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Sect 1 of 3

# Remedial Investigation Report for the 200-PW-2 Uranium-Rich Process Waste Group and the 200-PW-4 General Process Condensate Group Operable Units

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

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**Richland, Washington 99352**

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# EXECUTIVE SUMMARY

The purpose of this remedial investigation (RI) report is to evaluate the data generated during the RI and other characterization activities at the 200-PW-2 and 200-PW-4 Operable Units (OU).

The remedial investigation work was completed over an approximately 1-year period from April 2003 to April 2004, with most of the drilling and sampling occurring in the April-to-October-2003 timeframe.

The 200-PW-2 Uranium-Rich Process Waste Group OU contains 37 waste sites; the 200-PW-4 General Process Condensate and Process Waste Group contains 16 waste sites. This RI report focuses on the characterization of four waste sites in the 200-PW-2 OU: the 216-A-10 Crib, 216-A-19-Trench, 216-A-36B Crib, and 216-B-12 Crib. It also focuses on the characterization of the following sites at the 200-PW-4 OU: the 207-A South Retention Basin and the 216-A-37-1 Crib. The 216-A-19 Trench and the 216-B-12 Crib are representative sites; the remainder are *Resource Conservation and Recovery Act of 1976* (RCRA) treatment, storage, and disposal (TSD) units.

Two additional representative sites, the 216-U-8 Crib and the 216-U-12 Crib were contained in the 200-PW-2 OU when this RI was completed. The 216-U-12 Crib also is a RCRA TSD unit. The Work Plan governing data collection for this RI (*Uranium-Rich/General Process Condensate and Process Waste Group Operable Units RI/FS Work Plan and RCRA TSD Unit Sampling Plan*, DOE/RL-2000-60, Rev. 1[1]) indicates that new characterization data are not required for these two sites; data collected in an earlier characterization effort are discussed in this RI Report and compared to new gamma logging data collected under the Work Plan.

The 200-PW-2 OU contains 10 waste sites and the 200-PW-4 OU contains 2 waste sites that fall within the recently approved U Plant Closure Area, the 200-UW-1 OU. Waste sites in the new OU include the 216-U-8 and 216-U-12 Cribs. Since Hanford Federal Facility Agreement and Consent Order Change Number C-03-01 was approved by the U.S. Department of Energy,

U.S. Environmental Protection Agency, and Washington State Department of Ecology on April 27, 2004[2], this geographic closure approach will result in final remedial action decisions for these waste sites such that they no longer will need to be included in the record of decision for the 200-PW-2 and 200-PW-4 OUs. The 12 affected waste sites were retained in this remedial investigation report pending approval of the new approach. The focused feasibility study and proposed plan documents for the U Plant Closure Area[3] were provided to the regulators in the late fall of 2003, and were being reviewed and revised when this document was finalized.

During the RI process data are evaluated to determine if enough have been collected to support risk assessment and remedial decision making, estimate risk at the representative sites based on data collected during the RI and on other existing data, support the decision to proceed with a feasibility study (FS), and determine which constituents and site-specific considerations need to be addressed in the FS. This RI Report also provides data to support the evaluation of alternatives in the FS with regard to meeting potential applicable or relevant and appropriate requirements, risk reduction, and any potentially significant data gaps.

Data collected before and during the RI are discussed in this report. The field investigations at these sites include a surface radiation survey, surface soil and water sampling, drilling and sampling of one vadose zone borehole at each waste site, and borehole geophysical surveys, followed by surface and subsurface soil sampling. Geophysical logging was performed in the new boreholes and in existing boreholes near the 200-PW-2 and 200-PW-4 OU waste sites.

The data quality objectives for the RI were met. All boreholes required by the Work Plan[1] were completed. All required samples were taken and analyzed for contaminants of concern.

---

[1]DOE/RL-2000-60, 2004, *Uranium-Rich/General Process Condensate and Process Waste Group Operable Units RI/FS Work Plan and RCRA TSD Unit Sampling Plan*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

[2]"Modify Tri-Party Agreement Appendices B and C, Establish a New Operable Unit for Selected U Plant Area Waste Sites (200-UW-1) and Designate Ecology as the Lead Regulatory Agency," 2003, Hanford Federal Facility Agreement and Consent Order Change Control Form, Change Number C-03-01, dated March 16, 2003, approved by Joel Hebdon, U.S. Department of Energy, Richland Operations Office, on March 24, 2004; Nick Ceto, U.S. Environmental Protection Agency, on April 27, 2004; and Michael A. Wilson, Washington State Department of Ecology, on April 27, 2004.

[3] DOE/RL-2003-23, Draft B, *Focused Feasibility Study for the U Plant Closure Area Waste Sites*, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

The data are of sufficient quantity and quality to support risk assessment activities and to proceed to the FS to support evaluation of alternatives.

The risk assessment data evaluation methodology used in this RI Report considers applicable regulatory requirements, the data quality objective process conducted for the work plan, land-use uncertainties, risk assessment methodology, other OUs, and site-specific conditions. The data evaluation process consists of the following:

- Data screening for nondetected constituents and background constituents
- Human health risk assessment determinations for nonradiological constituents
- Qualitative evaluation of ecological risk based on site- and area-wide information
- Dose and risk evaluation for radiological constituents
- Comparison to risk-based concentrations for nonradiological constituents
- Evaluation of impacts to groundwater.

Conceptual contaminant distribution models developed in the Work Plan[1] were refined based on the RI data in this report. The contaminant distribution models depict current contaminant distribution beneath the representative sites. These models will be used in the FS to apply the analogous site approach to the remaining waste sites (analogous sites). See DOE/RL-98-28, *200 Areas Remedial Investigation/Feasibility Study Implementation Plan-Environmental Restoration Program* (the 200 Areas Implementation Plan), for more information.

A baseline risk assessment was performed using the RI data. The assessment was consistent with stated assumptions concerning land-use scenarios, cleanup goals, and potential receptors. A general summary of the data evaluation process can be stated as follows:

- A fate and transport assessment for nonradionuclides was performed using risk assessment guidance from the U. S. Environmental Protection Agency. The constituents were screened against Hanford Site background levels and *Washington Administrative Code*-defined risk-based concentrations.

- The RESidual RADioactivity dose model (ANL/EAD-4, *User's Manual for RESRAD*, Version 6[4]) was used to evaluate potential radionuclides that may be transported to groundwater. The model was used to predict potential doses from radionuclides; the doses then were converted to risk values.

- A qualitative assessment was performed on the constituents that exceeded risk-based concentrations or would potentially reach groundwater based on RESRAD modeling. This additional evaluation included frequency of detections, depth of detections, and whether a groundwater plume containing this constituent already exists.

