABILITY OF DATA

The DQA for the 618-8 Burial Ground determined that the data are of the right type, quality, and quantity to support site cleanup verification decisions within specified error tolerances. The evaluation verified that the sample design was sufficient for the purpose of clean site verification. All analytical data were found to be acceptable for decision-making purposes.

## B2.0 REFERENCES

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

BHI, 2000b, *Data Validation Procedure for Radiochemical Analysis*, BHI-01433, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

DOE-RL, 2004a, *300 Area Remedial Action Sampling and Analysis Plan*, DOE/RL-2001-48, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 2004b, *Remedial Design Report/Remedial Action Work Plan for the 300 Area*, DOE/RL-2001-47, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

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

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.

EPA, 2000, *Guidance for Data Quality Assessment*, EPA QA/G-9, QA00 Update, U.S. Environmental Protection Agency, Office of Environmental Information, Washington, D.C.

WCH, 2006a, *618-8 Burial Ground Cleanup Verification 95% UCL Calculations,* Calculation Number 0600X-CA-V0058, Washington Closure Hanford, Richland, Washington.

WCH, 2006b, *Closeout Plan for the 618-8 Burial Ground*, CCN 126068, Washington Closure Hanford, Richland, Washington.

WCH, 2006c, *Remedial Sampling*, Logbook EL-1395-11, Washington Closure Hanford, LLC., Richland, Washington.

# APPENDIX C

# CALCULATION BRIEF EXCERPTS

## DISCLAIMER FOR CALCULATIONS

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

## CALCULATION BRIEFS

The following calculation briefs have been prepared in accordance with ENG-1, *Engineering Services*, ENG-1-4.5, "Project Calculations," Washington Closure Hanford, Richland, Washington.

*618-8 Shallow Zone Sampling Plan*, Calculation No. 0300X-CA-V0067, Rev. 0, Washington Closure Hanford, Richland, Washington.

*618-8 Burial Ground Cleanup Verification 95% UCL Calculations*, Calculation No. 0600X-CA-V0058, Rev. 0, Washington Closure Hanford, Richland, Washington.

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

# CALCULATION COVER SHEET

| | | | |
|---|---|---|---|
| **Project Title:** | 618-8 Burial Ground Sample Design | **Job No.** | 14655 |
| **Area** | 300 Area | | |
| **Discipline** | Environmental Engineering | **Calc. No.** | 0300X-CA-V0067 |
| **Subject** | 618-8 Shallow Zone Sampling Plan | | |
| **Computer Program** | Excel | **Program No.** | Excel 2003 |

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

**Committed Calculation** ☒ **Preliminary** ☐ **Superseded** ☐ **Voided** ☐

| Rev. | Sheet Numbers | Originator | Checker | Reviewer | Approval | Date |
|---|---|---|---|---|---|---|
| 0 | Cover = 1 Sht<br>Calc = 1 Shts<br>Attach1 = 1 Sht<br>Attach2 = 1 Sht<br>Attach3 = 1 Shts<br>Total = 5 Shts | G. Cruz<br>02/06/06 | C.A. Bentz<br>2/6/06 | R.B. Kerkow<br>2/6/06 | M.J. Haass | 2/6/06 |
| | | | | | | |
| | | | | | | |
| **SUMMARY OF REVISIONS** | | | | | | |
| | | | | | | |
| | | | | | | |

* Obtain calc no. from DIS

DE01437.03 (12/09/2004)

**Washington Closure Hanford**

**CALCULATION SHEET**

Originator G. Cruz Date 2/2/2006 Calc. No. 0300X-CA-V0067 Rev. No. 0

Project 618-8 Burial Ground Sample Design Job No. 14655 Checked GB Date 2/6/06

Subject 618-8 Shallow Zone Sampling Plan Sheet No. 1 of 1

| | | | | |
|---|---|---|---|---|
| **Problem:** | Calculate and display required sampling nodes in concurrence with 300 Area | | | |
| | SAP DOE/RL-2001-48 Rev. 0 for verification and closure. | | | |
| **Given:** | -SAP (DOE/RL-2001-48 Rev. 0) requirements | | | |
| | -Shallow Sampling Area (Surface area of each zone determined from CAD program, | | | |
| | Attachment 3, Sht 1of1, CAD file 3X:020206B, 618-8 Burial Ground Shallow Zone Sampling Plan) | | | |
| **SAP Requirements:** | | | | |
| | -Develop a 16 node sampling grid for the sampling area | | | |
| Shallow Zone | -Use table 3-2 of the SAP to determine which four of the sixteen nodes will be sampled | | | |
| | to collect clean up verification samples | | | |
| | -Develop a 16 node sampling grid for the sampling area | | | |
| Overburden: | -Use table 3-2 of the SAP to determine which four of the sixteen nodes will be sampled | | | |
| | to collect clean up verification samples | | | |
| | -Develop a 16 node sampling grid for the sampling area | | | |
| Deep Zone: | -Use table 3-2 of the SAP to determine which four of the sixteen nodes will be sampled | | | |
| | to collect clean up verification samples | | | |
| **Determination of Shallow Zone Sampling Grid:** | | | | |
| Shallow Zone Sampling Grid Area determined from Table 3-2, SAP | | | | |
| Attachment 2, Number of Decision Subunits Based on Area (Converted to Sq Meters) | | | | |
| Total Area: | | 1767.24 | $m^2$ | |
| Area of Decision Subunits (total area 1 subunit) | | 1767.24 | $m^2$ | |
| Decision Subunit divided into 4 Sampling Areas: | | 441.81 | $m^2$ | |
| Sampling Areas divided into a 16 node grid (node numbers 1-16): | | 27.61 | $m^2$ | |
| Nodes to be Sampled (as determined from Attachment 1, Table A-1, Sample Grid Point Lookup Table) | | | | |
| | See Attachment 3, Sht 1of1, 618-8 Burial Ground Shallow Zone Sampling Plan, | | | |
| | for Sample Location Table | | | |

