DOE/RL-2010-111
Revision 0

Remaining Sites Verification Package for the 216-N-6 Waste Site Located in the 200-CW-3 Operable Unit

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

U.S. DEPARTMENT OF ENERGY
Richland Operations Office

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Approval

U.S. Department of Energy, Richland Operations Office

Signature 3/1/11 Date

U.S. Environmental Protection Agency, Region 10

Signature 3/2/11 Date

REMAINING SITES VERIFICATION PACKAGE FOR THE 216-N-6 WASTE SITE LOCATED IN THE 200-CW-3 OPERABLE UNIT

Executive Summary

This report summarizes the successful completion of the remedial action at the 216-N-6 Waste Site. This report demonstrates that the 216-N-6 Waste Site, following completion of the interim remedial action, meets the objectives for the selected remedy of removal, treatment, and disposal (RTD) specified in the *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington (100 Area Remaining Sites)* (EPA/541/R-99/039, Remaining Sites Record of Decision [ROD]).

The 216-N-6 Waste Site, also identified as the 216-N-6 Swamp, is part of the 200-CW-3 Operable Unit and is located in the 200 North Area of the Hanford Site. This pond received overflow cooling water from the 212-R Fuel Storage Facility. The field remedial action activities for the 216-N-6 Waste Site commenced with the initial site investigation in June 2009, progressed through RTD of contaminated soil, and concluded with verification sampling in September 2010. Evaluation of sampling results in October 2010 leads to the determination that, following completion of the remedial action, the site meets the remedial action goals and remedial action objectives (RAOs). Field work and determination of successful completion were conducted and performed in accordance with DOE/RL-2007-55, *Remedial Design/Remedial Action Work Plan for 200 North Area Waste Sites located in the 200-CW-3 Operable Unit* (RD/RAWP) and DOE/RL-2007-54, *Sampling and Analysis Plan for Remediation of 200 North Area Waste Sites Located in the 200-CW-3 Operable Unit.*

The analytical results show that the residual soil concentration of contaminants of concern supports the reasonably anticipated future land use recognized in the Remaining Sites ROD (EPA/541/R-99/039) and the RD/RAWP (DOE/RL-2007-55) (for the purposes of this interim action, RAOs were selected that would support unrestricted land use). These results support reclassification of the waste site to "interim closed out" in accordance with the process described in RL-TPA-90-0001, *Tri-Party Agreement Handbook Management Procedures*, Guideline Number TPA-MP-14, "Maintenance of

the Waste Information Data System (WIDS)." Finalization of this report constitutes concurrence by the signing parties that RAOs have been met, and thus backfill and/or contouring may take place as described in Sections 3.1.2 and 3.1.5 of the RD/RAWP. Once the waste site has been backfilled and/or contoured, native plant species will be seeded in each area, as applicable, as an interim step towards final revegetation, in accordance with Section 3.5.5 of the RD/RAWP. No institutional controls are required because no deep zone is associated with the 216-N-6 Waste Site.

The 216-N-6 Waste Site and data acquired from the subject sampling evolution will be included in the risk assessment and the remedial investigation and feasibility study addressing final remedial decisions of this area.

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Terms

bgs	below ground surface
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
COC	contaminant of concern
COPC	contaminant of potential concern
DOE	U.S. Department of Energy
DQA	data quality assessment
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
HEIS	Hanford Environmental Information System
MCL	maximum contaminant level
NA	not available
N/A	not applicable
NR	analysis not reported
OU	operable unit
PCB	polychlorinated biphenyl
PQL	practical quantitation limit
QA	quality assurance
QC	quality control
RAG	remedial action goal
RAO	remedial action objective
RDL	required detection limit
RD/RAWP	remedial design/remedial action work plan
RESRAD	RESidual RADioactivity

ROD	Record of Decision
RTD	removal, treatment, and disposal
SAP	sampling and analysis plan
WIDS	Waste Information Data System

REMAINING SITES VERIFICATION PACKAGE FOR THE 216-N-6 WASTE SITE LOCATED IN THE 200-CW-3 OPERABLE UNIT

1.0 STATEMENT OF PROTECTIVENESS

When the removal, treatment, and disposal (RTD) action was selected for for the 216-N-6 Waste Site, soil with contaminant concentrations above remedial action goals (RAGs) was excavated to an approximate depth of 4.6 m (15 ft) below ground surface. Contaminant concentrations in the remaining soils were determined through the analysis of soil samples collected from the excavated waste sites and the comparison of the analytical results against established cleanup standards. The results of verification sampling following implementation of the RTD remedy at the 216-N-6 Waste Site demonstrate that the waste site meets the cleanup standards specified in the *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6 and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington (100 Area Remaining Sites)* (Remaining Sites Record of Decision [ROD]) (EPA/541/R-99/039) and the *Remedial Design/Remedial Action Work Plan for 200 North Area Waste Sites located in the 200-CW-3 Operable Unit* (RD/RAWP) (DOE/RL-2007-55). The results summarized in this report demonstrate residual contaminant concentrations in the soil in the 216-N-6 Waste Site area support unrestricted future use of shallow zone soil (i.e., surface to 4.6 m [15 ft]) and contaminant levels remaining in the soil are protective of groundwater and the Columbia River. There is no deep zone for the 216-N-6 Waste Site; therefore, no institutional controls are required.

The data resulting from this remedial action will be evaluated against the final clean-up standards developed for the Outer Area. Those standards are in development by way of two independent baseline risk assessments. A baseline risk assessment for the river corridor portion of the Hanford Site, began in 2004, and includes a more complete quantitative ecological risk assessment than what was developed for the Remaining Sites ROD. Separately, an ecological risk assessment is in development for the final remedial action for the Outer Area. When complete, the risk assessment for the Outer Area will include the 200-CW-3 waste sites (including 216-N-6) to support final remedial decisions.

2.0 GENERAL SITE INFORMATION AND BACKGROUND

The 200-CW-3 Operable Unit (OU) is located in the 200 East and West Areas on the Hanford Site, in the 200 North Area (Figure 1). Operations in the 200 North Area were primarily related to irradiated nuclear fuel rod storage. Fuel rods were stored in water-filled basins while the decay of short-lived radioisotopes occurred (also known as "cooling"). The 200-CW-3 Waste Site Group includes areas of contamination resulting from the release of cooling water from the fuel storage basins.

The Waste Information Data System (WIDS) describes the 216-N-6 Waste Site as a pond that received overflow cooling water from the 212-R Fuel Storage Facility through a subgrade 46 cm (18-inch) diameter vitrified clay pipeline (600-287-PL). The dimensions provided by the WIDS database for this waste site are 152.4 m (500 ft) long by 45.72 m (150 ft) wide, which yields a calculated surface area of 6,967.72 m^2 (75,000 ft^2). The pond is situated 274 m (900 ft) south, southeast of the 212-R Building (shown in Figure 2), which has been demolished. The pond consisted of a natural depression in the terrain while in operation. The discharged water was dispersed through evaporation and infiltration into the ground. Historical records indicate the site was deactivated in June 1952 and backfilled with 0.61 to 1.83 m (2 to 6 ft) of clean soil.

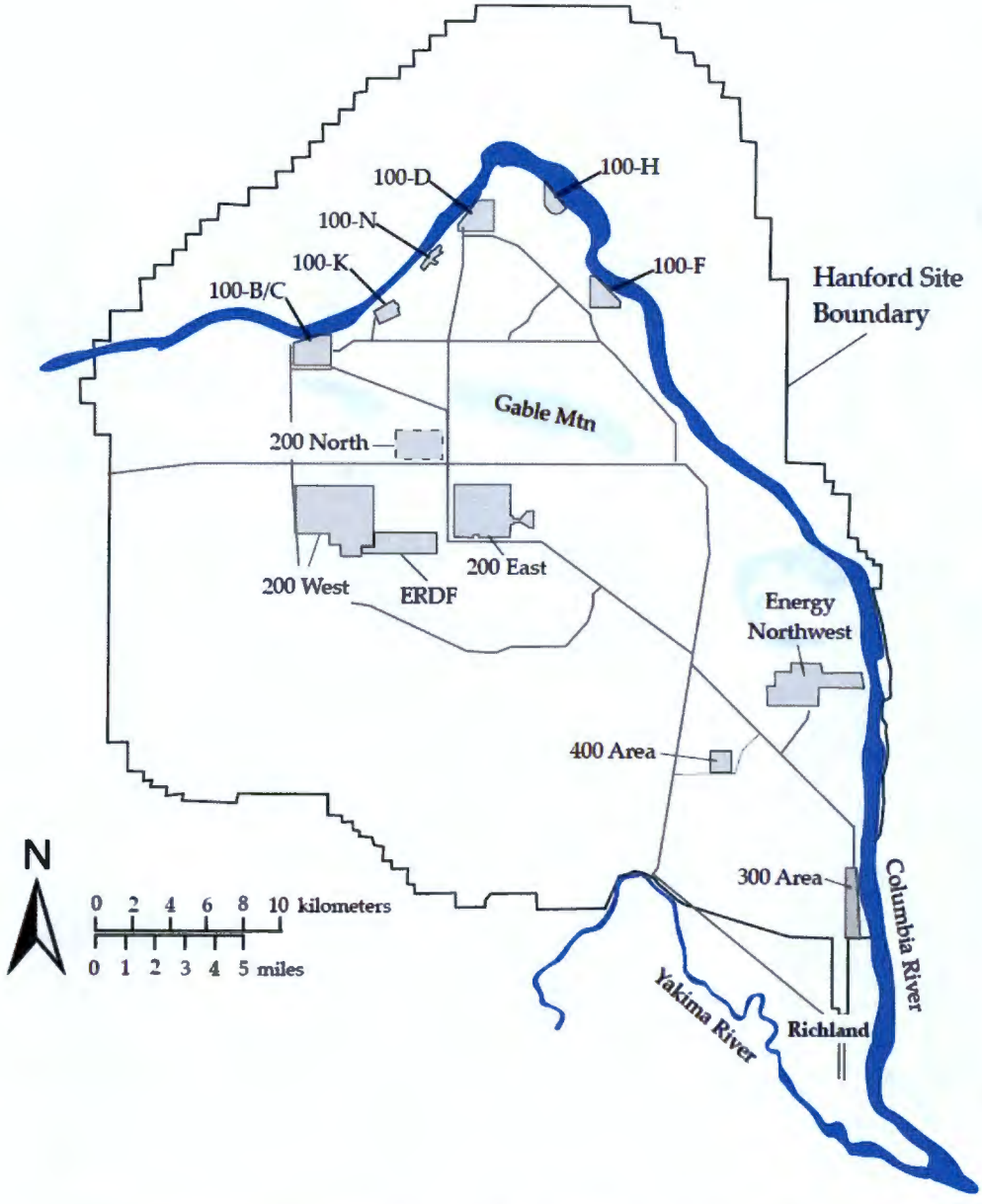

Figure 1. Location of the Hanford Site and the 200 North Area

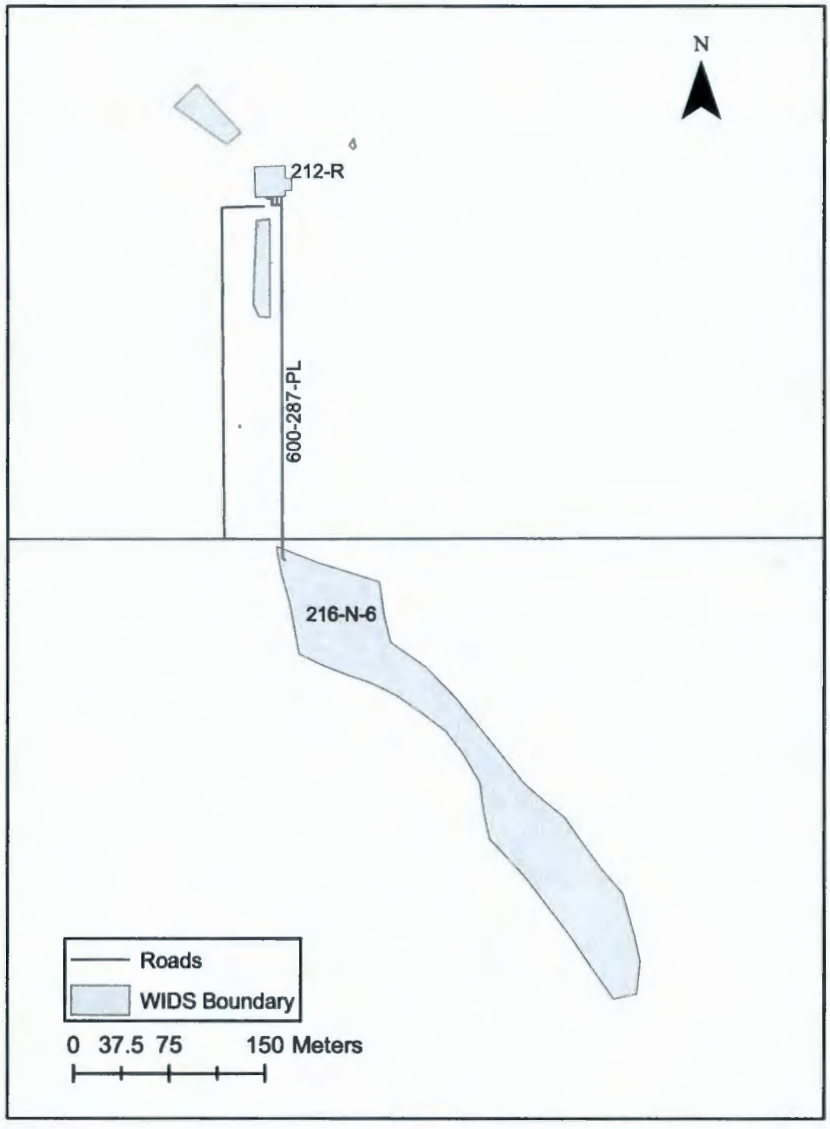

Figure 2. 216-N-6 Waste Site Location Map

3.0 SUMMARY OF REMEDIAL ACTION OBJECTIVES FOR THE 216-N-6 WASTE SITE

The analytical results from sampling evolutions (investigative and verification) of the 216-N-6 Waste Site indicate compliance with the RAGs and thus, the remedial action objectives (RAOs) identified in the Remaining Sites ROD (EPA/541/R-99/039) and the RD/RAWP (DOE/RL-2007-55). The RAOs provided in the Remaining Sites ROD and RD/RAWP are:

- RAO 1: Protect human and ecological receptors from exposure to contaminants in soils, structures, and debris by dermal exposure, inhalation, or ingestion of radionuclides, inorganics, or organics.