The results of the RI characterization confirmed expected contaminants of concern and correlate well with contaminant distribution models in the Work Plan. Contaminants of concern and risk and dose rates were identified for each waste site and will be carried forward into the FS for evaluation of remedial alternatives. Vadose zone fate and transport modeling were deemed unnecessary for these waste sites. Instead, a rationale was written for each constituent that exceeded screening levels at each waste site. This rationale gives the reasoning for its exclusion from further fate and transport modeling (other than RESRAD).

The risk assessment performed for the representative sites and TSDs is summarized in Table ES-1. The contaminants listed were found in the indicated sites at concentrations that exceeded risk screening levels. In some cases, even though no contaminants that exceeded risk levels were found at a given site, some contaminants of potential concern have been retained because there was no basis no exclude them (i.e., they had no site background and no listing in the pertinent regulations). These are not listed in the table. For expanded detail on contaminants found at waste sites included in this RI Report, please refer to Table 6-1, "Contaminants of Concern, Risk and Dose Summary," and Table 6-2, "Preliminary List of Contaminants for Confirmatory Sampling Phase at the 200-PW-2 and 200-PW-4 OUs."

---

[4] ANL/EAD-4, 2001, *User's Manual for RESRAD, Version 6*, Argonne National Laboratory, Environmental Assessment Division, Argonne, Illinois.

Table ES-1. Contaminants of Potential Concern Exceeding Risk Screening Levels.

| Risk | | Representative Sites | | TSD Sites | | | |
|---|---|---|---|---|---|---|---|
| | | **216-A-19 Trench** | **216-B-12 Crib** | **207-A South Retention Basin** | **216-A-10 Crib** | **216-A-36B Crib** | **216-A-37-1 Crib** |
| Human Health– Nonrad | Industrial – Total Excess Lifetime Cancer Risk from COCs >1 x $10^{-5}$ (WAC 173-303-745) | N | N | N | N | N | N |
| Human Health – Rad[1] | Industrial >15 mrem/yr; >$10^{-4}$ cancer risk | N | N | N | N | NA[3] | N |
| Groundwater Protection – Nonrad | > Soil Cleanup Levels for GW Protection, WAC 173-303-747 | Y $NO_3$, $NO_3/NO_2$, B, Mn, U | Y $NO_3$, $NO_3/NO_2$, U | Y[2] | Y Methylene Chloride, Diesel, Pentachloro-phenol | Y $NO_3$, $NO_2$, $NO_3/NO_2$, U | Y Al, Mn, $NO_3$, $NO_3/NO_2$, Tl |
| Groundwater Protection – Rad | > 15 mrem/yr[3] | N | N | N | Y $^{129}I$ peaks at 1,193 yr, 2,100 mrem/yr | Y $^{99}Tc$ peaks at 1,025 yr, 15.3 mrem/yr | N |
| Eco – Nonrad | Industrial > WAC 173-340-900, Table 749-3 | Y B, V | Y B | Y Ag | Y[2] B | Y Ag | Y Ba, B |
| Eco – Rad | Industrial > DOE-STD-1153-2002 | Y[2] | Y[2] | Y[2] | Y[2] | Y[2] | Y[2] |

[1]Three sites (216-A-19, 207-A, 216-A-37-1) were modeled both with and without cover because contamination was covered with clean fill material. Two sites (216-B-12, 216-A-10) were modeled only without cover because no clean fill material covered the contamination.

[2]No screening levels were exceeded; however contaminants of potential concern (COPC) are retained for consideration during the FS because some detected COPCs exceed background or no background levels were available; and screening levels were not available for these COPCs.

[3]NA = Not applicable. Contamination is so deep (7.6 m or 25 ft) that industrial modeling does not apply. RESRAD industrial modeling accounts only for radionuclide COPCs within 4.6 m (15 ft) of the ground surface.

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## TERMS

| | |
|---|---|
| ALARACT | as low as reasonably achievable control technology |
| ARAR | applicable or relevant and appropriate requirement |
| ASTM | American Society for Testing and Materials |
| AUF | Area Use Factor |
| BCG | biota concentration guide |
| BDAC | Biota Dose Assessment Committee |
| bgs | below ground surface |
| CERCLA | *Comprehensive Environmental Response, Compensation and Liability Act of 1980* |
| CFR | *Code of Federal Regulations* |
| CLARC | cleanup levels and risk calculation |
| COC | contaminant of concern |
| COEC | contaminant of ecological concern |
| COPC | contaminant of potential concern |
| COPEC | contaminant of potential ecological concern |
| CPP | CERCLA past practice |
| DCF | dose conversion factor |
| DOE | U.S. Department of Energy |
| DQA | data quality assessment |
| DQO | data quality objective |
| Ecology | Washington State Department of Ecology |
| Eco-SSL | Ecological Soil Screening Levels |
| EPA | U.S. Environmental Protection Agency |
| EPC | exposure point concentration |
| FS | feasibility study |
| FY | fiscal year |
| HAB | Hanford Advisory Board |
| HEIS | Hanford Environmental Information System |
| HI | hazard index |
| HQ | hazard quotient |
| HRLS | High-Rate Logging System |
| ID | inner diameter |
| IDW | investigation-derived waste |
| Implementation Plan | DOE/RL-98-28, *200 Areas Remedial Investigation/Feasibility Study Implementation Plan –Environmental Restoration Program* |
| IRIS | Integrated Risk Information System |
| LFI | limited field investigation |
| MDA | minimum detectable activity |
| MDL | minimum detection level |
| MTCA | Model Toxics Control Act |
| NEPA | *National Environmental Policy Act of 1969* |
| NMLS | Neutron-Moisture Logging System |
| OD | outer diameter |
| OU | operable unit |
| PCB | polychlorinated biphenyl |
| Pest/herb | pesticides and/or herbicides |

| | |
|---|---|
| PRG | preliminary remediation goal |
| PUREX | Plutonium-Uranium Extraction (Plant) |
| QA | quality assurance |
| QC | quality control |
| RA | risk assessment |
| rad | radionuclides |
| RAGS | Risk Assessment Guidance for Superfund |
| RAO | remedial action objective |
| RBC | risk-based concentration |
| RCRA | *Resource Conservation and Recovery Act of 1976* |
| REDOX | reduction-oxidation (process) |
| RESRAD | RESidual RADioactivity |
| RLS | Radiological Logging System |
| RPP | RCRA past-practice |
| RI | remedial investigation |
| RME | "reasonable maximum" exposure |
| ROD | record of decision |
| SGLS | spectral gamma-ray logging system |
| STOMP | Surface Transport Over Multiple Phases |
| SVOA | semivolatile organics analysis |
| SVOC | semivolatile organic compound |
| TIC | tentatively identified compound |
| TNC | The Nature Conservancy |
| TOC | total organic carbon |
| TPH | total petroleum hydrocarbons |
| Tri-Parties | U.S. Department of Energy, U.S. Environmental Protection Agency, and Washington State Department of Ecology |
| Tri-Party Agreement | *Hanford Federal Facility Agreement and Consent Order* |
| TSD | treatment, storage, and/or disposal (unit) |
| UCL | upper confidence limit |
| UPR | unplanned release |
| VOA | volatile organics analysis |
| VOC | volatile organic compound |
| WAC | *Washington Administrative Code* |
| WDOH | Washington State Department of Health |
| WIDS | Waste Information Data System |
| Work Plan | DOE/RL-2000-60, *Uranium Rich/General Process Condensate and Process Waste Group Operable Unit RI/FS Work Plan and RCRA TSD Unit Sampling Plan,* Rev. 1 |