**Washington Closure Hanford**

Originator G. Cruz Date 2/2/2006 Calc. No. 0300X-CA-V0067 Rev. No. 0

Project 618-8 Burial Ground Sample Design Job No. 14655 Checked CAB Date 2/6/06

Subject 618-8 Shallow Zone Sampling Plan Sheet No 1of1

ATTACHMENT 1

## Sample Grid Point Lookup Table.

| Default Plan | Sampling Area 1 | Sampling Area 2 | Sampling Area 3 | Sampling Area 4 | Sampling Area 5 | Sampling Area 6 | Sampling Area 7 | Sampling Area 8 | Sampling Area 9 | Sampling Area 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Closeout | 3 | 6 | 1 | 4 | 5 | 1 | 3 | 3 | 4 | 16 |
| Closeout | 4 | 7 | 11 | 3 | 15 | 15 | 5 | 13 | 10 | 10 |
| Closeout | 16 | 3 | 2 | 7 | 7 | 10 | 11 | 4 | 3 | 14 |
| Closeout | 10 | 15 | 4 | 12 | 1 | 13 | 4 | 8 | 16 | 4 |
| Not Sampling | 2 | 14 | 5 | 9 | 13 | 12 | 8 | 2 | 14 | 8 |
| Not Sampling | 13 | 10 | 9 | 13 | 2 | 16 | 1 | 12 | 5 | 3 |
| Not Sampling | 6 | 1 | 10 | 8 | 14 | 4 | 16 | 5 | 8 | 6 |
| Not Sampling | 1 | 9 | 13 | 1 | 10 | 5 | 12 | 1 | 1 | 15 |
| Not Sampling | 9 | 12 | 7 | 5 | 6 | 2 | 6 | 7 | 15 | 9 |
| Not Sampling | 15 | 16 | 15 | 14 | 16 | 6 | 2 | 15 | 11 | 1 |
| Not Sampling | 8 | 13 | 8 | 10 | 12 | 11 | 13 | 14 | 2 | 12 |
| Not Sampling | 5 | 2 | 3 | 11 | 4 | 3 | 9 | 10 | 7 | 11 |
| Not Sampling | 7 | 11 | 14 | 15 | 11 | 14 | 14 | 6 | 13 | 2 |
| Not Sampling | 11 | 4 | 6 | 2 | 9 | 7 | 7 | 11 | 9 | 7 |
| Not Sampling | 12 | 8 | 16 | 16 | 3 | 8 | 15 | 9 | 6 | 13 |
| Not Sampling | 14 | 5 | 12 | 6 | 8 | 9 | 10 | 16 | 12 | 5 |

** **Note:** Grid nodes for each sampling area in each waste site should be numbered consistently, e.g., begin numbering the nodes in the northwesternmost node. Then number consecutively left to right.

Washington Closure Hanford

Originator G. Cruz Date 2/2/2006 Calc. No. 0300X-CA-V0067 Rev. No. 0

Project 618-8 Burial Ground Sample Design Job No. 14655 Checked CSB Date 2/6/06

Subject 618-8 Shallow Zone Sampling Plan Sheet No. 1of1

## ATTACHMENT 2

## Number of Decision Subunits Based on Area.

| Site Verification Sampling Frequencies Based on Area. | | | | | |
|---|---|---|---|---|---|
| Decision Unit[a] | Waste Site Size[b] | Decision Subunits | Blocks[c] | Discrete Samples | Composite Samples |
| Shallow zone – 0 10 15 ft | Small: < 100,000 ft$^2$ | 1 | 4 | 16 | 4 |
| | Medium: >100,000 ft$^2$ < 400,000 ft$^2$ | 4 | 16 | 64 | 16 |
| | Large: >400,000 ft$^2$ | 8 | 32 | 128 | 32 |
| Deep Zone - >15 ft | Small: < 100,000 ft$^2$ | 1 | 4 | 16 | 4 |
| | Medium: >100,000 ft$^2$ < 400,000 ft$^2$ | 4 | 16 | 64 | 16 |
| | Large: >400,000 ft$^2$ | 8 | 32 | 128 | 32 |
| Overburen/layback stockpiles | Small: < 100,000 ft$^2$ | 1 | 4 | 16 | 4 |
| | Medium: >100,000 ft$^2$ < 400,000 ft$^2$ | 4 | 16 | 64 | 16 |
| | Large: >400,000 ft$^2$ | 8 | 32 | 128 | 32 |
| Staging pile areas (residual soil) | Small: < 100,000 ft$^2$ | 1 | 4 | 16 | 4 |
| | Medium: >100,000 ft$^2$ < 400,000 ft$^2$ | 4 | 16 | 64 | 16 |
| | Large: >400,000 ft$^2$ | 8 | 32 | 128 | 32 |