- RAO 2: Control the sources of groundwater contamination to minimize the impacts to groundwater resources, protect the Columbia River from further adverse impacts, and reduce the degree of groundwater cleanup that may be required under future actions.

Table 1 provides a summary of the applicable regulatory requirements, the RAGs, the remediation results, and the attainment of the RAOs. Appendix G presents detailed sample analysis data.

Table 1. Summary of Attainment of Remedial Action Objectives for the 216-N-6 Waste Site

Regulatory Requirement	Remedial Action Goals[a]	Results	Remedial Action Objectives Attained?
Direct Exposure – Radionuclides	Attain total dose for radionuclides that does not exceed 15-mrem/year above background over 1,000 years.	Residual concentrations of radionuclide COCs are below background or less than one-tenth the single radionuclide soil concentration equivalent to a 15 mrem/year dose rate calculated by RESRAD (Appendix A).	Yes
Direct Exposure – Nonradionuclides	Reduce concentration of inorganics and organics to WAC 173-340, Method B levels.	All individual COC concentrations are below the direct exposure criteria. Results are presented in Appendix B.	Yes
Risk Requirements – Nonradionuclides	Attain a hazard quotient of <1 for all individual noncarcinogens.	All individual COC concentrations are below Hanford Specific background value (see Appendix B and Appendix G, Table G-2). Therefore, any calculated individual hazard quotients are <1. See Appendix C for calculations.	Yes
	Attain a cumulative hazard quotient of <1 for noncarcinogens.	All individual COC concentrations are below Hanford Specific background value (see Appendix B and Appendix G, Table G-2). Therefore, any calculated cumulative hazard quotient is <1. See Appendix C for calculations.	
	Attain an excess cancer risk of $<1 \times 10^{-6}$ for individual carcinogens.	All individual COC concentrations are below background levels (see Appendix B and Appendix G, Table G-2). Therefore, any excess cancer risk calculated for these constituents meet the $<1 \times 10^{-6}$ criteria. See Appendix C for calculations.	
	Attain a cumulative excess cancer risk of $<1 \times 10^{-5}$ for carcinogens.	All individual COC concentrations are below background levels (see Appendix B and Appendix G, Table G-2). Therefore, any cumulative excess cancer risk calculated for these constituents meet the $<1 \times 10^{-5}$ criteria. See Appendix C for calculations.	

Regulatory Requirement	Remedial Action Goals[a]	Results	Remedial Action Objectives Attained?
Groundwater/River Protection – Radionuclides	Attain single COC groundwater and river protection RAGs.	Maximum residual concentrations of radionuclide COCs were detected below groundwater and river protection exposure criteria (Appendix D). Values calculated by RESRAD that are protective of the groundwater are also protective of the Columbia River, since contaminant pathway to the Columbia River is through the groundwater. ***NOTE**: For uranium-233/234 and uranium-238, the groundwater MCL of 21.2 pCi/L corresponds to a soil concentration of 0.185 pCi/g. However, the Hanford specific background for these uranium isotopes is 1.1 pCi/g. The RAG therefore defaults to 1.1 pCi/g.* (Appendix D, Footnote d).	Yes
	Attain national primary drinking water standards 4 mrem/yr (beta/gamma) dose rate to target receptor/organs.	Maximum residual concentrations of beta/gamma radionuclide COCs were detected below groundwater and river protection exposure criteria. (Appendix A, Footnote b).	
	Meet drinking water standards[b] for alpha emitters: the most stringent of 15 pCi/L MCL or 1/25th of the derived concentration guides from DOE Order 5400.5.	Maximum residual concentrations of alpha emitting radionuclide COCs were detected below groundwater and river protection exposure criteria (Table 2 and Appendix D). RESRAD calculations predict that the only alpha-emitting radionuclide COCs with the potential to reach groundwater within 1,000 years are the uranium isotopes. ***NOTE**: For uranium-233/234 and uranium-238, the groundwater MCL of 21.2 pCi/L corresponds to a soil concentration of 0.185 pCi/g. However, the Hanford specific background for these two uranium isotopes is 1.1 pCi/g. The RAG therefore defaults to 1.1 pCi/g.* (Appendix D, Footnote d).	Yes
	Meet total uranium standard of 21.2 pCi/L. [d]	For uranium-233/234 and uranium-238, the groundwater MCL of 21.2 pCi/L corresponds to a soil concentration of 0.185 pCi/g (Appendix C). However, the Hanford Site specific background for these two uranium isotopes is 1.1 pCi/g. The RAG therefore defaults to 1.1 pCi/g. (Appendix D, Footnote d).	
Groundwater/River Protection – Nonradionuclides	Attain individual nonradionuclide groundwater and river cleanup requirements.	Maximum detected results for all nonradionuclides are below the RAGs for protection of groundwater. (Appendix E).	Yes

Regulatory Requirement	Remedial Action Goals[a]	Results	Remedial Action Objectives Attained?

Notes:

a. Remaining Sites ROD.

b. "National Primary Drinking Water Regulations" (40 *Code of Federal Regulations* 141).

c. *Radiation Protection of the Public and the Environment* (DOE Order 5400.5).

d. Based on the isotopic distribution of uranium in the 100 Areas, 30 µg/L MCL corresponds to 21.2 pCi/L. Concentration-to-activity calculations are documented in *Calculation of Total Uranium Activity Corresponding to a Maximum Contaminant Level for Total Uranium of 30 Micrograms per Liter in Groundwater* (BHI Calculation 0100X-CA-V0038.

WAC 173-340, "Model Toxics Control Act—Cleanup"
Abbreviations: COC = contaminant of concern
MCL = maximum contaminant level (drinking water standard)
RAG = remedial action goal

4.0 INVESTIGATION WASTE SITE CHARACTERIZATION AND CONCEPTUAL MODEL SAMPLING

Initial investigative sampling was performed to determine the nature and extent of contaminants in the 216-N-6 Waste Site soils. These results served three primary purposes: (1) to confirm the selected remedy, (2) to support design of RTD implementation, and (3) to support waste characterization and disposal. The waste site was characterized in accordance with the DOE/RL-2007-55, *Remedial Design/Remedial Action Work Plan for 200 North Area Waste Sites located in the 200-CW-3 Operable Unit* (RD/RAWP) and the DOE/RL-2007-54, *Sampling and Analysis Plan for Remediation of 200 North Area Waste Sites Located in the 200-CW-3 Operable Unit* (SAP). Soil sampling and analysis and radiological screening confirmed that RTD was as the appropriate remedy selected for this site.

This section provides geophysical information for the area and waste site, the contaminants of concern (COCs) for the subject waste site, and a summary of the investigative sampling results as applicable to the development of the specific remedial action and verification sampling.

4.1 Geophysical Survey Results

The Hanford Site lies in a sediment-filled basin on the Columbia Plateau in southeastern Washington. The 200-CW-3 operable unit waste sites are located in the 200 North Area which is situated on the 200 Areas Plateau north of a relatively flat prominent terrace (Cold Creek Bar), on a flood channel formed during the late Pleistocene flooding. The elevation in the vicinity ranges from approximately 180 m (593 ft) in the northern part of the unit to about 170 m (560 ft) above mean sea level in the southern part. There are no natural surface drainage features within the 200 North Area.

The vadose zone beneath the 200 Areas ranges in thickness from approximately 55 m (180 ft) beneath the former U Pond in the 200 West Area to approximately 104 m (341 ft) in the southern portion of the 200 East Area to approximately 49 m (160 ft) along the western part of the 200 North Area. Basalt of the Columbia River Basalt Group and a sequence of overlying sediments comprise the local geology. Sediments in the vadose zone consist primarily of the Hanford formation, Cold Creek unit/silt-dominated facies of the Cold Creek unit, and Ringold Formation. The caliche or calcic facies of the Cold Creek unit is also present in the 200 West Area.

Groundwater beneath the Hanford Site is found in an upper primarily unconfined aquifer system and in deeper confined aquifers within the basalt. The Columbia River is the primary discharge area for both the unconfined and confined aquifers. The unconfined aquifer in the 200 North Area of the Central Plateau occurs in the Hanford formation. In general, groundwater flowing through the Central Plateau occurs in a predominantly easterly direction from the 200 West Area to the 200 East Area.

The nearest natural surface water body to the 200 North Area is West Lake (216-N-8 Pond) located approximately 0.8 km (0.5 mi) east. The potential for natural groundwater recharge within the 200 North Area is limited to precipitation infiltration. Estimates of recharge from precipitation at the Hanford Site range from 0 to 10 cm/yr (0 to 4 in/yr).

Waste Site 216-N-6 is a pond that received overflow cooling water from the 212-R Fuel Storage Facility through a pipeline (600-287-PL). The pond consisted of a natural depression in the terrain while in operation. The discharged water was dispersed by evaporation and infiltration into the ground. This site was associated with the 600-287-PL operational discharge line from 1944 through 1952 and, as a result, represents the potential time period the surface area soils could have been saturated. The pond was intermittently supplied with liquid discharged as gravity-fed overflow from the 212-R cooling basin during this period. In addition, the absence of a recurring liquid discharge (or any known liquid discharge) to this area after 1952 would have restricted any additional drivers for vertical migration and distribution of COCs through the sediments of the vadose zone other than the original operational discharges.

4.2 Contaminants of Concern

The COCs for the 216-N-6 Waste Site were identified based initially on historic/process information for the waste site and the contaminants of potential concern (COPCs) listed in the Remaining Sites ROD. Through the analytical results from the investigative sampling evolution, the COC list was developed, and it represents the full COPC list presented in the RD/RAWP and SAP. Table 2 provides the COCs for the 216-N-6 Waste Site.

Table 2. Contaminants of Concern for the 216-N-6 Waste Site

Barium	Americium-241
Antimony	Cesium-137
Arsenic	Cobalt-60
Chromium (III)	Europium-152
Mercury	Europium-154
Chromium (VI)	Europium-155
Cadmium	Plutonium-238
Lead	Plutonium-239/240
Manganese	Nickel-63
Zinc	Tritium-3
Polychlorinated Biphenyls (PCBs)	Strontium-90
	Technetium-99
	Thorium-232
	Uranium-233/234
	Uranium-235
	Uranium-238

4.3 Waste Site Sample Design for Conceptual Model Confirmation and RTD Design

The nature of the 200-CW-3 OU waste sites supports the use of judgment/focused sampling for the waste site investigations, as identified in EPA/240/R-02/005, *Guidance on Choosing a Sampling Design for Environmental Data Collection*. The function and discharge point of 216-N-6 pond was known. Investigative sampling was performed in a focused manner to determine the extent of contamination. Sampling was initiated at the point where effluent exited the discharge pipe and entered the pond (the northern most end of the waste site), which was expected to contain the highest concentration of COPCs. Sampling continued downgradient (with effluent flow) and laterally to identify locations that the COPCs were above action levels. In adherence to guidance in the RD/RAWP and SAP, samples were collected at various depths below the ground surface (bgs) (to a maximum of 15 ft bgs) to determine the vertical extent of contamination.

Due to the presence of radiological constituents in discharge stream, radiological field surveys were an integral element of the investigative sampling evolution allowing real-time indication of the presence of COPCs (based on radiological indicators) during the sample collection activities.

Investigative sampling was performed June 9 through June 15, 2009. As shown in Figure 3, 19 sample locations were identified. Sample locations 1 through 7 were targeted because they are located in the influent stream portion of the pond (lowest elevation) to define the extent of downgradient contamination from the point source. Sample locations 8 through 13 were targeted to define the lateral extent of contamination from the influent stream area. If the extent of contamination could not be determined based on locations 1 through 13, sampling would progress to sample locations 14 through 19. Following this rationale, additional sample locations would be developed based on sample results as needed.

The specific investigative sampling design for the 216-N-6 Waste Site was developed in accordance with the SAP, and follows the conceptual site model for surface spills developed under the remaining sites ROD. The conceptual model for surface spills includes the physical components and sample media at the site, sampling access, spatial boundaries and spatial distribution of contaminants.