# METRIC CONVERSION CHART

**Into Metric Units**

| *If You Know* | *Multiply By* | *To Get* |
|---|---|---|
| **Length** | | |
| inches | 25.4 | Millimeters |
| inches | 2.54 | Centimeters |
| feet | 0.305 | Meters |
| yards | 0.914 | Meters |
| miles | 1.609 | Kilometers |
| **Area** | | |
| sq. inches | 6.452 | sq. centimeters |
| sq. feet | 0.093 | sq. meters |
| sq. yards | 0.0836 | sq. meters |
| sq. miles | 2.6 | sq. kilometers |
| acres | 0.405 | Hectares |
| **Mass (weight)** | | |
| ounces | 28.35 | Grams |
| pounds | 0.454 | Kilograms |
| ton | 0.907 | metric ton |
| **Volume** | | |
| teaspoons | 5 | Milliliters |
| tablespoons | 15 | Milliliters |
| fluid ounces | 30 | Milliliters |
| cups | 0.24 | Liters |
| pints | 0.47 | Liters |
| quarts | 0.95 | Liters |
| gallons | 3.8 | Liters |
| cubic feet | 0.028 | cubic meters |
| cubic yards | 0.765 | cubic meters |
| **Temperature** | | |
| Fahrenheit | subtract 32, then multiply by 5/9 | Celsius |
| **Radioactivity** | | |
| picocuries | 37 | Millibecquerel |

**Out of Metric Units**

| *If You Know* | *Multiply By* | *To Get* |
|---|---|---|
| **Length** | | |
| millimeters | 0.039 | inches |
| centimeters | 0.394 | inches |
| Meters | 3.281 | feet |
| Meters | 1.094 | yards |
| kilometers | 0.621 | miles |
| **Area** | | |
| sq. centimeters | 0.155 | sq. inches |
| sq. meters | 10.76 | sq. feet |
| sq. meters | 1.196 | sq. yards |
| sq. kilometers | 0.4 | sq. miles |
| hectares | 2.47 | acres |
| **Mass (weight)** | | |
| Grams | 0.035 | ounces |
| kilograms | 2.205 | pounds |
| metric ton | 1.102 | ton |
| **Volume** | | |
| milliliters | 0.033 | fluid ounces |
| Liters | 2.1 | pints |
| Liters | 1.057 | quarts |
| Liters | 0.264 | gallons |
| cubic meters | 35.315 | cubic feet |
| cubic meters | 1.308 | cubic yards |
| **Temperature** | | |
| Celsius | multiply by 9/5, then add 32 | Fahrenheit |
| **Radioactivity** | | |
| millibecquerel | 0.027 | picocuries |

# 1.0 INTRODUCTION

This remedial investigation (RI) report for the 200-PW-2 Uranium-Rich Process Waste Group and the 200-PW-4 General Process Condensate and Process Waste Group Operable Units (OU) focuses on the characterization of four representative waste sites in the 200-PW-2 OU: the 216-A-10 Crib, 216-A-19-Trench, 216-A-36B Crib, and 216-B-12 Crib. It also focuses on the characterization of the following representative sites at the 200-PW-4 OU: the 207-A South Retention Basin and the 216-A-37-1 Crib. The representative waste sites were identified in DOE/RL-96-81, *Waste Site Grouping for 200 Areas Soil Investigations*, DOE/RL-98-28, *200 Areas Remedial Investigation/Feasibility Study Implementation Plan-Environmental Restoration Program* (Implementation Plan), and DOE/RL-2000-60, *Uranium-Rich/General Process Condensate and Process Waste Group Operable Units RI/FS Work Plan and RCRA TSD Unit Sampling Plan*, Rev. 1 (Work Plan), for evaluation as part of the RI. The representative sites were evaluated by implementing the data quality objective (DQO) process. The DQO process was used to determine the data that should be collected to assess site conditions and support remedial decision making.

The 200-PW-2 and 200-PW-4 OU representative waste sites were selected for characterization because waste stream inventories, effluent volumes received, and the current level of characterization suggest that contaminant inventories present in the subsurface beneath these receiving sites represent average or worst case conditions similar to those at the other waste sites in the OUs. In addition, any *Resource Conservation and Recovery Act of 1976* (RCRA) treatment, storage and disposal (TSD) units within these OUs have been characterized in accordance with agreements found in DOE/RL-98-28. This RI Report is prepared in fulfillment of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1989) (Tri-Party Agreement) Milestone M-015-43B.

The RI was conducted from April to November 2003 in accordance with the Work Plan (DOE/RL-2000-60, Rev. 1). Data were collected to characterize the nature and vertical extent of chemical and radiological contamination and the physical conditions in the vadose zone underlying the historical boundaries of the 216-A-19 Trench, the 216-B-12 Crib, the 216-A-10 Crib, and the 216-A-36B Crib, in the 200-PW-2 OU; and the 216-A-37-1 Crib and the 207-A South Retention Basin in the 200-PW-4 OU. Borehole drilling and sampling, large-diameter push-hole (drive casing) installation, direct-push sampling, surface and borehole geophysical surveys, and sampling and analysis of soils were conducted during the field activities. These efforts are summarized in CP-18666, *200-PW-2 and 200-PW-4 Operable Units Borehole Summary Report.*

Modifications to the Tri-Party Agreement M-013 series milestones for past-practice waste site investigations (Change Request M-013-02-01) describe the approach to investigate one or more OUs in a single RI/feasibility study (FS) process. This modification reduces the number of work plans, RI reports, and FSs needed for the 200 Area waste sites. The revised approach allows the collection of data needed to adequately characterize the waste sites in more than one OU at a time and to evaluate effective remedial alternatives for groups of OUs in a single effort. This approach permits the 200-PW-2 and 200-PW-4 OUs to be combined in a single RI Report.