[a] The shallow zone, deep zone, overburden stockpile, and staging pile areas each represent single decision units. The total number of decision units will vary because individual waste sites may not have a deep zone, overburden stockpile, and/or staging pile areas.
[b] Area of exposed surface after excavation or area of stockpile base (as applicable)
[c] Decision subunits are divided into four blocks to ensure that random sampling locations are not bunched together in one area

3X:020206B

E 593800/

N 116500


SCALE 1: 400

4 0 4 8 16 meters

## NOTES

1. SHALLOW ZONE NODE AREAS ARE APPROXIMATELY 27.61 SQUARE METERS.
2. SAMPLES ARE TAKEN FROM THE APPROXIMATE CENTER OF EACH NODE.
3. THE SHALLOW ZONE CONSISTS OF SAMPLING AREAS A1, A2, A3, & A4 WITHIN DECISION SUBUNIT 1.

## LEGEND

(8) CLEAN UP VERIFICATION SAMPLING NODE

## SAMPLE LOCATION TABLE

| DECISION SUBUNIT | SAMPLING AREA | SAMPLE NODE | NORTHING | EASTING |
|---|---|---|---|---|
| 1 | A1 | S-A1-3 | 116521.03 | 593820.18 |
| | | S-A1-4 | 116519.21 | 593822.56 |
| | | S-A1-10 | 116496.32 | 593806.40 |
| | | S-A1-16 | 116499.63 | 593823.61 |
| | A2 | S-A2-3 | 116492.61 | 593816.10 |
| | | S-A2-6 | 116485.98 | 593810.90 |
| | | S-A2-7 | 116490.31 | 593818.33 |
| | | S-A2-15 | 116484.36 | 593821.04 |
| | A3 | S-A3-1 | 116473.31 | 593810.36 |
| | | S-A3-2 | 116477.27 | 593816.75 |
| | | S-A3-4 | 116485.69 | 593829.35 |
| | | S-A3-11 | 116475.28 | 593827.88 |
| | A4 | S-A4-3 | 116457.15 | 593831.39 |
| | | S-A4-4 | 116450.81 | 593838.83 |
| | | S-A4-7 | 116454.50 | 593839.93 |
| | | S-A4-12 | 116450.74 | 593848.02 |

Attachment: 3 Sheet No. 1 of 1
Originator: G. Cruz Date 02/06/06
Chkd By: CSB Date 2/6/06
Calc. No. 0300X-CA-V0067 Rev. No. 0

ATTACHMENT 3

U.S DEPARTMENT OF ENERGY
DOE RICHLAND OPERATIONS OFFICE
RIVIER CORRIDOR CLOSURE CONTRACT

300 AREA
300 AREA REMEDIAL DESIGN
618-8 BURIAL GROUND
SHALLOW ZONE SAMPLING PLAN

# CALCULATION COVER SHEET

| | | | |
|---|---|---|---|
| **Project Title:** | 300 Area Field Remediation | **Job No.** | 14655 |
| **Area** | 600 | | |
| **Discipline** | Environmental | ***Calc. No.** | 0600X-CA-V0058 |
| **Subject** | 618-8 Burial Ground Cleanup Verification 95% UCL Calculations | | |
| **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<br>Sheets = 5<br><br>Total = 6 | B. S. Wiegman<br>5/9/06 | T. M. Blakley<br>5/9/06 | L. M. Dittmer<br>5/11/06 | R. B. Kerkow<br>5/15/06 | 5/15/06 |
| | | | | | | |
| | | | | | | |
| | | | | | | |

**SUMMARY OF REVISIONS**

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

WCH-DE-018 (4/14/06)

*Obtain Calc. No. from R&DC and Form from Intranet

*Washington Closure Hanford* CALCULATION SHEET

Originator B. S. Wiegman Date 05/09/06 Calc. No. 0600X-CA-V0058 Rev. No. 0
Project 300 Area Field Remediation Job No. 14655 Checked T. M. Blakley Date 05/09/06
Subject 618-8 Burial Ground Cleanup Verification 95% UCL Calculations Sheet No. 1 of 5

Summary

**Purpose:**
Calculate the 95% upper confidence limit (UCL) to evaluate compliance with cleanup standards for the subject site. Also, calculate the carcinogenic risk for applicable nonradionuclide analytes, perform the *Washington Administrative Code* (WAC) 173-340 (Model Toxics Control Act [MTCA]) 3-part test, if required, and calculate the relative percent difference (RPD) for each contaminant of concern (COC).