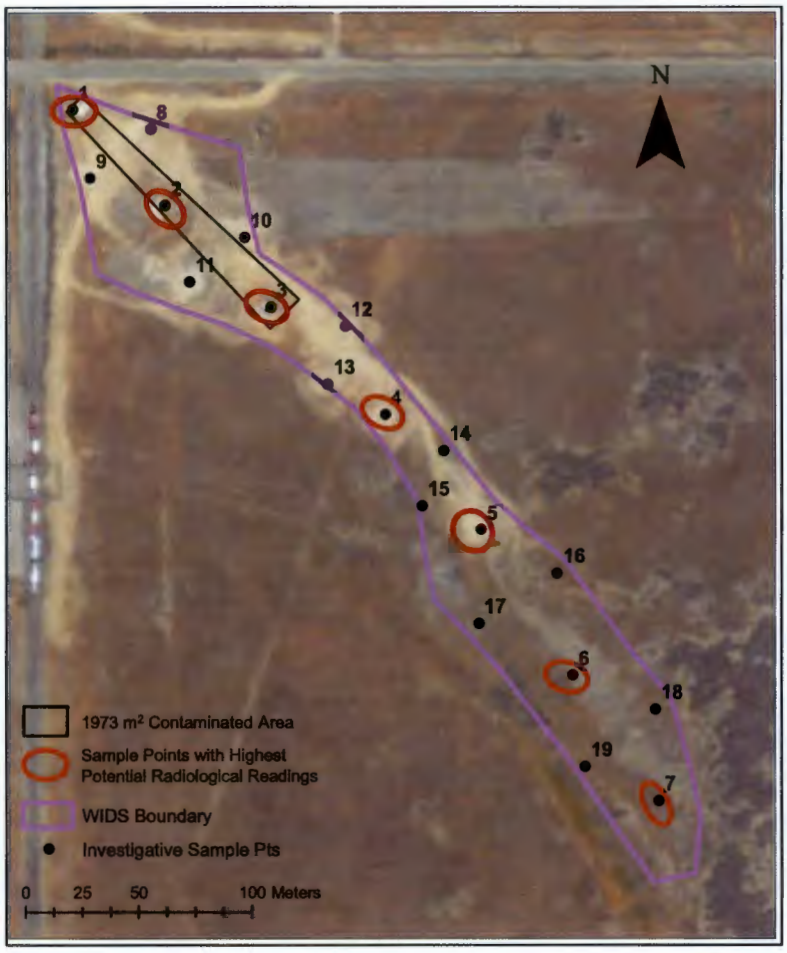

Figure 3. Aerial Image and Sample Locations

4.4 Sample Summary

As per the guidance prescribed in the SAP, discrete soil samples were collected at locations expected to contain highest concentrations of COPCs based on historic/process knowledge and at locations showing radiological and/or visual indicators (such as soil staining). Radiological indicators (dose rate readings above background) were found at three locations: sample location 1, 2, and 3.

Appendix F provides analytical results from investigative sampling, which provide the basis for transitioning from a listing of "potential" contaminants (COPCs), to the list of known contaminants (COCs). One constituent (cesium-137) was found above action levels at sample locations 1, 2, and 3 at various depths ranging from 0.9 to 1.5 m (3 to 5 ft) below ground surface. Additionally, sample location 1 returned results above RAGs for europium-152, strontium-90, and arsenic at 0.9 m (3 ft) below ground surface. Contaminants at all other sample locations were below Look-Up Values. The results of investigative sampling effectively identified and bounded the extent of the contaminated area to be subject to RTD. The investigative sampling reduced the area originally attributed to the waste site to 3,557 m^2 (38,287 ft^2) (Figure 4).

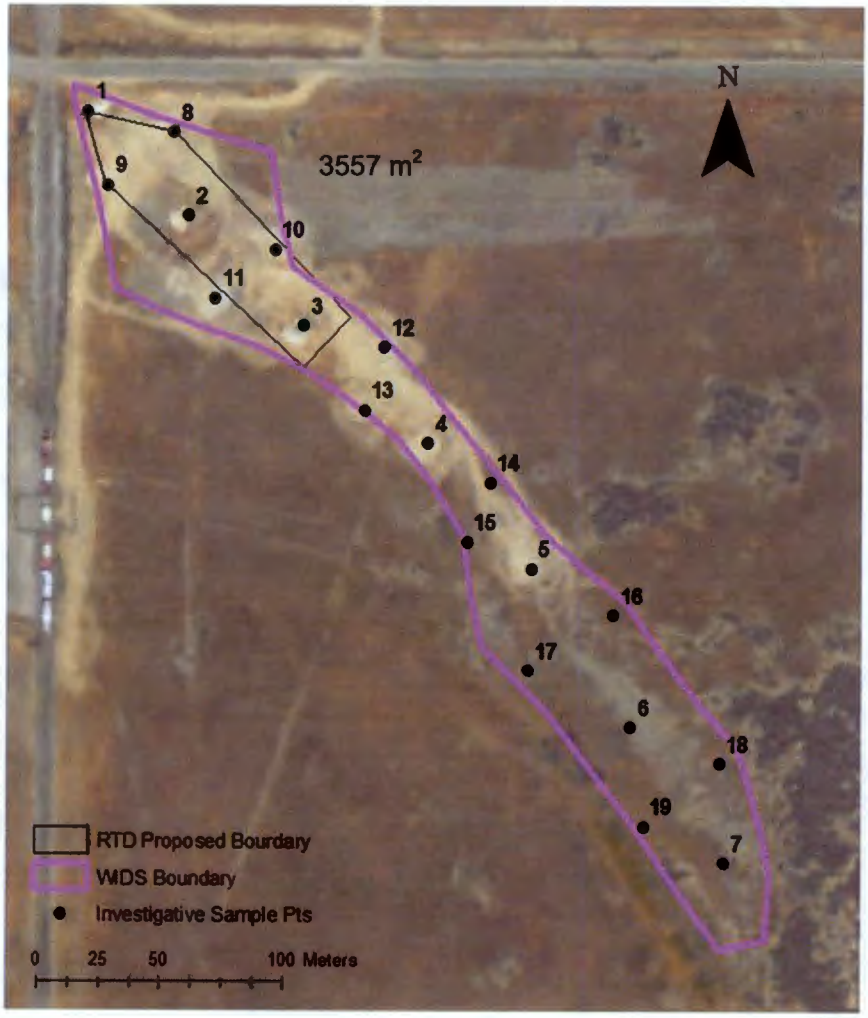

Figure 4. 216-N-6 RTD Area

5.0 WASTE SITE SAMPLING AFTER REMEDIATION ACTIVITIES

The selected remedy of RTD commenced at 216-N-6 Waste Site in July 2010 and was completed in August 2010. RTD activities involved the removal of contaminated soil from the 216-N-6 Waste Site and disposal at the Environmental Restoration Disposal Facility (ERDF).

The investigative sample findings provided the requisite information to commence excavation activities. As a result of plotting the investigative sample results, the extent of contamination became manifest, bounded by sample locations 1, 3, 8, 9, 10, and 11 (shown in Figure 4). Radiological field screening provided real-time input to further guide the excavation. The maximum vertical excavation depth was set at 4.6 m (15 ft) bgs.

The final excavation area was 2,584 m^2 (26,625.8 ft^2) measured at ground surface. Additionally, the excavation was finished with a slope of 1.5 to 1.0, to a range of depths with the base (floor) of the excavation varying from roughly 1.21 m (4 ft) to 2.43 m (8 ft) (shown in Figure 5). Approximately 7,408 metric tons (8,167 tons) of media (soil) were removed from the site and disposed of at ERDF.

Verification sampling was performed in September 2010. Laboratory analysis was performed to verify that remediation was complete and demonstrate quantitatively that RAOs were met. The following sections provide a summary of the results of verification sampling and the attainment of RAOs.

5.1 Verification Sampling

Discrete samples were collected from the remediated area using a statistical sampling design. The number of samples and sample locations were determined using Visual Sample Plan (VSP)[1] software and a statistical sampling design with random start and 95 percent upper confidence limit. Table 3 provides sample location coordinates, and Figure 5 provides a map of sample locations.

Figure 5 depicts the excavated area. As described in the SAP, results from radiological field screening for detectable radiological contamination or cesium-137, an "indicator" constituent, conducted during excavation aided in defining the extent of the excavation area. Seventeen verification soil samples were collected as follows:

- Seventeen verification samples (V-1 through V-17) were collected from the base (floor) and sidewalls of the excavation (where surface refers to newly remediated grade) and the sample interval is the 0 to 0.3 m (0 to 1 ft) below the new grade level.
- Four additional verification samples (V-1, V-5, V-11, V-17) were collected at a depth of 4.6 m (15 ft) below the original (or pre-excavation) ground surface to confirm the COCs remaining in the soil at 4.67 m (15 ft) were below RAGS, protective of groundwater and thus meet RAO 2.

[1] Visual Sample Plan (VSP) is a registered trademark of Pacific Northwest National Laboratory, Richland, WA.

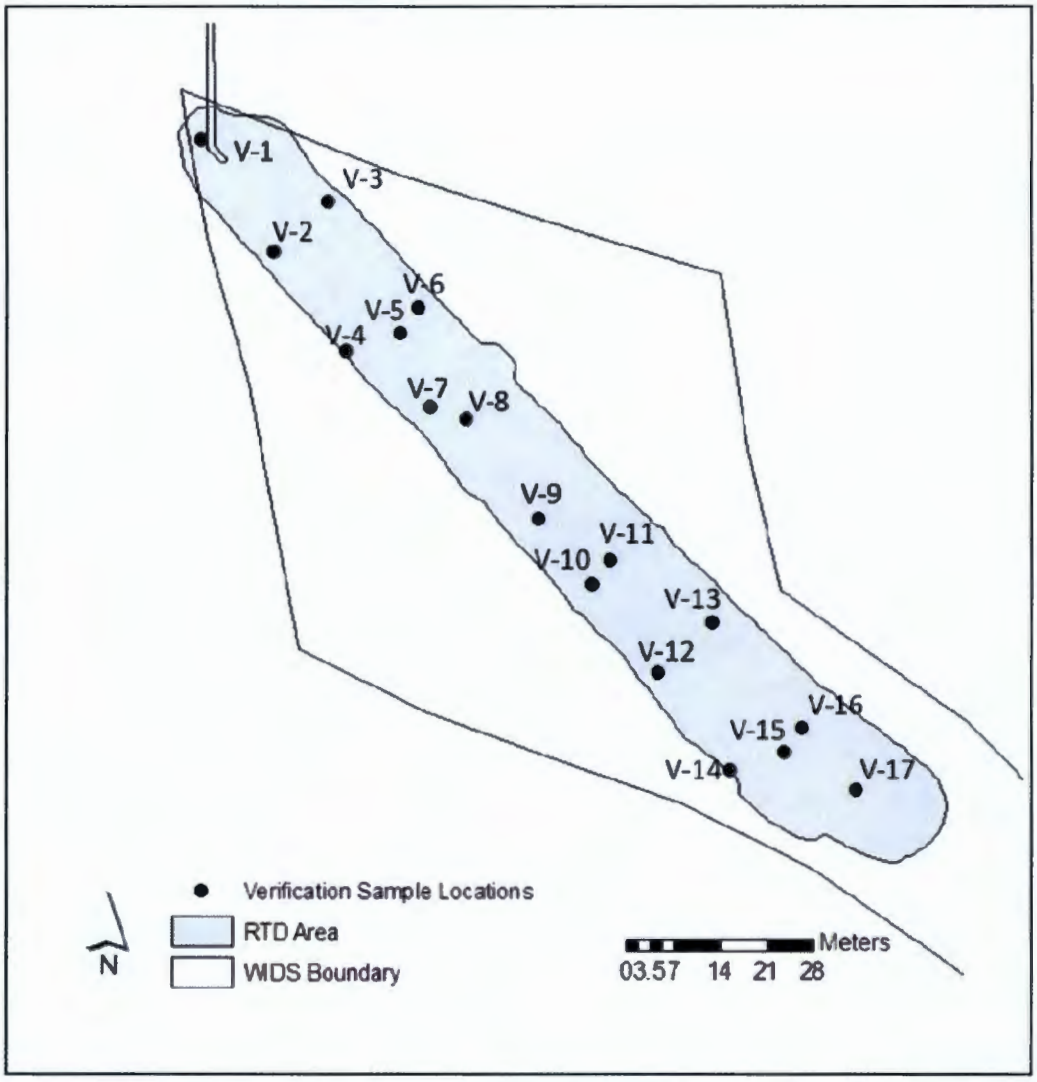

Figure 5. 216-N-6 RTD Area and Verification Sampling Locations

Verification sampling results were used to quantitatively demonstrate that residual concentrations of COCs remaining in the soil are below the RAGs and meet RAOs.

Appendix G provides photographs and analytical data for the 216-N-6 Waste Site verification sampling and analysis.