The OUs are consolidated because they received similar waste streams (that is, uranium-rich process condensate/process waste and general process condensate and process waste) and because the contaminant distribution beneath these waste sites is expected to be analogous for use, waste-site type, inventory, and effluent volume discharged.

As part of the Tri-Party Agreement (Ecology et al. 1989) change package M-013-02-01, M-015-02-01, and M-020-02-01, approved in June 2002, the 200-PW-4 OU work scope was consolidated with that of the 200-PW-2 OU. The initial work plan that included the 200-PW-2 OU was issued in May 2001; the revised work plan including the 200-PW-2 and 200-PW-4 OUs was issued in 2004. Data collected and remedial decisions made under the consolidated 200-PW-2 and 200-PW-4 RI/FS process will be applied to the remaining waste sites in these two OUs. The waste sites in the two OUs are listed in Table 1-1.

In October 2003 the Draft B versions of the DOE/RL-2003-23, *Focused Feasibility Study for the U Plant Closure Area Waste Sites*, and the DOE/RL-2003-24, *Proposed Plan for the U Plant Closure Area Waste Sites*, were provided to the U.S. Department of Energy (DOE), U.S. Environmental Protection Agency (EPA), and Washington State Department of Ecology (Ecology) (collectively the Tri-Parties) for review and comment. In April 2004, Tri-Party Agreement change package C-03-01 (TPA 2004) was approved by the Tri-Parties. It moved 11 waste sites previously identified in the 200-PW-2 and 200-PW-4 OUs into the newly designated 200-UW-1 OU. This new OU encompasses a number of waste sites near the U Plant (221-U) in the 200 West Area that will undergo remedial actions based on a geographical approach rather than the previously used process-based operable units. This geographic closure approach will result in remedial action decisions for these waste sites such that they will no longer be included in the record of decision (ROD) for the 200-PW-2 and 200-PW-4 OUs. In addition to these 11 waste sites, one additional 200-PW-2 OU waste site, the 270-W neutralization tank, will be addressed in the future as part of the 200-UW-1 OU via an engineering evaluation/cost estimate. This site will be reassigned to the 200-UW-1 OU at that time. These 12 waste sites are identified in Table 1-1. Because this RI Report and the Work Plan (DOE/RL-2000-60, Rev. 1) were substantially prepared prior to approval of Tri-Party Agreement change package C-03-01 (TPA 2004), waste sites assigned to the 200-UW-1 OU as of April 2004 are discussed in this RI Report as if they were still included in the 200-PW-2 and 200-PW-4 OUs, and are included for example in summaries of numbers of sites, types of sites, etc.

The characterization and remediation of waste sites at the Hanford Site are addressed in the Tri-Party Agreement (Ecology et al 1989). This agreement addresses the integration of cleanup programs under the *Comprehensive Environmental Response, Compensation and Liability Act of 1980* (CERCLA) and RCRA to provide a standard approach to directing cleanup activities and to ensure that applicable regulatory requirements are met. Details of this integration for the 200 Areas are presented in the Implementation Plan (DOE/RL-98-28) and in the Work Plan (DOE/RL-2000-60, Rev. 1).

The 200-PW-2 and 200-PW-4 OUs are located near the center of the Hanford Site in south-central Washington State (Figure 1-1). According to the Work Plan (DOE/RL-2000-60, Rev. 1), the 200-PW-2 OU consists of 25 RCRA past-practice (RPP) waste sites, 3 RCRA TSD units, and 9 unplanned release (UPR) sites. The 200-PW-4 OU consists of 13 RPP waste sites, 2 RCRA

TSD units and 1 UPR site. Waste sites in these OUs are listed in the Work Plan (DOE/RL-2000-60, Rev. 1) and shown in Figures 1-2, through 1-5. Figure 1-6 shows the source facilities associated with the 200-PW-2 and 200-PW-4 OUs representative waste sites and TSD units.

The RI for the 200-PW-2 OU focuses characterization on four of the sites that are considered to be representative of the OU. Three of these sites, the 216-A-19 Trench, 216-B-12 Crib, and 216-U-8 Crib, are RPP sites; the fourth site, the 216-U-12 Crib, is a RCRA TSD unit. Two additional RCRA TSD units in the 200-PW-2 OU (the 216-A-10 Crib and 216-A-36B Crib) were characterized to support RCRA closure activities for this OU. As a result of the OU consolidation process, the assessment of two additional RCRA TSD units, the 216-A-37-1 Crib and the 207-A South Retention Basin, from the 200-PW-4 OU has been integrated into the RI/FS process. By adding the assessment of the 200-PW-4 OU to the scope of the 200-PW-2 OU, the investigation of all process-waste-type-related RCRA TSD units can be accelerated.

Data from all the representative units and TSD units discussed in the previous paragraph were collected in fiscal year (FY) 2003 except for the 216-U-8 and the 216-U-12 Cribs. According to the Work Plan (DOE/RL-2000-60, Rev. 1), an evaluation of existing data undertaken during the DQO process (BHI-01411, *Remedial Investigation DQO Summary Report for the 200-PW-2 Uranium-Rich Process Waste Group Operable Unit*) showed that no additional soil samples were required at the 216-U-8 and 216-U-12 Cribs. These sites were characterized in 1995 as part of the 200-UP-2 OU characterization activities (DOE/RL-95-13, *Limited Field Investigation for the 200-UP-2 Operable Unit*). In addition, existing boreholes near these two sites were geophysically logged for comparison to historic records as a cost-efficient method of assessing potential changes in contaminant distribution. These data are evaluated as part of this RI/FS.

In January 2004, an Ecology letter (Ecology 2004) to the U.S. Department of Energy, Richland Operations Office, requested additional revisions to the Work Plan beyond those initially discussed when the 200-PW-4 OU was consolidated into the 200-PW-2 OU. Specifically, Ecology requested that the 216-S-7 Crib be characterized as an additional representative waste site for the 200-PW-2 OU. The U.S. Department of Energy, Richland Operations Office, agreed in its response letter (DOE/RL 2004) to prepare a separate sampling and analysis plan (SAP) to execute the additional sampling; this new SAP was included as an additional appendix in the revision to the Work Plan. Data collected from the characterization borehole to be drilled at the 216-S-7 Crib will be included in the FS, which will be written to meet Tri-Party Agreement (Ecology et al. 1989) Milestone M-15-43C. This allows the schedule for submittal of this RI Report (due in June 2004 as part of Tri-Party Agreement Milestone M-15-43B) to be met. Details summarizing the anticipated number of samples for the 216-S-7 Crib have been added as Appendix D of Rev. 1 of the Work Plan (DOE/RL-2000-60).