**Table of Contents:**


**Given/References:**
1) Sample Results.
2) All lookup values, remedial action goals (RAGs), and background values are taken from DOE-RL (2001), DOE-RL (2004b), and Ecology (1994) unless stated otherwise.
3) DOE-RL, 2001, Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes, DOE/RL-92-24, Rev. 4, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
4) DOE-RL, 2004a, *300 Area Remedial Action Sampling and Analysis Plan* (SAP), DOE/RL-2001-48, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
5) DOE-RL, 2004b, *Remedial Design Report/Remedial Action Work Plan for the 300 Area* (RDR/RAWP), DOE/RL-2001-47, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
6) Ecology, 1992, *Statistical Guidance for Ecology Site Managers*, Publication #92-54, Washington State Department of Ecology, Olympia, Washington.
7) Ecology, 1993, *Statistical Guidance for Ecology Site Managers, Supplement S-6, Analyzing Site or Background Data with Below-Detection Limit or Below-PQL Values (Censored Data Sets)*, Publication #92-54, Washington State Department of Ecology, Olympia, Washington.
8) Ecology, 1994, Natural Background Soil Metals Concentrations in Washington State, Publication No. 94-115, Washington State Department of Ecology, Olympia, Washington.
9) Ecology, 1996, *Model Toxics Control Act Cleanup Levels and Risk Calculations (CLARC II)*, Publication #94-145, Washington State Department of Ecology, Olympia, Washington.
10) 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.
11) WAC 173-340, 1996, "Model Toxics Control Act--Cleanup," *Washington Administrative Code*.

**Solution:**
Calculation methodology is described in Ecology Pub. #92-54 (Ecology 1992, 1993), below, and in the RDR/RAWP (DOE-RL 2004b). Use data from the attached worksheets to calculate the 95% UCL, hazard quotients, excess carcinogenic risk, perform the WAC 173-340 3-part test for nonradionuclides, and calculate the RPD for each COC in the primary-duplicate and primary-split sample pairs.

**Calculation Description:**
The subject calculations were performed on data from soil verification samples from the 618-8 waste site. The data were entered into an EXCEL 2003 spreadsheet and calculations performed by utilizing the built-in spreadsheet functions and/or creating formulae within the cells. The statistical evaluation of data for use in accordance with the RDR/RAWP (DOE-RL 2004b) is documented by this calculation. Split and duplicate RPD results are used in evaluation of data quality and are presented in the cleanup verification package (CVP) for this site.

***Methodology:***
For nonradioactive analytes with <50% of the data below detection limits and all radionuclide analytes, the statistical value calculated to evaluate the effectiveness of cleanup is the 95% UCL. For nonradioactive analytes with >50% of the data below detection limits, the maximum value for the data set is used instead of the 95% UCL. All nonradionuclide data reported as being below detection limits are set to ½ the detection limit value for calculation of the statistics (Ecology 1993). For radionuclide data, calculation of the statistics was done on the reported value. In cases where the laboratory does not report a value below the minimal detectable activity (MDA), half of the MDA is used in the calculation. For the statistical evaluation of primary-duplicate sample pairs, the samples are averaged before being included in the data set, after adjustments for censored data as described above.

For nonradionuclides, the WAC 173-340 statistical guidance suggests that a test for distributional form be performed on the data and the 95% UCL calculated on the appropriate distribution using Ecology software. For nonradionuclide small data sets ($n < 10$) and all radionuclide data sets, the calculations are performed assuming nonparametric distribution, so no test for distribution is performed. For nonradionuclide data sets of ten or greater, distributional testing is done using Ecology's MTCAStat software (Ecology 1993). Background is subtracted for applicable radionuclides only. Comparison against background levels for nonradionuclides is included within the CVP.

The hazard quotient (for shallow zone nonradionuclide COCs) is determined by dividing the statistical value (derived in this calculation) by the WAC 173-340 non-carcinogenic cleanup limit. The excess nonradionuclide carcinogenic risk is determined by dividing the statistical value by the WAC 173-340 carcinogenic cleanup limit and then multiplying by $10^{-5}$.

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

The RPD is calculated when both the primary value and either the duplicate or split values 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, listed in Table II-1 of the SAP (DOE-RL 2004a). The RPD calculations use the following formula: $RPD = [\,|M-S|/((M+S)/2)]*100$

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

For quality assurance/quality control (QA/QC) split and duplicate RPD calculations, a value less than +/- 30% indicates the data compare favorably. For regulatory splits, a threshold of 35% is used (EPA 1994). If the RPD is greater than 30% (or 35% for regulatory split data), further investigation regarding the usability of the data is performed. Additional discussion as necessary is provided in the data quality assessment section of the applicable CVP.

If regulator split comparison is required, an additional parameter is evaluated. A control limit of +/- 2 times the TDL shall be used if either the main or regulator split value is less than 5 times the TDL and above detection. In the case where only one result is greater than 5 times the TDL and the other is below, the +/- 2 times the TDL criteria applies. Therefore, the following calculation is performed as part of the evaluation for these two cases involving regulator split data: difference = main - regulator split. If the difference is greater than +/- 2 times the TDL, then further investigation regarding the usability of the data is performed and presented in the applicable CVP data quality assessment section.