Table 3. GPS Coordinates for 216-N-6 Verification Sampling

Sample Location	Northing	Easting
V-1	140035.23	571493.06
V-2	140024.29	571501.44
V-3	140031.64	571509.50
V-4	140009.57	571512.19
V-5	140012.33	571520.25
V-6	140016.01	571522.94
V-7	140001.29	571524.73
V-8	139999.45	571530.11
V-9	139984.74	571540.86
V-10	139975.08	571548.92
V-11	139978.76	571551.61
V-12	139962.21	571558.78
V-13	139969.56	571566.84
V-14	139947.49	571569.53
V-15	139950.25	571577.59
V-16	139953.93	571580.28
V-17	139944.73	571588.34

5.2 Radiological Survey Field Screening

Radiological field screening was performed over the entire surface of the remediated area. Due to process knowledge of comingled radiological and chemical constituents, field screening for radiological contamination was used as an indicator to locate areas of chemical contamination. The survey was performed using standard radiological survey instruments in accordance with approved practices and procedures to obtain dose and contamination measurements with sufficient sensitivity to meet clean-up levels. Radiological screening was also performed on the samples themselves during the collection of verification samples. Radiological field screening of the remediated surface and the samples collected indicated no detectable dose rates above background.

6.0 DATA EVALUATION

Results for the 216-N-6 Waste Site sampling and analysis for verification of remedy completion are provided in Appendix G. As shown in Table 4, all detected analytes were reported at concentrations below direct exposure, groundwater protection, and river protection RAGs, or below the Hanford Specific Background default value RAGs in the case of uranium-233/234 and uranium-238.

Nonradionuclide risk requirements for the 216-N-6 Waste Site include an individual and cumulative hazard quotient of less than 1.0, individual contaminant carcinogenic risks of less than 1×10^{-6}, and a cumulative carcinogenic risk of less than 1×10^{-5}. Risk values are not calculated for constituents that are either not detected or are detected at concentrations below Hanford Site or Washington State background values (Appendix G).

- The individual hazard quotients for noncarcinogenic constituents were less than 1.0. There were no constituents detected above Hanford Specific Background values. Therefore, there are no constituents used in the individual hazard quotients. See Appendix C for more information.

- The cumulative hazard quotient for all noncarcinogenic constituents was less than 1.0. There were no constituents detected above Hanford Specific Background values. Therefore, there are no constituents used in the cumulative hazard quotient. See Appendix C for more information.
- The individual carcinogenic risk values for carcinogenic constituents above background are all below 1 x 10-6. There were no constituents detected above Hanford Specific Background values. Therefore, there are no constituents used in the individual excess carcinogenetic risk calculation. See Appendix C for more information.
- The cumulative excess carcinogenic risk value for carcinogenic constituents above background is below 1 x 10-5. There were no constituents detected above Hanford Specific Background values. Therefore, there are no constituents used in the cumulative excess carcinogenetic risk calculation. See Appendix C for more information.

7.0 DATA QUALITY ASSESSMENT

A data quality assessment (DQA) review was performed to compare the sampling approach and analytical data with the sampling and data requirements specified by the SAP (DOE/RL-2007-54). This review involves evaluation of the data to determine if they are of the right type, quality, and quantity to support the intended use (EPA/600/R-96/084, *Guidance for Data Quality Assessment, Practical Methods for Data Analysis*). The assessment review completes the data life cycle (i.e., planning, implementation, and assessment) that was initiated by the data quality process.

Level C data validation as defined in the contractor's validation procedures, which are based on EPA functional guidelines (e.g., *Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses* [Bleyler, 1988a]; *Laboratory Data Validation Functional Guidelines for Evaluating Organics Analyses* [Bleyler, 1988b]), was performed for the entire sampling and analysis data package for the investigative and verification samples collected for 216-N-6. Level C validation is a review of the quality control (QC) data and specifically requires verification of deliverables and requested versus reported analyses and qualification of the results based on: (a) analytical holding times, (b) method blank results, (c) matrix spike/matrix spike duplicate, (d) surrogate recoveries, (e) duplicates, and (f) analytical method blanks.

Specific data quality objectives for the site are found in the SAP (DOE/RL-2007-54). All samples were collected per the sample design described in Section 5.1. The COCs for 216-N-6 are in listed Table 2.

All of the sampling and analysis data generated from the verification sampling of 216-N-6 Waste Site is tracked through the Hanford Environmental Information System (HEIS). All of the 216-N-6 sampling and analysis data were found to be useable for decision-making purposes as provided in the following summary:

HEIS Identification Numbers: B280Y3, B23133, B280Y4, B280Y5, B280Y6, B280Y7, B28134, B280Y8, B280Y9, B28100, B28101, B28102, B28103, B28135, B28104, B28105, B28106, B28107, B28108, B28109, B28110, B28136, B28111, B28137, B28112, B28113, B28114, B28115, B28138, B28116, B28117, B28118, B28119, B28120, B28121, B28139, B28122, B28123, B28124, B28125, B28126, B28127, B28128, B28140, equipment blanks: B28153, B28154, B28157, B28158, and trip blanks B28155, B28159, B28156.

Blanks: Trip, field, and equipment blanks with complete analyses were acceptable.

Field Duplicates: All duplicates were acceptable.

Matrix Spike/Matrix Spike Duplicate and Laboratory Control Standard/Laboratory Control Standards Duplicate: Matrix spike/matrix spike duplicate and laboratory control standard/laboratory control standards duplicate were run to an acceptable percentage recovery test as a result for calculation of relative percent difference (RPD) for QC purposes based on laboratory quality assurance (QA)/QC procedures.

Radiochemistry, Inductively Coupled Plasma Metals, PCBs, and Chromium (VI) Analyses: Analytical reports submitted for validation and verified for completeness based on the percentage of data determined to be valid (i.e., not rejected). The completion percentage was 100 percent. The data has been determined to be useable for decision-making purposes.

Field Screening: Relative to analytical data in sample media, physical data, and/or field screening results are of lesser importance in making inferences of risk. Due to the secondary importance of such data, no validation for physical property data and/or field screening results was performed. However, field QA/QC was reviewed to ensure that the data are useable. Field instrumentation, calibration, and QA checks were performed in accordance with the following:

- Calibration of radiological field instruments on the Hanford Site is performed under contract by Pacific Northwest National Laboratory, as specified in their program documentation.
- Daily calibration checks are performed and documented for each instrument used to characterize areas that are under investigation. These checks are made on standard materials that are sufficiently like the matrix under consideration that direct comparison of data can be made.

The review and approval of completed field radiation surveys by the radiological controls organization represents the data validation and usability review for handheld field radiological measurements.

The DQA review for these waste sites found the analytical results to be accurate within the standard errors associated with the methods, including sampling and sample handling. The data are of the correct type, quality, and quantity to support the intended use. Detection limits, precision, accuracy, and sampling data group completeness were assessed to determine if any analytical results should be rejected as a result of quality assurance and quality control deficiencies. All analytical data were found acceptable for decision-making purposes. All of the sampling analytical data are stored in the HEIS and are summarized in Appendix G. All qualifiers have also been added accordingly into the data for Appendix G.

8.0 SUMMARY SUPPORTING INTERIM CLOSED OUT RECLASSIFICATION

In September 2010, discrete soil samples were collected from the 216-N-6 Waste Site using a statistically based sampling approach with additional samples collected from locations judgmentally selected from process and sampling knowledge. The analytical results were compared to the Deep and Shallow Zone Look-Up Values to determine whether further remediation was required. The analytical results from the soil samples are below the applicable Look-Up Values.

The analytical results from the soil samples meet the RAGs for direct exposure, groundwater protection, and river protection. In accordance with this evaluation, the sampling results support reclassification of the 216-N-6 Waste Site to 'interim closed out' status, as recorded on the Waste Site Reclassification Form Control Number 2010-092. Per RL-TPA-90-0001, *Tri-Party Agreement Handbook Management Procedures*, Guideline Number TPA-MP-14, "Maintenance of the Waste Information Data System (WIDS),TPA-MP-14, 'interim closed out' status indicates that a waste site meets cleanup standards specified in an interim action record of decision or action memorandum and related work plan(s), but for

which a final record of decision has not been issued. Final remedial action evaluations and decisions for this waste site will be made under the final remedial action process for the Outer Area.

Finalization of this report constitutes concurrence by the signing parties that RAOs have been attained, thus backfill and/or contouring may take place, as described in Sections 3.1.2 and 3.1.5 of the RD/RAWP. Backfilling prior to finalization of this report may be necessary where worker safety or other issues warrant that action. Once the waste site has been backfilled and/or contoured, native plant species will be seeded in the area, as applicable, as an interim step toward final revegetation, in accordance with Section 3.5.5 of the RD/RAWP.

Table 4. Comparison of Maximum Soil Analyses to Remedial Action Goals for the 216-N-6 Waste Site [a]

Radiological Contaminant of Concern	Hanford Site-Specific Background Activity (pCi/g)	Maximum Soil Analyses (pCi/g)	Remedial Action Goals			Does the Maximum Exceed RAGs?
			Direct Exposure (pCi/g)	Soil Cleanup Level for Groundwater Protection (pCi/g)	Soil Cleanup Level for River Protection (pCi/g)	
Americium-241	N/A	0.049	31.1	1,577,000	1,577,000	No
Cesium-137	1.1	1.5 [b]	6.2	NA [c]	NA [c]	No
Cobalt-60	0.008	U	1.4	NA [c]	NA [c]	No
Europium-152	N/A	0.26 [b]	3.3	NA [c]	NA [c]	No
Europium-154	0.033	U	3.0	NA [c]	NA [c]	No
Europium-155	0.054	U	125	NA [c]	NA [c]	No
Nickel-63	N/A	105 [b]	4,026	NA [c]	NA [c]	No
Plutonium-238	0.004	0.042 [b]	37.4	1,123	1,123	No
Plutonium-239/240	0.025	0.019	33.9	718,600	718,600	No
Strontium-90	0.18	U	4.5	NA [c]	NA [c]	No
Technetium-99	N/A	U	15	15 [d]	15 [d]	No
Throium-232	1.3	0.47	1.3	NA [c]	NA [c]	No
Tritium (H-3)	N/A	U	510	35.5	106.7	No
Uranium-233/234	1.1	0.20	1.1	1.1 [e]	1.1 [e]	No
Uranium-235	0.11	0.025	1.0	1.0 [d]	1.0 [d]	No
Uranium-238	1.1	0.23	1.1	1.1 [e]	1.1 [e]	No

Non-Radiological Contaminant of Concern	Hanford Site-Specific Background Concentration (mg/kg)	Maximum Soil Analyses (mg/kg)	Remedial Action Goals			Does the Maximum Exceed RAGs?
			Direct Exposure (mg/kg)	Soil Cleanup Level for Groundwater Protection (mg/kg)	Soil Cleanup Level for River Protection (mg/kg)	
Antimony	5 [f]	U	32	6.0 [d]	6.0 [d]	No
Arsenic	6.5	3.3	6.5 [f]	6.5 [f]	6.5 [f]	No
Barium	132	85.1	5,600	NA [c]	NA [c]	No
Cadmium	0.81 [f]	U	80	NA [c]	NA [c]	No
Chromium Total	18.5	10.3	80,000	NA [c]	NA [c]	No
Chromium (VI)	N/A	U	400	8.0	2.2	No
Lead	10.2	6.92	353	NA [c]	NA [c]	No
Manganese	512	380	11,200	NA [c]	NA [c]	No
Mercury	0.33	U	24	NA [c]	NA [c]	No
Zinc	67.8	43.4	24,000	NA [c]	NA [c]	No
Polychlorinated Biphenyls	N/A	U	0.5	NA [c]	NA [c]	No

Notes:

[a] Site RAGs are taken from the RD/RAWP (DOE/RL-2007-55), where available, without further consideration of updated toxicity data or amendments (2004) to cleanup regulations in WAC 173-340.

[b] The maximum cesium-137, europium-152, nickel-63, and plutonium-238 results exceed the Hanford Site-Specific background for the specific radionuclide. However, the RESRAD calculation predicts that cesium-137, europium-152, nickel-63, and plutonium-238 will not reach groundwater within 1,000 years based on the 100 Area generic site model using soil column layers and depths.

[c] RESRAD predicts constituent will not reach groundwater within 1,000 years based on 100 Area generic site model using soil column layers and depths.

[d] The remedial action goal is below the practical quantitation limit (PQL). The value presented is the PQL.

[e] The calculated soil concentration cleanup level of 0.185 pCi/g is below the Hanford Specific Background Activity of 1.1 pCi/g. Therefore the soil concentration protection of groundwater defaults to 1.1 pCi/g.

[f] Where cleanup levels are less than background or required detection limit (RDLs), cleanup levels default to background or RDLs per Ecology 1996, WAC 173-340-700(4)(d) and WAC 173-340-707(2), respectively. The arsenic cleanup level of 20 mg/kg has been agreed to by the Tri-Party Agreement Project Managers Managers (the basis is documented in DOE/RL-96-17, Rev 5, 2.1.2.1).

Abbreviations: NA = Not Applicable (see note c above) N/A = Not Available RAG = Remediation Action Goal
U = Analyte was not detected above laboratory detection limits. Detection limits are below RAGs.