The 200-PW-2 OU waste sites received uranium-rich process condensate and/or process waste, primarily from waste streams generated at the 221/224-U Plant Uranium Recovery Project, the Reduction-Oxidation (REDOX) Facility, and the 224-U/$UO_3$ Program for the Plutonium Uranium Extraction (PUREX) Plant, as well as at the 221-B (B Plant) and Hot Semiworks (C Plant) Facilities in the 200 East and 200 West Areas. Most of the process waste sites (cribs and trenches) received uranium-rich solutions from both the cold runs that used nonirradiated

uranium and the startup phases that used irradiated uranium before the three main plants began operation. The process condensates were vapors collected from thermally hot process steps that were condensed and subsequently discharged to the ground.

The 200-PW-4 OU waste sites received mostly process drainage, process distillate discharge, and miscellaneous condensates from the U and T Plants, the REDOX Facility, the PUREX Facility, the Hot Semiworks Facility (C Plant), and several contributing tank farm-related facilities such as the S and A Tank Farm condensates and the 242-A Evaporator.

The Work Plan (DOE/RL-2000-60, Rev. 1) describes the process history of these OUs in detail.

## 1.1 PURPOSE

This RI Report evaluates the data generated during the RI and other characterization activities to determine if sufficient data have been collected to support risk assessment and remedial decision making, to estimate risks at the representative sites based on the data collected during the RI and on existing data, to support the decision to proceed with an FS, and to determine those constituents and site-specific considerations that need to be addressed in the FS. This RI Report also provides data to support the evaluation of alternatives in the FS with regard to meeting potential applicable or relevant and appropriate requirements (ARAR), applying risk reduction, and identifying significant data gaps, if any. This RI Report includes an evaluation of the baseline risk using characterization data generated during the RI and significant data from other investigations. Risk is evaluated for nonradiological constituents using EPA risk assessment guidance. Risk from radiological constituents is evaluated through the RESidual RADioactivity (RESRAD) computer dose model (ANL/EAD-4).

## 1.2 SUPPORTING DOCUMENTS AND REMEDIAL INVESTIGATION BASIS

Supporting documents that provided the basis for the RI Report are as follows.

- **DOE/RL-96-81, *Waste Site Grouping for 200 Areas Soil Investigations*.** This document presents the final prioritized waste site groups, identifies representative sites, and provides preliminary conceptual contaminant distribution models for the waste groups.

- **DOE/RL-98-28**. This plan outlines a strategy to streamline the characterization and remediation of waste sites in the 200 Areas, including CERCLA past-practice sites, RPP sites, and RCRA TSD units; outlines the framework for implementing assessment activities and evaluating remedial alternatives in the 200 Areas to ensure consistency in documentation, level of characterization, and decision making; establishes a regulatory framework to integrate the requirements of RCRA and CERCLA into one standard approach for cleanup activities in the 200 Areas; lists potential ARARs; identifies preliminary remedial action objectives (RAO); and discusses potentially feasible remedial technologies that may be used in the 200 Areas.

- **DOE/RL-2000-60, Rev. 0,** ***200-PW-2 Uranium-Rich Process Waste Group Operable Unit RI/FS Work Plan and RCRA TSD Unit Sampling Plan.*** This work plan describes the path forward for the characterization of the 200-PW-2 OU. It describes the planned characterization of representative waste sites 216-A-10 Crib, 216-A-19 Trench, 216-A-36B Crib, and 216-B-12 Crib.

- **DOE/RL-2000-60, Rev. 1,** ***Uranium-Rich/General Process Condensate and Process Waste Group Operable Units RI/FS Work Plan and RCRA TSD Unit Sampling Plan.*** This work plan describes the path forward for characterization of the 200-PW-2 OU and for consolidation of the 200-PW-4 waste sites into a single RI/FS process. It describes the planned characterization of representative waste sites 216-A-10 Crib, 216-A-19 Trench, 216-A-36B Crib and 216-B-12 Crib, 207-A South Retention Basin, and 216-A-37-1 Crib.

- **CP-18666,** ***Borehole Summary Report for PW-2 and PW-4 Operable Unit.*** This report describes the characterization activities performed at the 200-PW-2 and 200-PW-4 OU representative waste sites in FY 2003.

- **BHI-01411,** ***Remedial Investigation DQO Summary Report for the 200-PW-2 Uranium-Rich Process Waste Group Operable Unit.*** This report describes the DQO process that was followed for the 200-PW-2 OU, which confirmed the waste sites to be investigated and the contaminants of concern to be analyzed.

- **CP-14176,** ***Remedial Investigation Data Quality Objectives Summary Report for the 200-PW-4 Operable Unit.*** This report describes the DQO process that was followed for the 200-PW-4 OU, which confirmed the waste sites to be investigated and the contaminants of concern to be analyzed.

- **CP-14682,** ***Data Quality Objectives Summary Report for the Designation of the 200-PW-2 and 200-PW-4 Investigation-Derived Waste.*** This report describes the DQO process that was followed for additional contaminants of concern required to address investigation-derived waste concerns for disposal of waste at the Environmental Restoration Disposal Facility.

- **DOE/RL-95-13,** ***Limited Field Investigation for the 200-UP-2 Operable Unit.*** The report discusses the field investigation results for the 216-U-8 and 216-U-12 Cribs, including surface radiological survey results, surface soil and vegetation sampling results, data results summary, and site recommendations.

- **DOE/RL-95-106,** ***Focused Feasibility Study for the 200-UP-2 Operable Unit.*** The study describes characterization activities performed at the 216-U-8 and 216-U-12 Cribs. It contains physical descriptions and process knowledge; a radiation area remedial action project description; a summary of the 216-U-8 and 216-U-12 Cribs' site investigation data, contaminants of potential concern, extent of contamination; and the 216-U-12 Crib post-closure plan.

## 1.3 DATA EVALUATION METHODOLOGY

The data evaluation methodology used in this RI Report considers applicable regulatory requirements, DQO processes (BHI-01411 and CP-14176) conducted for the Work Plan (DOE/RL-2000-60, Rev. 1), land-use uncertainties, risk assessment methodology, other OUs, and site-specific conditions. This evaluation process ultimately supports use of the data in the FS. This RI Report does not make recommendations based on the data; its purpose is to provide sufficient evaluation of different aspects of the data to support the FS development and evaluation of remedial alternatives and selection of a preferred remedy or remedies in the RCRA closure plans and the RPP proposed plan and ROD.

The data evaluation process was preceded by collection and validation of the data. Also, a data quality assessment (DQA) was performed. The data were collected under the Work Plan (DOE/RL-2000-60, Rev. 1) based on the DQOs established for these OUs (BHI-01411 and CP-14176). In accordance with the quality assurance/quality control (QA/QC) procedures specified in the Work Plan (DOE/RL-2000-60, Rev. 1), at least 10 percent of all data were validated. Summary tables providing information such as frequency of detection, minimum and maximum detected values, etc., are provided in Appendix A. A summary of the data validation effort is presented in Appendix B.