No regulatory split samples were collected for this site.

*Washington Closure Hanford* CALCULATION SHEET

Originator B. S. Wiegman Date 05/09/06 Calc. No. 0600X-CA-V0058 Rev. No. 0
Project 300 Area Field Remediation Job No. 14655 Checked T. M. Blakley Date 05/09/06
Subject 618-8 Burial Ground Cleanup Verification 95% UCL Calculations Sheet No. 2 of 5

**Summary (continued)**

Results:

The results presented in the summary tables that follow are for use in RESidual RADioactivity dose/risk analysis and the CVP for this site.

**Results Summary**

| Analyte | Shallow Zone | | Units |
|---|---|---|---|
| | Result | Qualifier | |
| Silver | 0.15 | U | mg/kg |
| Arsenic | 3.7 | | mg/kg |
| Barium | 93.3 | | mg/kg |
| Cadmium | 0.07 | U | mg/kg |
| Chromium | 11.8 | | mg/kg |
| Lead | 4.8 | | mg/kg |
| Selenium | 0.83 | | mg/kg |
| Uranium-233/234 | 0 (< BG) | | pCi/g |
| Uranium-235 | 0.118 | U | pCi/g |
| Uranium-238 | 0 (< BG) | | pCi/g |
| Total Uranium | 1.7 | | mg/kg |

**WAC 173-340 Evaluation**

3-Part Test:

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

Risk Estimate:

Nonrad noncarcinogenic index sum: 2.1E-03
Nonrad carcinogenic risk: 0

**Relative Percent Difference Results* QA/QC Analysis**

| Analyte | Shallow Zone | |
|---|---|---|
| | Duplicate Analysis** | Split Analysis** |
| Silver | | |
| Arsenic | | |
| Barium | 2.4% | 15% |
| Cadmium | | |
| Chromium | 12% | 22% |
| Lead | | |
| Selenium | | |
| Uranium-233/234 | | |
| Uranium-235 | | |
| Uranium-238 | | |

*A blank cell indicates that RPD evaluation was not required.
**The significance of the reported RPD values is addressed within the Data Quality Assessment for the CVP for this site.
QA/QC = quality assurance/quality control
RPD = relative percent difference
U = undetected

CALCULATION SHEET

*Washington Closure Hanford*

**Originator** B. S. Wiegman **Date** 05/09/06 **Calc. No.** 0600X-CA-V0058 **Rev. No.** 0
**Project** 300 Area Field Remediation **Job No.** 14655 **Checked** T. M. Blakley **Date** 05/09/06
**Subject** 618-8 Burial Ground Cleanup Verification 95% UCL Calculations **Sheet No.** 3 of 5

**Shallow Zone Sample Data**

| Sampling Area | HEIS Number | Sample Date | Silver | | | Arsenic | | | Barium | | | Cadmium | | | Chromium | | | Lead | | | Selenium | | | Total Uranium | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| A1 | J11271 | 1/31/2006 | 0.15 | U | 0.15 | 3.4 | | 0.36 | 81.3 | | 0.02 | 0.07 | U | 0.07 | 10.4 | | 0.17 | 4.5 | | 0.33 | 0.81 | | 0.38 | 1.28 | | 0.017 |
| Duplicate of J11271 | J11272 | 1/31/2006 | 0.15 | U | 0.15 | 4.1 | | 0.36 | 79.4 | | 0.02 | 0.07 | U | 0.07 | 11.7 | | 0.17 | 4.2 | | 0.33 | 0.76 | | 0.38 | 1.13 | | 0.017 |
| A2 | J11273 | 1/31/2006 | 0.15 | U | 0.15 | 3.8 | | 0.34 | 97.6 | | 0.02 | 0.07 | U | 0.07 | 12.4 | | 0.17 | 5.1 | | 0.32 | 0.51 | | 0.21 | 1.67 | | 0.017 |
| A3 | J11274 | 1/31/2006 | 0.15 | U | 0.15 | 2.4 | | 0.36 | 87.0 | | 0.02 | 0.07 | U | 0.07 | 10.2 | | 0.17 | 4.4 | | 0.33 | 0.85 | | 0.38 | 1.72 | | 0.017 |
| A4 | J11275 | 1/31/2006 | 0.15 | U | 0.15 | 2.4 | | 0.36 | 69.1 | | 0.02 | 0.07 | U | 0.07 | 9.4 | | 0.17 | 3.9 | | 0.32 | 0.69 | | 0.38 | 1.35 | | 0.017 |