9.0 SUMMARY OF PROJECT COSTS

For the purposes of reporting costs of remedial action for the 216-N-6 Waste Site, costs are pro-rated utilizing an activity/schedule-based methodology. This method is not considered to be audit-quality data. Actual costs for waste site clean-up will continue to be collected for each operable unit or closure area in accordance with the current cost tracking methodology. These costs will then be included, in accordance with *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) requirements, in the remedial action report for the final remedial action of the operable unit or closure area. Table 5 provides the cost summary.

Table 5. Cost Summary

Cost Item	Actual Cost FY 2009 ($$)	Actual Cost FY 2010 ($$)	Actual Total Cost ($$)
Remedial Action Capital (Construction) Costs	0	0	0
Remedial Action Operating Costs	$161,400	$1,769,600	$1,831,000
Total Remedial Action Cost	$161,400	$1,769,600	$1,831,000
Projected Yearly Operation and Maintenance Cost	0	0	0

10.0 REFERENCES

40 CFR 141, "National Primary Drinking Water Regulations," *Code of Federal Regulations*. Available at: http://www.access.gpo.gov/nara/cfr/waisidx_10/40cfr141_10.html.

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

BHI Calculation 0100XCAV0046, 2004, *100 Area Radionuclide and Nonradionuclide Lookup Values for the 1995 Interim Remedial Action Record of Decision*, Bechtel Hanford, Inc., Richland, WA.

Bleyler, Ruth, 1988a, *Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses*, Hazardous Site Evaluation Division, U.S. Environmental Protection Agency, Washington, D.C. Available at: http://www2.hanford.gov/ARPIR/index.cfm?content=findpage&AKey=D196013784.

Bleyler, Ruth, 1988b, *Laboratory Data Validation Functional Guidelines for Evaluating Organics Analyses*, Hazardous Site Evaluation Division, U.S. Environmental Protection Agency, Washington, D.C. Available at: http://www2.hanford.gov/ARPIR/index.cfm?content=findpage&AKey=D196013785.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601, et seq. Available at: http://epw.senate.gov/cercla.pdf.

DOE Order 5400.5 Chg 2, 1993, *Radiation Protection of the Public and the Environment*, U.S. Department of Energy, Washington, D.C. Available at: https://www.directives.doe.gov/directives/current-directives/5400.5-BOrder-c2/view?searchterm=None.

DOE/RL-92-24, 2001, *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes*, Rev. 4, 2 vols., U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www2.hanford.gov/arpir/?content=findpage&AKey=0096062. http://www2.hanford.gov/arpir/?content=findpage&AKey=0096061.

DOE/RL-96-17, 2004, *Remedial Design/Remedial Action Work Plan for the 100 Area*, Rev. 5, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D6542354.

DOE/RL-2007-54, 2008, *Sampling and Analysis Plan for Remediation of 200 North Area Waste Sites Located in the 200-CW-3 Operable Unit*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0810230106.

DOE/RL-2007-55, 2008, *Remedial Design/Remedial Action Work Plan for 200 North Area Waste Sites Located in the 200-CW-3 Operable Unit*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0810230107.

Ecology, 2005, Cleanup Levels and Risk Calculations (CLARC) database, Washington State Department of Ecology. Available at: https://fortress.wa.gov/ecy/clarc/CLARCHome.aspx.

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. Available at: http://www.hanford.gov/?page=81.

Ecology Publication 94-115, 1994, *Natural Background Soil Metals Concentrations in Washington State*, Toxics Cleanup Program, Washington State Department of Ecology, Olympia, Washington. Available at: http://www.ecy.wa.gov/pubs/94115.pdf.

EPA/240/R-02/005, 2002, *Guidance on Choosing a Sampling Design for Environmental Data Collection*, EPA QA/G-5S, Office of Environmental Information, U.S. Environmental Protection Agency, Washington, D.C. Available at: http://www.epa.gov/quality/qs-docs/g5s-final.pdf.

EPA/540/R-93/081, 1994, *Guidance Manual for the Integrated Exposure Uptake Biokenetic Model for Lead in Children*, Publication Number 9285.7-15, U.S. Environmental Protection Agency, Washington, D.C.

EPA/540-R-00-007, 2000, *Soil Screening Guidance for Radionuclides: User's Guide*, OSWER 9355.4-16A, Office of Radiation and Indoor Air, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C. Available at: http://www.epa.gov/superfund/health/contaminants/radiation/radssg.htm.

EPA/541/R-99/039, 1999, *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6 and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington (100 Area Remaining Sites)*, U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Olympia, Washington.

EPA/600/R-03/027, 2003, *Guidance for Obtaining Representative Laboratory Analytical Subsamples from Particulate Laboratory Samples*, U.S. Environmental Protection Agency, Washington, D.C.

EPA/600/R-96/084, 2000, *Guidance for Data Quality Assessment, Practical Methods for Data Analysis*, EPA QA/G-9, QA00 Update, U.S. Environmental Protection Agency, Washington, D.C. Available at: http://www.clu-in.org/conf/tio/pasi_121603/g9-final.pdf.

Gy, Pierre, 1998, *Sampling for Analytical Purposes*, John Wiley and Sons, New York, New York.

Pitard, F.F., 1993, *Pierre Gy's Sampling Theory and Sampling Practice: Heterogeneity, Sampling Correctness, and Statistical Process Control*, 2nd ed, CRC Press, Inc., Boca Raton, Florida.

Ramsey, C.A., M.E. Ketterer, and J.H. Lowry, 1989, "Application of Gy's Sampling Theory to the Sampling of Solid Waste Materials," in *Proceedings of the EPA Fifth Annual Waste Testing and Quality Assurance Symposium.*

RL-TPA-90-0001, 2007, *Tri-Party Agreement Handbook Management Procedures*, Guideline Number TPA-MP-14, "Maintenance of the Waste Information Data System (WIDS)," Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www.hanford.gov/files.cfm/TPA-MP14.pdf.

Shleien, Bernard, Lester A. Slaback, Jr., and Brian Kent Birky, 1998, *Handbook of Health Physics and Radiological Health*, 3rd Edition, Williams & Wilkins Co., Baltimore, Maryland.

Smith, P.L., 2004, "Principles and Practices for Correct Sampling and the Impact on Statistical Data Quality," *EPA 23rd Annual National Conference on Managing Environmental Quality Systems*, Tampa, Florida, April 13-16.

WAC 173-340, "Model Toxics Control Act—Cleanup," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-340.

340-700, "Overview of Cleanup Standards."

340-707, "Analytical Considerations."

340-740, "Unrestricted Land Use Soil Cleanup Standards."

340-750, "Cleanup Standards to Protect Air Quality."

WDOH/320-015, 1997, *Hanford Guidance for Radiological Cleanup*, Rev. 1, Washington State Department of Health, Olympia, Washington. Available at: http://www.doh.wa.gov/ehp/rp/environmental/cleanup.pdf.

Appendix A

Comparison of Maximum Soil Sample Analyses to 100 Area Radionuclide Soil Concentrations Corresponding to an Equivalent Dose of 15 Mrem/Yr

APPENDIX A

Table A-1 shows the soil activity for a 15 mrem/yr dose (pCi/g) compared to Hanford Specific Background Activity and the maximum results for each radionuclide listed.

Table A-1. Comparison of Maximum Soil Results to 100 Area Radionuclide Soil Concentrations Corresponding to an Equivalent Dose of 15 mrem/yr

Radionuclide	Soil Activity for 15 mrem/yr Dose (except as noted) (pCi/g)	Hanford Specific Background Activity (pCi/g)	Source of Single Radionuclide Soil Concentration	Maximum Results (pCi/g)
Americium-241	31.1	N/A	WDOH/320-015 [a]	0.049
Cesium-137	6.2	1.1	WDOH/320-015 [a]	1.5
Cobalt-60	1.4 [b]	0.008	WDOH/320-015 [a]	U
Europium-152	3.3 [b]	N/A	WDOH/320-015 [a]	0.26
Europium-154	3.0 [b]	0.033	WDOH/320-015 [a]	U
Europium-155	125 [b]	0.054	RESRAD Calc [c]	U
Nickel-63	4,026 [b]	N/A	RESRAD Calc [c]	105
Plutonium-238	37.4	0.004	RESRAD Calc [c]	0.042
Plutonium-239/240	33.9	0.025	WDOH/320-015 [a]	0.019 (<BG)
Strontium-90	4.5 [b]	0.18	WDOH/320-015 [a]	U
Technetium-99	8.5 [b]	N/A	WDOH/320-015 [a]	U
Thorium-232	1.0	1.3	RESRAD Calc [c]	0.47 (<BG)
Tritium (H-3)	510 [b]	N/A	RESRAD Calc [c]	U
Uranium-233/234	0.78	1.1	RESRAD Calc [c]	0.20 (<BG)
Uranium-235	0.84	0.11	RESRAD Calc [c]	0.025 (<BG)
Uranium-238	0.84	1.1	RESRAD Calc [c]	0.23 (<BG)

Notes:

[a] From WDOH/320-015, *State of Washington Department of Health Interim Regulatory Guidance: Hanford Guidance for Radiological Cleanup.*

[b] Radionuclide concentrations for beta/gamma in water corresponding to a 4 mrem/yr dose (C4 mrem/yr) from EPA/540-R-00-007, *Soil Screening Guidance for Radionuclides: User's Guide.*

[c] Per Table 2-2, DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area.*

Abbreviations:

U = Analyte not detected above laboratory detection limits. Detection limits below RAGs.
N/A = Not applicable
<BG = Less than background

Appendix B

Comparison of Maximum Soil Sample Analyses to Nonradionuclide Direct Exposure Cleanup Levels

APPENDIX B

Table B-1 compares the maximum investigative sample results to the nonradionuclide direct exposure cleanup levels.

Table B-1 Comparison of Maximum Sample Analyses to Nonradionuclide Direct Exposure Cleanup Levels

Contaminant	Hanford Site Specific Background[b] (mg/kg)	RDL (mg/kg)	Direct Exposure Cleanup Levels[a] (mg/kg)		Direct Exposure Cleanup Level (mg/kg)	Maximum Results (mg/kg)
			Carcinogen	Noncarcinogen		
Metals						
Antimony	5[c]	0.6	N/A	32	32	U
Arsenic	6.5	1.0	0.667	24	20[d]	3.3
Barium	132	2	N/A	5,600	5,600	85.1
Cadmium	0.81[c]	0.5	13.9[e]	80	13.9	U
Chromium, Total	18.5	1	N/A	80,000	80,000	10.3
Chromium VI	NA	0.5	2.1[e]	400	400	U
Lead	10.2	0.5	N/A	353[f]	353	6.92
Manganese	512	5	N/A	11,200	11,200	380
Mercury	0.33	0.2	N/A	24	24	U
Zinc	67.8	1	N/A	24,000	24,000	43.4
PCBs						
Polychlorinated Biphenyls	NA	0.017	0.5[g]	N/A	0.5	U

Notes:

[a] Calculated using the appropriate formulas from, WAC 173-340-740, with toxicity values updated through July 2004, from the EPA Integrated Risk Information System (IRIS) at http://www.epa.gov/iris or from the Risk Assessment Information System (RAIS) database of the Oak Ridge National Laboratory (ORNL) on the Internet at http://risk.lsd.ornl.gov.

[b] Unless otherwise noted, background concentrations are 90th percentile values of the log normal distribution of site-wide soil background data (DOE-RL-92-24, *Hanford Site Background: Part 1 Soil Background for Nonradionuclide Analytes*).

[c] Hanford Site-specific background not available. Value is from Ecology Publication 94-115, *Natural Background Soil Metals Concentrations in Washington State*.

[d] The arsenic cleanup level of 20 mg/kg has been agreed to by the Tri-Party Agreement Project Managers (the basis is documented in DOE/RL-96-17, *Remedial Design/Remedial Action Work Plan for the 100 Area*).

[e] Carcinogenic cleanup level calculated based on the inhalation exposure pathway; WAC 173-340-750(3).

[f] Calculated using EPA/540/R-93/081, *Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children*.

[g] The soil cleanup value for PCBs is based on the formula presented in WAC 173-340-740(3)(a)(iii)(B), WAC 173-340-740, and the cancer potency factor for ingestion of PCBs of 2.0 kg-day/mg (soils) from the EPA Integrated Risk Information System (IRIS) on the internet at http://www.epa.gov/iris on January 3, 2006.

Abbreviations:

N/A = Not Applicable
NA = Not Available
RDL = Required Detection Limit
U = Analyte not detected above laboratory detection limits. Detection limits below RAGs

Appendix C

Hazard Quotients and Excess Carcinogenic Risk

APPENDIX C

PURPOSE

The purpose of this appendix is to provide documentation to support the calculation of the hazard quotient (HQ) and carcinogenic (excess cancer) risk values for the 216-N-6 Waste Site remedial action. In accordance with the RAGs in the RD/RAWP (DOE/RL-2007-55), the following criteria must be met:

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

GIVEN/REFERENCES

DOE/RL-2007-55, *Remedial Design/Remedial Action Work Plan for 200 North Area Waste Sites located in the 200-CW-3 Operable Unit*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

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

SOLUTION

1. Calculate an HQ for each noncarcinogenic constituent detected above background and compare it to the individual HQ of <1.0 (DOE/RL-2007-55).
2. Sum the HQs and compare to the cumulative HQ criterion of <1.0.
3. Calculate an excess cancer risk value for each carcinogenic constituent detected above background and compare it to the individual excess cancer risk criterion of $<1 \times 10^{-6}$ (DOE/RL-2007-55).
4. Sum the excess cancer risk values and compare to the cumulative cancer risk criterion of $<1 \times 10^{-5}$.