The data evaluation process consists of the following:

- Data screening for undetected constituents
- Data screening against background constituents
- Human health risk assessment determinations for nonradiological constituents
- Evaluation of ecological risk using indicator concentrations
- Human health dose and risk evaluation for radiological constituents
- Comparison to *Washington Administrative Code* (WAC) 173-340-745, "Soil Cleanup Standards for Industrial Properties,"
- Evaluation of impacts to groundwater.

Details of this evaluation are provided in Chapters 4 and 5. A flowchart of the data evaluation process is provided as Figure 1-7.

### 1.3.1 Identification of Contaminants of Potential Concern

Initially the entire data set was screened and undetected constituents were eliminated from further consideration. Because of the limited number of samples, 95 percent upper confidence limits were not calculated; maximum concentrations for specific horizons were used for comparisons and evaluation. The data were compared to the 90$^{th}$ percentile of the background

concentrations from DOE/RL-92-24, *Hanford Site Background: Part 1, Soil Background for Inorganics*; DOE/RL-96-12, *Hanford Site Background: Part 2, Soil Background for Radionuclides*; and Ecology Publication No. 94-115, *Natural Background Soil Metals Concentrations in Washington State*. If the maximum detected value was less than the 90$^{th}$ percentile background value, the constituent was eliminated as a contaminant of concern (COC). If background data were not available for a constituent, the constituent was retained for further evaluation, as described in Sections 1.3.2 and 1.3.3.

### 1.3.2 Human Health Risk Evaluation

The risk evaluation for the representative sites is based on EPA risk assessment guidance. Radiological constituents are addressed through a dose and risk evaluation. Human health risks are evaluated for an industrial exposure scenario using site-specific data and exposure assumptions obtained from state and Federal guidance documents. The land surrounding the 200 East and 200 West Areas was designated as industrial-exclusive in DOE/EIS-0222-F, *Final Hanford Comprehensive Land Use Plan Environmental Impact Statement*. The 200-PW-2 and 220-PW-4 OU waste sites are located in this industrial-exclusive land-use area.

The Tri-Parties undertook the task of developing a risk framework to support risk assessments in the Central Plateau. This included a series of workshops completed in 2002 with representatives from DOE, EPA, Ecology, the Hanford Advisory Board (HAB), the Tribal Nations, the state of Oregon, and other interested stakeholders. The workshops focused on the different programs involved in activities in the Central Plateau and the need for a consistent application of risk assessment assumptions and goals. The results of the risk framework are documented in letter HAB 132, "Exposure Scenarios Task Force on the 200 Area," in the Tri-Parties' response to "Consensus Advice #132: Exposure Scenarios Task Force on the 200 Area" (Klein et al. 2002), and in *Report of the Exposure Scenarios Task Force* (HAB 2002). The following items summarize the risk framework description from the Tri-Parties' response to the HAB. Clarifications have been added to the original response language.

- The Core Zone (200 Areas including B Pond [main pond] and S Ponds) will have an industrial scenario for the foreseeable future.

- The Core Zone will be remediated and closed, allowing for "other uses" consistent with an industrial scenario (environmental industries) that will maintain an active human presence in this area, which in turn will enhance the ability to maintain the institutional knowledge of waste left in place for future generations. Exposure scenarios used for this zone should include a reasonable maximum exposure to a worker/day user, to possible Native American users, and to intruders.

- The DOE will follow the required regulatory processes for groundwater remediation (including public participation) to establish the points of compliance and RAOs. It is anticipated that groundwater contamination under the Core Zone will preclude beneficial use for the foreseeable future, which is at least the period of waste management and institutional controls (150 years). It is assumed that the tritium and I-129 plumes beyond the Core Zone boundary will exceed the drinking water standards for the next 150 to

300 years (less for the tritium plume). It is expected that other groundwater contaminants will remain below, or be restored to, drinking water levels outside the Core Zone.

- No drilling for water use or otherwise will be allowed in the Core Zone. An intruder scenario will be calculated for in assessing the risk to human health and environment.

- An industrial land-use scenario will set cleanup levels on the Central Plateau. Waste sites outside the Core Zone but within the Central Plateau (200 N Area, Gable Mountain Pond, B/C Crib Controlled Area) will be remediated and closed based on an evaluation of multiple land-use scenarios to optimize institutional-control cost and long-term stewardship.

- Other land-use scenarios (e.g., residential, recreational) may be used for comparison purposes to support decision making, especially for the following:

  - The post-institutional controls period (> 150 years)
  - Sites near the core zone perimeter to analyze opportunities to "shrink the site"
  - Early (precedent-setting) closure/remediation decisions.

- This framework does not deal with the tank waste retrieval decision.

Because the 200-PW-2 and 200-PW-4 OU waste sites are located in the 200 Area Core Zone, this description serves as the basis for the risk assessment activities. The risk assessment is presented for an industrial land-use scenario in Chapter 4. The risk assessment will follow the risk guidelines identified through the Risk Framework workshops as documented in the Tri-Parties' response to HAB Advice #132 (Klein et al. 2002). Risk evaluations for possible Native American users and intruder scenarios may be considered in the FS for informational purposes.

The risk evaluation for the 200-PW-2 and 200-PW-4 OUs is based on these guidelines, as well as on EPA and Washington State risk assessment guidance. Radiological constituents are addressed through a dose evaluation, described in Section 1.3.3, which then is converted to a risk value. Hypothetical human health risks are calculated for industrial-exposure scenarios using inputs developed from other Hanford Site OUs, site-specific data, and guidance documents.

The DOE worked for several years with cooperating agencies and stakeholders to define land-use goals for the Hanford Site and develop future land-use plans (*The Future for Hanford: Uses and Cleanup, The Final Report of the Hanford Future Site Uses Working Group,* [Drummond 1992]). The cooperating agencies and stakeholders included the National Park Service, Tribal Nations, states of Washington and Oregon, local county and city governments, economic and business development interests, environmental groups, and agricultural interests. These efforts were reported initially by Drummond (1992) and culminated in DOE/EIS-0222-F and the associated 64 FR 61615, "Hanford Comprehensive Land-Use Plan Environmental Impact Statement, Hanford Site, Richland, Washington; Record of Decision (ROD)," which were issued in 1999.

Drummond (1992) identified the following nine general recommendations:

- Protect the Columbia River
- Deal realistically and forcefully with groundwater contamination
- Use the Central Plateau wisely for waste management
- Do no harm during cleanup or with new development
- Cleanup of areas of high future use value is important
- Clean up to the level necessary to enable the future-use option to occur
- Transport waste safely and be prepared
- Capture economic development opportunities locally
- Involve the public in future decisions about the Hanford Site.