**Statistical Computation Input Data**

| Sampling Area | HEIS Number | Sample Date | Silver mg/kg | | | Arsenic mg/kg | | | Barium mg/kg | | | Cadmium mg/kg | | | Chromium mg/kg | | | Lead mg/kg | | | Selenium mg/kg | | | Total Uranium pCi/g | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A1 | J11271/J11272 | 1/31/2006 | 0.08 | | | 3.8 | | | 80.4 | | | 0.04 | | | 11.1 | | | 4.4 | | | 0.79 | | | 1.21 | | |
| A1 | J11273 | 1/31/2006 | 0.08 | | | 3.8 | | | 97.6 | | | 0.04 | | | 12.4 | | | 5.1 | | | 0.51 | | | 1.67 | | |
| A2 | J11274 | 1/31/2006 | 0.08 | | | 2.4 | | | 87.0 | | | 0.04 | | | 10.2 | | | 4.4 | | | 0.85 | | | 1.72 | | |
| A4 | J11275 | 1/31/2006 | 0.08 | | | 2.4 | | | 69.1 | | | 0.04 | | | 9.4 | | | 3.9 | | | 0.69 | | | 1.35 | | |

**Statistical Computations**

| | Silver | | | Arsenic | | | Barium | | | Cadmium | | | Chromium | | | Lead | | | Selenium | | | Total Uranium | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 95% UCL value based on | Small data set. Use nonparametric z-statistic. | | | Small data set. Use nonparametric z-statistic. | | | Small data set. Use nonparametric z-statistic. | | | Small data set. Use nonparametric z-statistic. | | | Small data set. Use nonparametric z-statistic. | | | Small data set. Use nonparametric z-statistic. | | | Small data set. Use nonparametric z-statistic. | | | Small data set. Use nonparametric z-statistic. | | |
| N | 4 | | | 4 | | | 4 | | | 4 | | | 4 | | | 4 | | | 4 | | | 4 | | |
| % < Detection limit | 100% | | | 0% | | | 0% | | | 100% | | | 0% | | | 0% | | | 0% | | | 0% | | |
| mean | 0.08 | | | 3.1 | | | 83.5 | | | 0.04 | | | 10.8 | | | 4.4 | | | 0.7 | | | 1.5 | | |
| st. dev. | 0.00 | | | 0.79 | | | 11.9 | | | 0.00 | | | 1.3 | | | 0.5 | | | 0.15 | | | 0.249 | | |
| Z-statistic | 1.645 | | | 1.645 | | | 1.645 | | | 1.645 | | | 1.645 | | | 1.645 | | | 1.645 | | | 1.645 | | |
| 95% UCL on mean | 0.08 | | | 3.7 | | | 93.3 | | | 0.04 | | | 11.8 | | | 4.8 | | | 0.83 | | | 1.69 | | |
| max value | 0.15 | U | | 4.1 | | | 97.6 | | | 0.07 | U | | 12.4 | | | 5.1 | | | 0.85 | | | 1.72 | | |
| Statistical value | 0.15 | U | | 3.7 | | | 93.3 | | | 0.07 | U | | 11.8 | | | 4.8 | | | 0.83 | | | 1.69 | | |
| Background | 0.73 | | | 6.5 | | | 132 | | | 0.81 | | | 18.5 | | | 10 | | | 0.78 | | | 3.21 | | |
| Statistical value above background | 0.15 | U | | 3.7 | | | 93.3 | | | 0.07 | U | | 11.8 | | | 4.8 | | | 0.83 | | | 1.69 | | |
| **Most Stringent Cleanup Limit for nonradionuclide and RAG type** | 0.73 | BG/River Protection[a] | | 20 | DC | | 1600 | DC | | 13.9 | DC | | 120000 | DC | | 353 | DC | | 1 | River Protection[a] | | 53 | GW | |
| **WAC 173-340 3-PART Test** | | | | | | | | | | | | | | | | | | | | | | | | |
| 95% UCL > Cleanup Limit? | NO | | | NO | | | NO | | | NO | | | NO | | | NO | | | NO | | | NO | | |
| > 10% above Cleanup Limit? | NO | | | NO | | | NO | | | NO | | | NO | | | NO | | | NO | | | NO | | |
| Any sample > 2X Cleanup Limit? | NO | | | NO | | | NO | | | NO | | | NO | | | NO | | | NO | | | NO | | |
| **EXCESS RISK EVALUATION** | | | | | | | | | | | | | | | | | | | | | | | | |
| **WAC 173-340 Non-Carcinogenic Cleanup:** | 400 | | | 24 | | | 5600 | | | 80 | | | 120000 | | | 353 | | | 400 | | | 240 | | |
| Hazard quotient for each nonradionuclide: | 0 | | | 0 | | | 0 | | | 0 | | | 0 | | | 0 | | | 2.1E-03 | | | 0 | | |
| **WAC 173-340 Carcinogenic Cleanup:** | NA | | | 0.7 | | | NA | | | 13.9 | | | NA | | | NA | | | NA | | | NA | | |
| Risk for each carcinogenic nonradionuclide: | 0 | | | 0 | | | 0 | | | 0 | | | 0 | | | 0 | | | 0 | | | 0 | | |
| **WAC 173-340 3-Part-Test Compliance?** NO | Because all silver values are below background (0.73 mg/kg), calcualtion of excess risk is not required. | | | Because all arsenic values are below background (6.5 mg/kg), calcualtion of excess risk is not required. | | | Because all barium values are below background (132 mg/kg), calcualtion of excess risk is not required. | | | Because all cadmium values are below background (0.81 mg/kg), calcualtion of excess risk is not required. | | | Because all chromium values are below background (18.5 mg/kg), calcualtion of excess risk is not required. | | | Because all lead values are below background (0.10 mg/kg), calcualtion of excess risk is not required. | | | Because all selenium values are below background (0.78 mg/kg), calcualtion of excess risk is not required. | | | Because all uranium values are below background (3.21 mg/kg), calcualtion of excess risk is not required. | | |
| **Nonrad noncarcinogenic index sum:** 2.1.E-03 | | | | | | | | | | | | | | | | | | | | | | | | |
| **Nonrad carcinogenic risk:** 0 | | | | | | | | | | | | | | | | | | | | | | | | |