METHODOLOGY

Hazard quotient and carcinogenic risk calculations were computed using the data from Appendix G, Table G-2. Of the contaminants of concern listed in Appendix G, Table G-2, no constituents require the HQ and risk calculations because no analytes were detected above the Hanford Site background value.

CONCLUSION

The 216-N-6 Waste Site meets the requirements for the hazard quotients and carcinogenic (excess cancer) risk as identified in the RD/RAWP (DOE/RL-2007-55).

Appendix D

Comparison of Maximum Soil Sample Analyses to Soil Activities Calculated by RESRAD to be Protective of 100 Area Groundwater

APPENDIX D

Table D-1 shows the comparison of the maximum soil sample results to the soil activities calculated by RESidual RADioactivity (RESRAD).

Table D-1. Comparison of Maximum Soil Sample Results to Soil Activities Calculated by RESRAD to be Protective of 100 Area Groundwater

Radionuclide	Groundwater MCL[a] (pCi/L)	Soil Concentration Protective of Groundwater[b] (pCi/g)	Maximum Results (pCi/g)
Americium-241	1.2	1,577,000	0.049
Cesium-137	60	NA[c]	1.5
Cobalt-60	100	NA[c]	U
Europium-152	200	NA[c]	0.26
Europium-154	60	NA[c]	U
Europium-155	600	NA[c]	U
Nickel-63	50	NA[c]	105
Plutonium-238	1.6	1,123	0.042
Plutonium-239/240	1.2	718,600	0.019 (<BG)
Strontium-90	8	NA[c]	U
Technetium-99	900	15	U
Thorium-232	2	NA[c]	0.47 (<BG)
Tritium (H-3)	20,000	35.5	U
Uranium-233/234	21.2	1.1[d]	0.20 (<BG)
Uranium-235	21.2	1.0	0.025 (<BG)
Uranium-238	21.2	1.1[d]	0.23 (<BG)

Notes:

[a] MCL = Maximum contaminant level calculated from National Bureau of Standards (NBS Handbook 69) maximum permissible concentration (MPC) as cited in EPA/540-R-00-007, the RAG from the RD/RAWP (DOE/RL-2007-55), or the MCL from 40 CFR 141.66.

[b] From the RD/RAWP (DOE/RL-2007-55).

[c] RESRAD predicts constituent will not reach groundwater within 1,000 years based on 100 Area generic site model using soil column layers and depths.

[d] The calculated soil concentration cleanup level of 0.185 pCi/g is below the Hanford Specific Background Activity of 1.1 pCi/g. Therefore the soil concentration protection of groundwater defaults to 1.1 pCi/g.

Abbreviations:

U = Analyte not detected above laboratory detection limits. Detection limits below RAGs.
<BG= Less than background

Appendix E

Summary of Comparison of Maximum Soil Sample Analyses to 100 Area Nonradionuclide Cleanup Levels for Protection of Groundwater and the Columbia River

APPENDIX E

Table E-1 provides a comparison of the maximum soil sample results to the 100 Area nonradionuclide cleanup levels established to protect groundwater and the Columbia River.

Table E-1. Summary of Comparison of Maximum Soil Sample Results to 100 Area Nonradionuclide Cleanup Levels for Protection of Groundwater and the Columbia River

Contaminant	Soil Cleanup Levels (mg/kg)		Maximum Results (mg/kg)
	Protective of Groundwater	Protective of the Columbia River	
Metals			
Antimony	6.0[a]	6.0[a]	U
Arsenic	6.5[b]	6.5[b]	3.3
Barium	NA[c]	NA[c]	85.1
Cadmium	NA[c]	NA[c]	U
Chromium, Total	NA[c]	NA[c]	10.3
Chromium (VI)	8.0	2.2	U
Lead	NA[c]	NA[c]	6.92
Manganese	NA[c]	NA[c]	380
Mercury	NA[c]	NA[c]	U
Zinc	NA[c]	NA[c]	43.4
PCBs			
PCB	NA[c]	NA[c]	U

Notes:

[a] The remedial action goal is below the practical quantitation limit (PQL). The value presented is the PQL.

[b] The remedial action goal is below background. The value presented is background.

[c] The RESRAD model predicts the contaminant will not reach the groundwater within a 1,000-year period (DOE/RL-2007-55, Table 2-1).

Abbreviations:

NA = Not Applicable

U = Analyte not detected above laboratory detection limits. Detection limits below RAGs

Appendix F

Conceptual Model Investigation Sampling Data Summary

APPENDIX F

This appendix provides a data summary of the conceptual model investigative sampling data (Tables F-1 and F-2).

Figure F-1. 216-N-6 Investigative Sampling Location

Note: Fieldwork was performed based on investigative sample data and historical knowledge, with consideration of potential radiological and hazardous contaminant concerns (Figure F-1). Field screening of potential contaminants confirmed planning assumptions and ensured protection of personnel.

Table F 1a. Investigation Results for Shallow Zone 216-N-6 Sample Locations for Radionuclide COPCs

COPCs	Remedial Action Goal – Shallow Zone [<4.6 m (15 ft)][a] (pCi/g)	Hanford Specific Background Activity (pCi/g)	HEIS #B20W87 Sample Location #1 0.9 m (3 ft) Depth (pCi/g)	HEIS #B20MN2 Sample Location #1 4.6 m (15 ft) Depth (pCi/g)	HEIS #B20W86 Sample Location #8 4.6 m (15 ft) Depth (pCi/g)	HEIS #B20MN4 Sample Location #9 4.6 m (15 ft) Depth (pCi/g)	HEIS #B20W88 Sample Location #2 1.2 m (4 ft) Depth (pCi/g)	HEIS #B20MN3 Sample Location #2 4.6 m (15 ft) Depth (pCi/g)	HEIS #B20W85 Sample Location #10 4.6 m (15 ft) Depth (pCi/g)	HEIS #B20MN5 Sample Location #11 4.6 m (15 ft) Depth (pCi/g)	HEIS #B20MN7 Sample Location #3 1.5 m (5 ft) Depth (pCi/g)
Americium-241	31.1	NA	1.35	0.026	0.0760	0.110	U	0.120	0.0440	0.0510	0.110
Cesium-137	6.2	1.1	153	0.0678	U	U	25.4	4.84	U	U	14.9
Cobalt-60	1.4	0.008	0.741	U	U	U	U	U	U	U	U
Europium-152	3.3	NA	18.1	U	U	U	1.53	0.250	U	U	0.306
Europium-154	3	0.033	U	U	U	U	U	U	U	U	U
Europium-155	125	0.054	U	U	U	U	U	U	0.0167	U	U
Nickel-63	4,026	NA	7.07	U	U	U	U	U	U	U	U
Plutonium-238	37.4	0.004	U	U	U	U	U	U	U	U	U
Plutonium-239/240	33.9	0.025	13.1	0.0200	0.0180	U	0.581	0.190	U	U	0.0960
Strontium-90	4.5	0.18	22.5	U	U	U	3.03	U	U	U	U
Technetium-99	15[b]	NA	U	U	U	U	U	U	U	U	U
Thorium-232[c]	1.300	1.3	0.560	0.282	0.250	0.235	0.531	0.186	0.212	0.206	0.215
Tritium (H-3)	35.5	NA	0.685	U	U	U	U	U	U	U	U
Uranium-233/234	1.1[d]	1.1	0.652	0.190	0.160	0.140	U	0.150	0.180	0.130	0.110
Uranium-235	1.0[b]	0.11	U	0.0190	0.0150	U	U	0.0170	U	0.0130	U
Uranium-238	1.1[d]	1.1	0.515	0.160	0.130	0.120	0.364	0.160	0.110	0.110	0.140

Notes:

[a] In the shallow zone, cleanup must achieve the direct exposure RAOs and the groundwater/Columbia River RAO; therefore, the lowest value among the "Protection from Direct Exposure," "Protective of Groundwater," and "Protective of the Columbia River" values is the applicable look-up value.

[b] The remedial action goal is below the practical quantitation limit (PQL). The value presented is the PQL.

[c] Thorium conversion:

1 mg/kg = 1 µg/g

Thorium-232 Specific Activity – 1.09E-07 Ci/g (Shleien et al., 1998, *Handbook of Health Physics and Radiological Health*)

pCi/g = (Result µg/g)(SpA Ci/g)(1 g/10^6 µg)(10^{12} pCi/1 Ci)

[d] The remedial action goal is below background. The value presented is background.

HEIS =Hanford Environmental Information System

NA = Not Available.

U = Analyte was not detected above laboratory detection limit.

Soil Samples	Test Results	Converted Test Results
B20MN2	2.57 mg/kg	0.282 pCi/g
B20W86	2.28 mg/kg	0.250 pCi/g
B20MN4	2.14 mg/kg	0.235 pCi/g
B20MN3	1.70 mg/kg	0.186 pCi/g
B20W85	1.93 mg/kg	0.212 pCi/g
B20MN5	1.88 mg/kg	0.206 pCi/g
B20MN7	1.96 mg/kg	0.215 pCi/g

Table F 1b. Investigation Results for Shallow Zone 216-N-6 Sample Locations for Radionuclide COPCs

COPCs	Remedial Action Goal – Shallow Zone [<4.6 m (15 ft)]a (pCi/g)	Hanford Specific Background Activity (pCi/g)	HEIS #B20MN6 Sample Location #3 1.5 m (5 ft) Depth Duplicate (pCi/g)	HEIS #B20MN8 Sample Location #3 4.6 m (15 ft) Depth (pCi/g)	HEIS #B20MP2 Sample Location #12 4.6 m (15 ft) Depth (pCi/g)	HEIS #B20MN9 Sample Location #13 4.6 m (15 ft) Depth (pCi/g)	HEIS #B20MP0 Sample Location #4 4.6 m (15 ft) Depth (pCi/g)	HEIS #B20MP1 Sample Location #5 4.6 m (15 Ft) Depth (pCi/g)	HEIS #B20LB3, B20LB2 Field Blank (pCi/g)	HEIS #B20MV7 Equipment Blank (pCi/g)	HEIS#B20LB1 Trip Blank (pCi/g)
Americium-241	31.1	NA	0.0750	0.09	0.0440	0.0840	0.0340	0.0430	U	U	NR
Cesium-137	6.2	1.1	15.0	0.07	U	U	U	U	U	U	NR
Cobalt-60	1.4	0.008	U	U	U	U	U	U	U	U	NR
Europium-152	3.3	NA	0.333	U	U	U	U	U	U	U	NR
Europium-154	3	0.033	U	U	U	U	U	U	U	U	NR
Europium-155	125	0.054	U	U	U	U	U	U	U	U	NR
Nickel-63	4,026	NA	U	U	U	U	U	U	U	U	NR
Plutonium-238	37.4	0.004	U	U	U	U	U	U	U	U	NR
Plutonium-239/240	33.9	0.025	0.0830	U	U	U	U	U	U	U	NR
Strontium-90	4.5	0.18	0.430	U	U	U	U	U	U	U	NR
Technetium-99	15[b]	NA	U	U	U	U	U	U	U	U	NR
Thorium-232[c]	1.300	1.3	0.206	0.246	0.223	0.296	0.167	0.201	U	U	NR
Tritium (H-3)	35.5	NA	U	U	U	U	U	U	U	U	U
Uranium-233/234	1.1[d]	1.1	0.160	0.13	0.150	0.150	0.130	0.120	U	0.15	NR
Uranium-235	1.0[b]	0.11	7.70E-3	0.02	0.0150	0.0290	0.0160	0.0160	U	U	NR
Uranium-238	1.1[d]	1.1	0.150	0.13	0.130	0.120	0.140	0.140	U	U	NR

Notes:

[a] In the shallow zone, cleanup must achieve the direct exposure RAOs and the groundwater/Columbia River RAO; therefore, the lowest value among the "Protection from Direct Exposure,"
"Protective of Groundwater," and "Protective of the Columbia River" values is the applicable look-up value.

[b] The remedial action goal is below the PQL. The value presented is the PQL.

[c] Thorium conversion:
1 mg/kg = 1 µg/g
Th-232 Specific Activity – 1.09E-07 Ci/g (Shleien et al., 1998, *Handbook of Health Physics and Radiological Health*)
pCi/g = (Result µg/g)(SpA Ci/g)(1 g/106 µg)(1012 pCi/1 Ci)

[d] The remedial action goal is below background. The value presented is background.

HEIS =Hanford Environmental Information System
NA = Not Available.
NR = Analysis Not Required. Trip Blank is analyzed for tritium only.
U = Analyte was not detected above laboratory detection limit.