Specific to the Central Plateau, the findings and recommendations from the Future Site Uses Working Group are as follows.

- The Central Plateau is unique.

- Some type of government presence or oversight should be assumed for the foreseeable future.

- Waste from other Hanford Site locations should be concentrated in the 200 Areas.

- Waste management, storage, and disposal activities should be concentrated within the 200 Areas whenever feasible to minimize the amount of land devoted to these activities, and adverse impacts to clean areas also should be minimized.

- Wastes generated in or coming to the 200 Areas from the rest of the Site will not necessarily be permanently disposed of in the 200 Area. Offsite shipments are occurring and may continue. New technologies may be applied to waste in the future.

- Waste and contaminants within the 200 Areas should be treated and managed to prevent migration from the 200 Areas to other areas or off the Hanford Site.

- Access to the "exclusive" areas, including "exclusive buffers," will be restricted to personnel who are properly trained and monitored.

The working group identified a single cleanup scenario for the Central Plateau. This scenario assumes that future uses of the surface, subsurface, and groundwater in and immediately surrounding the 200 East and 200 West Areas will be industrial (exclusive).

Consistent with the Future Site Uses Working Group report (Drummond 1992), the core zone (which includes the 200 East and 200 West Areas) has been designated as industrial (exclusive) in DOE/EIS-0222-F. All of the 200-PW-2 and 200-PW-4 OU waste sites are located within this exclusive-use area. The industrial exposure scenario is used to evaluate each representative site.

Nonradiological constituents from the shallow zone soil 0 m to 4.6 m (0 to 15 ft) below ground surface (bgs) are screened to industrial soil risk-based concentrations (RBC) and industrial air RBCs for direct contact and inhalation of ambient air, respectively. Nonradiological constituents from the deep-zone soil (0 m to water table) are compared with the soil RBCs for protection of

groundwater. For the purposes of this RI Report, contaminant concentrations were compared to RBCs developed under CERCLA guidance (EPA/540/R-92/003, *Risk Assessment Guidance for Superfund: Volume I -- Human Health Evaluation Manual (Part B. Development of Risk-Based Preliminary Remediation Goals), Interim*) using the excess lifetime cancer risk range of $10^{-4}$ to $10^{-6}$ and a hazard quotient of 1.0 using an industrial land-use scenario for nonradiological contaminants. Because the waste sites in these OUs are within the Core Zone, RBCs used for screening correspond to a $10^{-5}$ risk level.

### 1.3.3 Modeling Approach

Risk and dose estimates were modeled for radiological constituents identified as contaminants of potential concern (COPC) using RESRAD Version 6 (ANL/EAD-4). Dose and risk estimates were modeled for shallow-zone soil 0 m to 4.6 m (0 to 15 ft) bgs on the basis of direct exposure to soils for an industrial exposure scenario. Dose estimates then were compared to direct exposure standards for the public and workers. Risk estimates also were provided for comparison to Washington State and EPA target risk ranges. Input parameters were developed on the basis of previous Hanford Site RESRAD modeling activities, 200 Areas-specific geologic and hydrogeologic information sources, and data collected for this RI Report.

Groundwater was evaluated for nonradiological constituents based on existing standards for protection of groundwater. The fate and transport evaluation included evaluating the frequency of detection, the location of the constituent within the soil column, the distribution coefficient, whether the constituent has already reached groundwater, and whether modeling would provide additional information beyond that already known. Additional information is provided in Chapters 4 and 5.

### 1.3.4 Ecological Risk Evaluation Methodology

DOE/RL-2001-54, *Central Plateau Ecological Evaluation Report*, has been prepared to support ecological evaluations under the RI/FS process for Central Plateau waste sites. DOE/RL-2001-54 completes a screening-level ecological risk assessment for the Central Plateau in accordance with the eight-step EPA ecological risk assessment process presented in EPA/540/R-97/006, *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (see Figure 1-1 in DOE/RL-2001-54).

The document contains a compilation and evaluation of ecological sampling data that have been collected over many years from undisturbed and disturbed habitats in the Central Plateau. The document describes the habitats on the Central Plateau, including sensitive habitats, and the plants and animals that inhabit them. It identifies potential species of concern, including threatened and endangered species and new-to-science species. A detailed survey of the Central Plateau performed in 2000 and 2001 is incorporated into the ecological evaluation document and provides a current, detailed description of the ecological setting of the Central Plateau and augments the ecological information presented in this RI Report.

DOE/RL-2001-54 helps answer questions about the Central Plateau ecological resources that are important to preserve and protect. The document also identifies ecological data needs that can be addressed in future ecological sampling activities on the Central Plateau.

The screening-level ecological risk assessment in DOE/RL-2001-54 is meant to be a conservative evaluation of risk to ecological receptors unique to the Central Plateau from stressors—in this case, introduction of contaminants and habitat elimination. The screening-level ecological risk assessment identifies pathways for ecological receptors to be exposed to the contamination and evaluates potential risk from those exposures.

Chapter 2 of DOE/RL-2001-54 describes the physical and ecological setting of the Central Plateau and identifies important aspects of the ecology and the condition of the waste sites to consider during the ecological risk assessment. For instance, while most waste sites are in a disturbed habitat with little vegetation to support wildlife, the nearby shrub-steppe offers a more hospitable habitat for wildlife. This region needs protection because similar habitat is being encroached on and eliminated in other parts of eastern Washington. Individual species whose populations are limited and are designated as sensitive species also must be protected.

Recent surveys of the biological diversity on the Hanford Site have identified a number of new-to-science species whose protection status has not yet been determined. The U.S. Fish and Wildlife Service and Washington State may gather additional information from the scientific community at the Hanford Site to help them determine the protection status of the new species. Most of the waste in the waste sites has been stabilized, thereby limiting ecological access. The decisions to stabilize and remediate waste sites must balance the potential disruption to the ecosystem both at and adjacent to the waste sites, as well as from distant locations (e.g., borrow source sites).

The conceptual site model in DOE/RL-2001-54, Chapter 3, explains the ecological resources and the ways that receptors may be exposed. It shows where chemicals and radionuclides from the waste sites are likely to come into contact with receptors in the environment. The exposure pathways that are expected to be complete at most waste sites are as follows:

- Direct contact with or ingestion of soil by invertebrates (e.g., beetles, ants) and burrowing mammals
- Uptake of contaminants in soil by vegetation
- Bioaccumulation through ingestion of food items (e.g., food chain effects) consumed by wildlife that may forage at the waste sites.