[a] No value is provided for this constituent in the 300 Area RDR/RAWP (DOE-RL 2004b), values for selenium and silver are determined based on WAC 173-340-740, 1996.

BG = background
DC = direct contact
GW = groundwater
HEIS = Hanford Environmental Information System
NA = not applicable
PQL = practical quantitation limit
Q = qualifier
RAG = remedial action goal
U = undetected
UCL = upper confidence limit
WAC = *Washington Administrative Code*

**Shallow Zone Sample Data (continued)**

| Sampling Area | HEIS Number | Sample Date | Uranium-233/234 pCi/g | Q | MDA | Uranium-235 pCi/g | Q | MDA | Uranium-238 pCi/g | Q | MDA |
|---|---|---|---|---|---|---|---|---|---|---|---|
| A1 | J11271 | 1/31/2006 | 0.540 | | 0.27 | 0 | U | 0.31 | 0.439 | | 0.26 |
| Duplicate of J11271 | J11272 | 1/31/2006 | 0.736 | | 0.26 | 0.081 | U | 0.31 | 0.401 | | 0.26 |
| A2 | J11273 | 1/31/2006 | 0.780 | | 0.35 | 0.056 | U | 0.42 | 0.734 | | 0.35 |
| A3 | J11274 | 1/31/2006 | 1.19 | | 0.40 | 0.314 | U | 0.48 | 0.363 | U | 0.40 |
| A4 | J11275 | 1/31/2006 | 0.778 | | 0.25 | 0.078 | U | 0.30 | 0.518 | | 0.25 |

**Statistical Computation Input Data**

| Sampling Area | HEIS Number | Sample Date | Uranium-233/234 pCi/g | | | Uranium-235 pCi/g | | | Uranium-238 pCi/g | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| A1 | J11271/J11272 | 1/31/2006 | 0.638 | | | 0.041 | | | 0.420 | | |
| A1 | J11273 | 1/31/2006 | 0.780 | | | 0.056 | | | 0.734 | | |
| A2 | J11274 | 1/31/2006 | 1.19 | | | 0.314 | | | 0.363 | | |
| A4 | J11275 | 1/31/2006 | 0.778 | | | 0.078 | | | 0.518 | | |

**Statistical Computations**

| | Uranium-233/234 | | | Uranium-235 | | | Uranium-238 | | |
|---|---|---|---|---|---|---|---|---|---|
| Statistical value based on | Radionuclide data set. Use nonparametric z-statistic. | | | Radionuclide data set. Use nonparametric z-statistic. | | | Radionuclide data set. Use nonparametric z-statistic. | | |
| N | 4 | | | 4 | | | 4 | | |
| % < Detection limit | 0% | | | 100% | | | 25% | | |
| mean | 0.847 | | | 0.122 | | | 0.509 | | |
| st. dev. | 0.238 | | | 0.129 | | | 0.163 | | |
| Z-statistic | 1.645 | | | 1.645 | | | 1.645 | | |
| 95% UCL on mean | 1.04 | | | 0.228 | | | 0.643 | | |
| max value | 1.19 | | | 0.314 | U | | 0.734 | | |
| Statistical value | 1.04 | | | 0.228 | U | | 0.643 | | |
| Background | 1.1 | | | 0.11 | | | 1.1 | | |
| Statistical value above background | 0 (< BG) | | | 0.118 | U | | 0 (< BG) | | |

HEIS = Hanford Environmental Information System
MDA = minimum detectable activity
NA = not applicable
Q = qualifier
RAG = remedial action goal
U = undetected
UCL = upper confidence limit
WAC = *Washington Administrative Code*

CALCULATION SHEET

*Washington Closure Hanford*

Originator B. S. Wiegman | Date 05/09/06 | Calc. No. 0600X-CA-V0058 | Rev. No. 0
Project 300 Area Field Remediation | Job No. 14655 | Checked T. M. Blakley | Date 05/09/06
Subject 618-8 Burial Ground Cleanup Verification 95% UCL Calculations | Sheet No. 5 of 5