Soil Sample	Test Results	Converted Test Results
B20MN6	1.88 mg/kg	0.206 pCi/g
B20MN8	2.24 mg/kg	0.246 pCi/g
B20MP2	2.03 mg/kg	0.223 pCi/g
B20MN9	2.70 mg/kg	0.296 pCi/g
B20MP0	1.52 mg/kg	0.167 pCi/g
B20MP1	1.83 mg/kg	0.201 pCi/g
B20MV7	U	U

Table F 2a. Investigation Results for Shallow Zone 216-N-6 Sample Locations for Nonradionuclide COPCs

COPCs	Look-Up Values Summary Remedial Action Goal – Shallow Zone [<4.6 m (15 ft)][a] (mg/kg)	Hanford Specific Background Concentration (mg/kg)	HEIS #B20W87 Sample Location #1 0.9 m (3 ft) Depth (mg/kg)	HEIS #B20MN2 Sample Location #1 4.6 m (15 ft) Depth (mg/kg)	HEIS #B20W86 Sample Location #8 4.6 m (15 ft) Depth (mg/kg)	HEIS #B20MN4 Sample Location #9 4.6 m (15 ft) Depth (mg/kg)	HEIS #B20W88 Sample Location #2 1.2 m (4 ft) Depth (mg/kg)	HEIS #B20MN3 Sample Location #2 4.6 m (15 ft) Depth (mg/kg)	HEIS #B20W85 Sample Location #10 4.6 m (15 ft) Depth (mg/kg)	HEIS #B20MN5 Sample Location #11 4.6 m (15 ft) Depth (mg/kg)	HEIS #B20MN7 Sample Location #3 1.5 m (5 ft) Depth (mg/kg)
Antimony	6.0[b]	5[c]	1.15	U	U	U	U	U	U	U	U
Arsenic	6.5[d]	6.5	6.86	2.44	2.22	1.61	2.44	2.07	1.93	1.49	3.04
Barium	5,600	132	79.0	61.3	59.1	60.3	55.6	43.6	52.3	37.4	89.3
Cadmium	80	0.81[c]	0.630	U	U	U	0.160	0.290	U	U	0.150
Chromium (III)[e]	80,000	18.5	334	5.99	4.92	1.84	57.9	12.1	2.99	2.81	11.3
Chromium (VI)	2.2	NA	U	U	U	U	U	0.400	U	U	U
Lead	353	10.2	202	3.43	3.91	2.19	5.65	3.92	2.80	2.35	5.63
Manganese	11,200	512	253	314	537	192	163	222	243	152	343
Mercury	24	0.33	U	U	U	U	0.100	U	U	U	U
Zinc	24,000	67.8	210	46.1	31.6	28.2	156	61.2	31.2	19.4	150
PCBs	0.5	NA	U	U	U	U	U	U	U	U	U

[a] In the shallow zone, cleanup must achieve the direct exposure RAOs and the groundwater/Columbia River RAO; therefore, the lowest value among the "Protection from Direct Exposure," "Protective of Groundwater," and "Protective of the Columbia River" values is the applicable look-up value.

[b] The remedial action goal is below the PQL. The value presented is the PQL.

[c] Hanford Site-specific background not available; therefore, values were taken from Ecology Publication 94-115, *Natural Background Soil Metals Concentrations in Washington State*.

[d] The remedial action goal is below background. The value presented is background.

[e] Chromium (III) is calculated by subtracting chromium (VI) from total chromium.

HEIS = Hanford Environmental Information System
NA = Not Available.
PCB = Polychlorinated biphenyls
U = Analyte not detected above laboratory detection limit.

Table F 2b. Investigation Results for Shallow Zone 216-N-6 Sample Locations for Nonradionuclide COPCs

COPCs	Remedial Action Goal – Shallow Zone [<4.6 m (15 ft)][a] (mg/kg)	Hanford Specific Background Concentration (mg/kg)	HEIS #B20MN6 Sample Location #3 1.5 m (5 ft) Depth Duplicate (mg/kg)	HEIS #B20MN8 Sample Location #3 4.6 m (15 ft) Depth (mg/kg)	HEIS #B20MP2 Sample Location #12 4.6 m (15 ft) Depth (mg/kg)	HEIS #B20MN9 Sample Location #13 4.6 m (15 ft) Depth (mg/kg)	HEIS #B20MP0 Sample Location #4 4.6 m (15 ft) Depth (mg/kg)	HEIS #B20MP1 Sample Location #5 4.6 m (15 ft) Depth (mg/kg)	HEIS #B20LB3 Field Blank (mg/kg)	HEIS #B20MV7 Equipment Blank (mg/kg)
Antimony	6.0[b]	5[c]	U	U	U	U	U	U	U	U
Arsenic	6.5[d]	6.5	2.48	1.82	2.14	2.10	2.04	1.58	U	U
Barium	5,600	132	73.0	45.80	52.1	64.1	36.2	46.3	U	0.00266
Cadmium	80	0.81[c]	0.130	U	U	U	U	U	0.00266	U
Chromium (III)[e]	80,000	18.5	5.82	3.41	3.42	3.94	2.01	3.18	U	0.00103
Chromium (VI)	2.2	NA	0.300	U	U	U	U	U	U	U
Lead	353	10.2	4.32	3.12	3.44	3.65	2.67	3.12	0.000195	0.000462
Manganese	11,200	512	306	202.00	232	299	249	193	0.000111	0.00875
Mercury	24	0.33	U	U	U	U	U	U	U	U
Zinc	24,000	67.8	119	28.10	116	36.4	25.6	25.9	0.00222	0.00274
PCBs	0.5	NA	U	U	U	U	U	U	U	U

[a] In the shallow zone, cleanup must achieve the direct exposure RAOs and the groundwater/Columbia River RAO; therefore, the lowest value among the "Protection from Direct Exposure," "Protective of Groundwater," and "Protective of the Columbia River" values is the applicable look-up value.

[b] The remedial action goal is below the PQL. The value presented is the PQL.

[c] Hanford Site-specific background not available; therefore, values were taken from Ecology Publication 94-115, *Natural Background Soil Metals Concentrations in Washington State*.

[d] The remedial action goal is below background. The value presented is background.

[e] Chromium (III) is calculated by subtracting chromium (VI) from total chromium.

HEIS = Hanford Environmental Information System
NA = Not Available.
PCB = Polychlorinated biphenyls
U = Analyte not detected above laboratory detection limit.

Appendix G

Verification Sampling Data Summary

APPENDIX G

This appendix provides a data summary of the verification sampling data (Table G-1 and G-2).

Figure G-1. 216-N-6 RTD Excavation

NOTE: Fieldwork was performed based on investigative sample data and historical knowledge, with consideration of radiological and hazardous contaminant concerns (Figure G-1). Field screening of contaminants ensured protection of personnel.

Figure G-2. 216-N-6 Aerial of Final Excavation

Table G-1a. 216-N-6 Verification Sampling Radiological Results

COC	Look-Up Values Summary Remedial Action Goal – Shallow Zone [<4.6 m (15 ft)][a] (pCi/g)	Hanford Specific Background Activity[b] (pCi/g)	Required Detection Limit[c] pCi/g	Laboratory Minimum Detection Limit pCi/g	HEIS# B280Y3, B28111 V-1 Surface[d] (pCi/g)	HEIS# B28133, B28137 V-1 4.67 m (15 ft)[d] (pCi/g)	HEIS # B280Y4, B28112 V-2 Surface[d] (pCi/g)	HEIS# B280Y5, B28113 V-3 Surface[d] (pCi/g)	HEIS# B280Y6, B28114 V-4 Surface[d] (pCi/g)	HEIS# B280Y7, B28115 V-5 Surface[d] (pCi/g)	HEIS# B28134, B28138 V-5 4.67 m (15 ft)[d] (pCi/g)	HEIS# B280Y8, B28116 V-6 Surface[d] (pCi/g)	HEIS# B280Y9, B28117 V-7 Surface[d] (pCi/g)	HEIS# B28100, B28118 V-8 Surface[d] (pCi/g)	HEIS# B28101, B28119 V-9 Surface[d] (pCi/g)	HEIS# B28102, B28120 V-10 Surface[d] (pCi/g)	HEIS# B28103, B28121 V-11 Surface[d] (pCi/g)
Americium-241	31.1	NA	1	0.016	0.037	0.03	0.037	0.04	0.012	0.029	0.028	0.029	0.038	U	U	U	0.032
Cesium-137	6.2	1.1	0.05	0.056[e]	0.4	0.063	0.051	U	U	0.33	U	U	1.5	0.14	0.37	0.25	0.19
Cobalt-60	1.4	0.008	0.05	0.056[e]	U	U	U	U	U	U	U	U	U	U	U	U	U
Europium-152	3.3	NA	0.1	0.15[e]	U	U	U	U	U	U	U	U	0.26	U	U	U	U
Europium-154	3.0	0.033	0.1	0.18[e]	U	U	U	U	U	U	U	U	U	U	U	U	U
Europium-155	125	0.054	0.1	0.19[e]	U	U	U	U	U	U	U	U	U	U	U	U	U
Nickel-63	4,026	NA	30	3.75	U	U	U	U	105	U	U	U	U	U	U	U	U
Plutonium-238	37.4	0.004	1	0.044	U	U	U	U	0.042	U	U	U	U	U	U	U	U
Plutonium-239/240	33.9	0.025	1	0.028	0.085	U	0.019	U	U	U	U	U	0.14	0.02	0.015	0.024	0.022
Strontium-90	4.5	0.18	1	0.48	U	U	U	U	U	U	U	U	U	U	U	U	U
Technetium-99	15[f]	NA	1	0.33	U	U	U	U	U	U	U	U	U	U	U	U	U
Thorium-232 [g]	1.3	1.3	1	0.01	0.29	0.23	0.23	0.19	0.21	0.47	0.24	0.21	0.27	0.24	0.34	0.29	0.30
Tritium	35.5	NA	30	7.82	U	U	U	U	U	U	U	U	U	U	U	U	U
Uranium-233/234	1.1[h]	1.1	1	0.017	0.19	0.15	0.19	0.14	0.15	0.17	0.15	0.11	0.2	0.14	0.15	0.18	0.16
Uranium-235	1.0[f]	0.11	1	0.019	U	U	0.021	0.021	0.016	U	0.022	U	U	U	U	U	0.015
Uranium-238	1.1[h]	1.1	1	0.017	0.19	0.14	0.11	0.17	0.18	0.23	0.19	0.14	0.17	0.17	0.12	0.17	0.12

Notes:

[a] In the shallow zone, cleanup must achieve the direct exposure RAOs and the groundwater/Columbia River RAO; therefore, the lowest value among the "Protection from Direct Exposure," "Protective of Groundwater," and "Protective of the Columbia River" values is the applicable look-up value.

[b] Unless otherwise noted, background concentrations are 90th percentile values of the log normal distribution of the site-wide solid background data.

[c] Detection limits are taken from DOE/RL-2007-54 unless otherwise noted.

[d] Surface is 0 to 0.3 m (0 to 1 ft) at the base of the excavation and 4.67 m (15 ft) is from original grade.

[e] Laboratory minimum detection limit is above detection limit required by DOE/RL-2007-54. Both detection limits are below RAG.

[f] The remedial action goal is below the PQL. The value presented is the PQL.

[g] Thorium conversion:

1 mg/kg = 1 µg/g

Thorium-232 Specific Activity – 1.09E-07 Ci/g (Shleien et al., 1998, *Handbook of Health Physics and Radiological Health*)

pCi/g = (Result µg/g)(SpA Ci/g)(1 g/10^6 µg)(10^{12} pCi/1 Ci)

[h] The remedial action goal is below background. The value presented is background.

Abbreviations:

HEIS = Hanford Environmental Information System
mg/kg = milligrams per kilogram
NA = Not Available
U = Analyte not detected above laboratory detection limit.