**Split-Duplicate Analysis**

**Shallow Zone Sample Results:**

| Sampling Area | HEIS Number | Silver | | | Arsenic | | | Barium | | | Cadmium | | | Chromium | | | Lead | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| A1 | J11271 | 0.15 | U | 0.15 | 3.4 | | 0.36 | 81.3 | | 0.02 | 0.07 | U | 0.07 | 10.4 | | 0.17 | 4.5 | | 0.33 |
| Duplicate of J11271 | J11272 | 0.15 | U | 0.15 | 4.1 | | 0.36 | 79.4 | | 0.02 | 0.07 | U | 0.07 | 11.7 | | 0.17 | 4.2 | | 0.33 |
| Split of J11271 | J11277 | 1.1 | U | 1.1 | 3.5 | | 1.1 | 94.9 | | 21.3 | 0.53 | U | 0.53 | 8.3 | | 1.1 | 3.9 | | 1.1 |

**Shallow Zone Analysis:**

| TDL | | 0.2 | 10 | 2 | 0.2 | 1 | 5 |
|---|---|---|---|---|---|---|---|
| Duplicate Analysis | Both > MDA? | No-Stop (acceptable) | **Yes (continue)** | **Yes (continue)** | No-Stop (acceptable) | **Yes (continue)** | **Yes (continue)** |
| | Both > 5xTDL? | | No-Stop (acceptable) | **Yes (calc RPD)** | | **Yes (calc RPD)** | No-Stop (acceptable) |
| | RPD | | | 2.4% | | 12% | |
| Split Analysis | Both > MDA? | No-Stop (acceptable) | **Yes (continue)** | **Yes (continue)** | No-Stop (acceptable) | **Yes (continue)** | **Yes (continue)** |
| | Both > 5xTDL? | | No-Stop (acceptable) | **Yes (calc RPD)** | | **Yes (calc RPD)** | No-Stop (acceptable) |
| | RPD | | | 15% | | 22% | |

**Shallow Zone Sample Results (continued)**

| Sampling Area | HEIS Number | Selenium | | | Total Uranium | | | Uranium-233/234 | | | Uranium-235 | | | Uranium-238 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | mg/kg | Q | PQL | mg/kg | Q | PQL | pCi/g | Q | MDA | pCi/g | Q | MDA | pCi/g | Q | MDA |
| A1 | J11271 | 0.81 | | 0.38 | 1.28 | | 0.017 | 0.540 | | 0.270 | 0.000 | U | 0.310 | 0.439 | | 0.260 |
| Duplicate of J11271 | J11272 | 0.76 | | 0.38 | 1.13 | | 0.017 | 0.736 | | 0.260 | 0.081 | U | 0.310 | 0.401 | | 0.260 |
| Split of J11271 | J11277 | 0.33 | B | 1.6 | 3.28 | | 0.020 | 1.14 | | 0.053 | 0.078 | | 0.030 | 1.10 | | 0.053 |

**Shallow Zone Analysis**

| TDL | | 1 | 1.0 | 1.0 | 0.5 | 1.0 |
|---|---|---|---|---|---|---|
| Duplicate Analysis | Both > MDA? | **Yes (continue)** | **Yes (continue)** | **Yes (continue)** | No-Stop (acceptable) | **Yes (continue)** |
| | Both > 5xTDL? | No-Stop (acceptable) | No-Stop (acceptable) | No-Stop (acceptable) | | No-Stop (acceptable) |
| | RPD | | | | | |
| Split Analysis | Both > MDA? | No-Stop (acceptable) | **Yes (continue)** | **Yes (continue)** | No-Stop (acceptable) | **Yes (continue)** |
| | Both > 5xTDL? | | No-Stop (acceptable) | No-Stop (acceptable) | | No-Stop (acceptable) |
| | RPD | | | | | |

Note: The significance of the reported RPD values, including values greater than 30%, is addressed within the Data Quality Assessment section of the Cleanup Verification Package for this site.

B = analyte found in method blank

HEIS = Hanford Environmental Information System

MDA = minimum detectable activity

PQL = practical quantitation limit

Q = qualifier

RPD = relative percent difference

TDL = target detection limit

U = undetected

# DISTRIBUTION

U.S. Department of Energy
Richland Operations Office

| | |
|---|---|
| J. R. Franco | A3-04 |
| S. L. Sedgwick | A7-80 |
| D. C. Smith (5) | A3-04 |
| RL Correspondence Control | A5-10 |
| DOE-RL Public Reading Room | H2-53 |

Fluor Hanford, Inc.

| | |
|---|---|
| J. P. Shearer (WIDS) | A0-21 |

Washington Closure Hanford

| | |
|---|---|
| K. A. Anselm | H9-02 |
| R. A. Carlson | X0-17 |
| S. W. Clark | H9-01 |
| F. M. Corpuz | L6-06 |
| J. W. Darby | L6-06 |
| L. A. Dietz | H0-23 |
| L. M. Dittmer | H9-02 |
| M. J. Haass | L6-06 |
| R. B. Kerkow | L6-06 |
| J. E. Thomson | H0-23 |
| Records and Document Control | H0-30 |
| Hanford Technical Library | P8-55 |