Soil samples	Test Results	Converted Test Results
B280Y3	2.64 mg/kg	0.29 pCi/g
B28133	2.08 mg/kg	0.23 pCi/g
B280Y4	2.1 mg/kg	0.23 pCi/g
B280Y5	1.74 mg/kg	0.19 pCi/g
B280Y6	1.92 mg/kg	0.21 pCi/g
B280Y7	4.24 mg/kg	0.47 pCi/g
B28134	2.21 mg/kg	0.24 pCi/g
B280Y8	1.94 mg/kg	0.21 pCi/g
B280Y9	2.47 mg/kg	0.27 pCi/g
B28100	2.17 mg/kg	0.24 pCi/g
B28101	3.12 mg/kg	0.34 pCi/g
B28102	2.67 mg/kg	0.29 pCi/g
B28103	2.71 mg/kg	0.30 pCi/g

Table G-1b. 216-N-6 Verification Sampling Radiological Results

COC	Look-Up Values Summary Remedial Action Goal – Shallow Zone [<4.6 m (15 ft)][a] (pCi/g)	Hanford Specific Background Activity[b] (pCi/g)	Required Detection Limit[c] pCi/g	Laboratory Minimum Detection Limit pCi/g	HEIS# B28135, B28139 V-11 4.67 m (15 ft)[d] (pCi/g)	HEIS# B28104, B28122 V-12 Surface[d] (pCi/g)	HEIS# B28105, B28123 V-13 Surface[d] (pCi/g)	HEIS# B28106, B28124 V-14 Surface[d] (pCi/g)	HEIS# B28107, B28125 V-15 Surface[d] (pCi/g)	HEIS# B28108, B28126 V-16 Surface[d] (pCi/g)	HEIS# B28109, B28127 V-17 Surface[d] (pCi/g)	HEIS# B28110, B28128 V-17 Dup Surface[d] (pCi/g)	HEIS# B28136, B28140 V-17 4.67 m (15 ft)[d] (pCi/g)	HEIS# B28153, B28157 Equipment Blank (pCi/g)	HEIS# B28154, B28158 Equipment Blank (pCi/g)	HEIS# B28155 Trip Blank (pCi/g)	HEIS# B28156, B28159 Field Blank (pCi/g)
Americium-241	31.1	NA	1	0.016	0.049	0.02	0.015	0.024	U	0.027	0.026	0.038	0.021	0.25	U	NR	U
Cesium-137	6.2	1.1	0.05	0.056[e]	U	U	U	0.15	0.12	U	U	U	U	U	U	NR	U
Cobalt-60	1.4	0.008	0.05	0.056[e]	U	U	U	U	U	U	U	U	U	U	U	NR	U
Europium-152	3.3	NA	0.1	0.15[e]	U	U	U	U	U	U	U	U	U	U	U	NR	U
Europium-154	3.0	0.033	0.1	0.18[e]	U	U	U	U	U	U	U	U	U	U	U	NR	U
Europium-155	125	0.054	0.1	0.19[e]	U	U	U	U	U	U	U	U	U	U	U	NR	U
Nickel-63	4,026	NA	30	3.75	U	U	U	U	5.13	U	U	U	U	U	U	NR	U
Plutonium-238	37.4	0.004	1	0.044	U	U	U	U	U	U	U	U	U	U	U	NR	U
Plutonium-239/240	33.9	0.025	1	0.028	U	0.019	U	0.017	0.015	0.017	0.014	U	U	0.38	U	NR	U
Strontium-90	4.5	0.18	1	0.48	U	U	U	U	U	U	U	U	U	U	U	NR	U
Technetium-99	15[f]	NA	1	0.33	U	U	U	U	U	U	U	U	U	U	U	NR	U
Thorium-232 [g]	1.3	1.3	1	0.01	0.27	0.23	0.27	0.26	0.27	0.28	0.27	0.25	0.28	U	U	NR	U
Tritium	35.5	NA	30	7.82	U	U	U	U	U	U	U	U	U	U	U	U	U
Uranium-233/234	1.1[h]	1.1	1	0.017	0.18	0.14	0.16	0.12	0.12	0.16	0.15	0.12	0.15	U	U	NR	0.067
Uranium-235	1.0[f]	0.11	1	0.019	0.017	0.025	0.025	U	U	U	0.015	U	U	U	U	NR	U
Uranium-238	1.1[h]	1.1	1	0.017	0.15	0.16	0.17	0.085	0.14	0.17	0.16	0.14	0.17	U	U	NR	0.067

Notes:

[a] In the shallow zone, cleanup must achieve the direct exposure RAOs and the groundwater/Columbia River RAO; therefore, the lowest value among the "Protection from Direct Exposure," "Protective of Groundwater," and "Protective of the Columbia River" values is the applicable look-up value.

[b] Unless otherwise noted, background concentrations are 90th percentile values of the log normal distribution of the site-wide solid background data.

[c] Detection limits are taken from DOE/RL-2007-54 unless otherwise noted.

[d] Surface is 0 to 0.3 m (0 to 1 ft) at the base of the excavation and 4.67 m (15 ft) is from original grade.

[e] Laboratory minimum detection limit is above detection limit required by DOE/RL-2007-54. Both detection limits are below RAG.

[f] The remedial action goal is below the PQL. The value presented is the PQL.

[g] Thorium conversion:

1 mg/kg = 1 µg/g

Th-232 Specific Activity – 1.09E-07 Ci/g (Shleien et al., 1998, *Handbook of Health Physics and Radiological Health*)

pCi/g = (Result µg/g)(SpA Ci/g)(1 g/10^6 µg)(10^{12} pCi/1 Ci)

[h] The remedial action goal is below background. The value presented is background.

Abbreviations:

HEIS = Hanford Environmental Information System
pCi/g = picocuries per gram
NA = Not Available
NR = Analysis Not Required. Trip Blank is analyzed for tritium only.
U = Analyte not detected above laboratory detection limit.

Soil samples	Test Results	Converted Test Results
B28135	2.5 mg/kg	0.27 pCi/g
B28104	2.08 mg/kg	0.23 pCi/g
B28105	2.42 mg/kg	0.27 pCi/g
B28106	2.4 mg/kg	0.26 pCi/g
B28107	2.43 mg/kg	0.27 pCi/g
B28108	2.59 mg/kg	0.28 pCi/g
B28109	2.43 mg/kg	0.27 pCi/g
B28110	2.27 mg/kg	0.25 pCi/g
B28136	2.53 mg/kg	0.28 pCi/g
B28153	U	U
B28154	U	U
B28156	U	U

Table G-2a. 216-N-6 Verification Sampling Nonradiological Results

COC	Look-Up Values Summary Remedial Action Goal – Shallow Zone [<4.6 m (15 ft)][a] (mg/kg)	Hanford Specific Background Concentration[b] (mg/kg)	Required Detection Limit[c] mg/kg	Laboratory Minimum Detection Limit mg/kg	HEIS# B280Y3, B28111 V-1 Surface[d] (mg/kg)	HEIS# B28133, B28137 V-1 4.67 m (15 ft)[d] (mg/kg)	HEIS # B280Y4, B28112 V-2 Surface[d] (mg/kg)	HEIS# B280Y5, B28113 V-3 Surface[d] (mg/kg)	HEIS# B280Y6, B28114 V-4 Surface[d] (mg/kg)	HEIS# B280Y7, B28115 V-5 Surface[d] (mg/kg)	HEIS# B28134, B28138 V-5 4.67 m (15 ft)[d] (mg/kg)	HEIS# B280Y8, B28116 V-6 Surface[d] (mg/kg)	HEIS# B280Y9, B28117 V-7 Surface[d] (mg/kg)	HEIS# B28100, B28118 V-8 Surface[d] (mg/kg)	HEIS# B28101, B28119 V-9 Surface[d] (mg/kg)	HEIS# B28102, B28120 V-10 Surface[d] (mg/kg)	HEIS# B28103, B28121 V-11 Surface[d] (mg/kg)
Antimony	6.0[e]	5	0.6	0.32	U	UN	U	U	U	U	UN	U	U	U	U	U	U
Arsenic	6.5[f]	6.5	0.5	0.42	3.14	1.91	3.21	3.05	2.65	2.92	2.84	2.71	2.46	2.33	3.05	3.3	2.55
Barium	5,600	132	0.2	0.21[c]	83.8	44.5	66.5	68.3	85.1	63.5	53.3	50.6	61.3	53.5	42.5	62.8	51
Cadmium	80	0.81[g]	0.1	0.11[c]	U	U	U	U	U	U	U	U	U	U	U	U	U
Chromium (III)[h]	80,000	18.5	1	0.53	7.04	4.71	4.54	6.17	6.76	4.45	5.13	1.89	10.3	3.77	4.64	7.64	4.73
Chromium (VI)	2.2	NA	0.5	0.1	U	U	U	U	U	U	U	U	U	U	U	U	U
Lead	353	10.2	0.5	0.11	5.61	3.22	4.43	4.52	5.13	4.12	3.73	3.5	4.96	3.72	4.02	6.92	3.81
Manganese	11,200	512	0.5	0.11	280	244	275	273	317	300	307	253	290	275	257	375	296
Mercury	24	0.33	0.05	0.053[c]	U	U	U	U	U	U	U	U	U	U	U	U	U
Zinc	24,000	67.8	1	0.85	32.7	31.7	33.4	31.3	32.6	34.3	30.5	30.5	39.3	32	33.9	41.6	37.6
PCBs	0.5	NA	0.5	0.009	U	U	U	U	U	U	U	U	U	U	U	U	U

Notes:

[a] In the shallow zone, cleanup must achieve the direct exposure RAOs and the groundwater/Columbia River RAO; therefore, the lowest value among the "Protection from Direct Exposure," "Protective of Groundwater," and "Protective of the Columbia River" values is the applicable look-up value.

[b] Unless otherwise noted, background concentrations are 90th percentile values of the log normal distribution of the site-wide solid background data (DOE/RL-92-24, Hanford Site Background: Part 1 Soil Background for Nonradionuclide Analytes).

[c] Detection limits are taken from DOE/RL-2007-54 unless otherwise noted.

[d] Surface is 0 to 0.3 m (0 to 1 ft) at the base of the excavation and 4.67 m (15 ft) is from original grade.

[e] The remedial action goal is below the PQL. The value presented is the PQL.

[f] The remedial action goal is below background. The value presented is background.

[g] Hanford Site-specific background not available; therefore, values were taken from Ecology Publication 94-115, *Natural Background Soil Metals Concentrations in Washington State*.

[h] Samples were analyzed for Total Chromium and Chromium (VI). The concentration for Chromium (III) is obtained by subtracting the concentration of Chromium (VI) from the concentration of Total Chromium.

Abbreviations:

HEIS = Hanford Environmental Information System
mg/kg = milligrams per kilogram
PCB = polychlorinated biphenyl
NA = Not Available
U = Analyte not detected above laboratory detection limit.

Table G-2b. 216-N-6 Verification Sampling Nonradiological Results

COC	Look-Up Values Summary Remedial Action Goal – Shallow Zone [<4.6 m (15 ft)][a] (mg/kg)	Hanford Specific Background Concentration[b] (mg/kg)	Required Detection Limit[c] mg/kg	Laboratory Minimum Detection Limit mg/kg	HEIS# B28135, B28139 V-11 4.67 m (15 ft)[d] (mg/kg)	HEIS# B28104, B28122 V-12 Surface[d] (mg/kg)	HEIS# B28105, B28123 V-13 Surface[d] (mg/kg)	HEIS# B28106, B28124 V-14 Surface[d] (mg/kg)	HEIS# B28107, B28125 V-15 Surface[d] (mg/kg)	HEIS# B28108, B28126 V-16 Surface[d] (mg/kg)	HEIS# B28109, B28127 V-17 Surface[d] (mg/kg)	HEIS# B28110, B28128 V-17 Dup Surface[d] (mg/kg)	HEIS# B28136, B28140 V-17 4.67 m (15 ft)[d] (mg/kg)	HEIS# B28153, B28157 Equipment Blank (mg/kg)	HEIS# B28154, B28158 Equipment Blank (mg/kg)	HEIS# B28155 FTB (mg/kg)	HEIS# B28156, B28159 FB (mg/kg)
Antimony	6.0[e]	5	0.6	0.32	UN	U	U	U	U	U	U	U	UN	U	U	NR	U
Arsenic	6.5[f]	6.5	0.5	0.42	2.67	2.54	3.2	2.57	2.24	3.05	2.18	2	2.48	U	U	NR	U
Barium	5,600	132	0.2	0.21[c]	58.6	61.4	70.1	80.1	72.6	52.1	53	51.1	51.1	0.00022	U	NR	U
Cadmium	80	0.81[g]	0.1	0.11[c]	U	U	U	U	U	U	U	U	U	U	U	NR	U
Chromium (III)[h]	80,000	18.5	1	0.53	5.73	5.05	6	6.51	3.97	3.93	3.23	3.32	5.29	U	U	NR	U
Chromium (VI)	2.2	NA	0.5	0.1	U	U	U	U	U	U	U	U	U	U	U	NR	U
Lead	353	10.2	0.5	0.11	4.21	5.22	5.56	5.35	4.16	3.79	3.33	3.42	4.23	U	U	NR	U
Manganese	11,200	512	0.5	0.11	289	289	380	324	366	363	379	325	320	U	U	NR	U
Mercury	24	0.33	0.05	0.053[c]	U	U	U	U	U	U	U	U	U	U	U	NR	U
Zinc	24,000	67.8	1	0.85	33.1	34	43.4	33.8	39.3	43.3	40.2	38.4	36.3	U	0.00719	NR	U
PCBs	0.5	NA	0.5	0.009	U	U	U	U	U	U	U	U	U	U	U	NR	U

Notes:

[a] In the shallow zone, cleanup must achieve the direct exposure RAOs and the groundwater/Columbia River RAO; therefore, the lowest value among the "Protection from Direct Exposure," "Protective of Groundwater," and "Protective of the Columbia River" values is the applicable look-up value.

[b] Unless otherwise noted, background concentrations are 90th percentile values of the log normal distribution of the site-wide solid background data. Source: Hanford Site Background: Part 1 Soil Background for Nonradionuclide Analytes (DOE/RL-92-24).

[c] Detection limits are taken from DOE/RL-2007-54 unless otherwise noted.

[d] Surface is 0 to 0.3 m (0 to 1 ft) at the base of the excavation and 4.67 m (15 ft) is from original grade.

[e] The remedial action goal is below the PQL. The value presented is the PQL.

[f] The remedial action goal is below background. The value presented is background.

[g] Hanford Site-specific background not available; therefore, values were taken from Ecology Publication 94-115, *Natural Background Soil Metals Concentrations in Washington State*.

[h] Chromium (III) is calculated by subtracting chromium (VI) from total chromium.

Abbreviations:

HEIS	=	Hanford Environmental Information System
mg/kg	=	milligrams per kilogram
PCB	=	polychlorinated biphenyl
NA	=	Not Available
NR	=	Analysis Not Required. Trip Blank is analyzed for tritium only.
U	=	Analyte not detected above laboratory detection limit.