Chapter 4 of DOE/RL-2001-54 discusses the toxicity values available for contaminants believed to be present in the Central Plateau. Contaminants were identified from preliminary sampling data available from a subset of waste sites. These contaminants were screened, primarily for the likelihood of their presence in the environment (i.e., half-life and persistence). A literature search for bird and mammalian toxicity values was performed. Toxicity values are not available for some contaminants. A risk management decision will be needed to determine how contaminants without toxicity values will be handled during the risk assessment for each OU.

Chapter 5 of DOE/RL-2001-54 presents the exposure parameters used for estimating the exposure in a quantitative manner. In a screening-level ecological risk assessment most exposure parameters are set conservatively at 100 percent. The only organism-specific factor necessary is body weight, and this variable is available in the literature. This section further evaluated the exposure pathways and constructed a food chain exposure model for wildlife specific to the Central Plateau. The wildlife are shown in the food chain and habitat model in DOE/RL-2001-54.

DOE/RL-2001-54, Chapter 6, is the screening-level risk calculation for the Central Plateau. Washington State and DOE provide contaminant-specific numerical values (WAC 173-340-900, "Tables," and biota concentration guides [BCG]) to potential risks. These are conservative numbers designed to address all possibilities while considering potential risks. Data are available for a subset of the Central Plateau waste sites. These maximum concentrations of contaminants detected at the waste sites were compared with the state and DOE screening-level values. For chemicals, 12 metals, pentachlorophenol, and 4-dinitrophenol were detected at a maximum concentration above the screening level. The high number of metals presenting a risk requires closer examination. Site-specific bioavailability data would be helpful for understanding whether this is a reflection of the conservative nature of the screening assessment or an actual risk to the ecosystems at the waste sites. Concentrations of four radionuclides, $^{137}Cs$, $^{226}Ra$, $^{228}Ra$, and $^{90}Sr$, were above acceptable limits in the soil samples. It is important to recognize the limitations and uncertainty associated with risks identified by screening-level assessments. The risk calculations are useful for determining relative risks between waste sites, not site-specific risks. The information should be considered carefully along with actual biological evidence from the waste site area to determine if a hazard exists. Data are available for hundreds of wastes sites in the Central Plateau (see DOE/RL-2001-54, Appendix C). These data include soil from the waste site, vegetation, and soil invertebrates.

The screening-level ecological risk assessment in DOE/RL-2001-54 leads to the problem formulation stage of a baseline ecological risk assessment. During problem formulation, the risk managers and others consider the toxicity evaluation, conceptual model exposure pathways, and assessment endpoints to support cleanup decisions. As a result, they are able to better define the initial risks and determine direction for the DQO process, if it is needed. The DQO then will complete the following:

- Establish the level of effort needed to assess ecological risk at a particular site or OU
- Identify relevant and available data
- Design a conceptual model of the ecological threats at a site and measures to assess those threats
- Select methods and models to be used in the various components of the risk assessment
- Develop assumptions to fill data gaps for toxicity and exposure assessments based on logic and scientific principles
- Interpret the ecological significance of observed or predicted effects.

Data collected during the RI directly support the ecological evaluation. Contaminant data from the soil sampling conducted in the RI are compared against WAC 173-340-900, Table 749-3, "Ecological Soil Indicator Concentrations," as the beginning step of the OU-specific screening-level evaluation of ecological risk from nonradiological constituents. For radiological constituents, no promulgated screening or cleanup levels are available. Biota concentration guides from DOE/STD-1153-2002, *Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota*, are used in this evaluation of radiological constituents. Additional details are provided in Chapter 4.

### 1.3.5 Analogous Site Approach

The concept and rationale for using analogous sites to reduce the amount of site characterization is discussed in the 200 Areas Implementation Plan (DOE/RL-98-28). The use of this approach relies on, first, grouping sites with similar location, geology, waste site history, and contaminants, and then choosing one or more representative sites for comprehensive field investigations, including sampling. Findings from site investigations at representative sites are extended to apply to other sites in the waste group that were not characterized. Sites for which field data have not been collected are assumed to have chemical characteristics similar to those of the sites that were characterized. Confirmatory investigations of limited scope, rather than full characterization efforts, can be performed at the sites not selected as representative sites. The regulatory pathway and documentation requirements are streamlined and less characterization is performed for remedial decision making.

Data from representative sites are used to evaluate remedial alternatives and to select one or more alternatives to apply for the entire waste group. Although a degree of uncertainty exists in employing the analogous-site concept, substantial benefit is realized in the early selection of a remedy that allows early cleanup action to be performed.

Selection of representative sites is fundamental to the implementation of the analogous site approach. These sites often are indicative of worst case and typical conditions in an OU and in some cases have been characterized extensively. The representative waste sites evaluated in this RI Report were identified as being representative of sites within their respective OUs in the 200 Areas Implementation Plan (DOE/RL-98-28); therefore, data collected from these sites and the resulting contaminant distribution models are anticipated to be representative of the remaining (or analogous) waste sites in the OUs.

This analogous approach was enhanced in June 2002 with Tri-Party Agreement change packages M-013-02-01, M-015-02-01, and M-020-02-01, that consolidated the 200-PW-2 and 200-PW-4 OUs into one Work Plan (DOE/RL-2000-60, Rev. 1).

Of the 23 source OUs in the 200 Areas, the 200-PW-2 OU was assigned a higher priority, because waste sites in this OU have relatively high inventories of a mobile contaminant, uranium, and some waste sites are known contributors to uranium contamination in groundwater. In addition, the OU includes RCRA TSD unit waste sites that have Tri-Party Agreement-required closure plans scheduled in the year 2005.

Existing data on each waste site have been assembled and evaluated to develop a conceptual understanding of the waste site. The approach that was used to further investigate, characterize, and evaluate the sites is presented in the Work Plan (DOE/RL-2000-60, Rev. 1). Preliminary remedial action alternatives that are likely to be considered for these OUs are identified in the Work Plan. These preliminary remedial action alternatives are to be further developed and agreed to in the FS/closure plans, in the proposed plan/proposed permit conditions to WA7890008967, the *Hanford Facility RCRA Permit*, and in the eventual ROD and permit modification for these OUs. A DQO process was conducted for the 200-PW-2 OU (BHI-01411) to define the radiological and nonradiological constituents to be characterized and to specify the number, type, and location of samples to be collected at the TSD units and representative sites in the 200-PW-2 OU. A second DQO process was conducted for the 200-PW-4 OU (CP-14176). The results of the DQO process for both OUs formed the basis for the Work Plan (DOE/RL-2000-60, Rev. 1).

A proposed plan and ROD will be written identifying the proposed remedy (or remedies) for all waste sites in the OUs. The ROD will include criteria for any post-ROD confirmation sampling and analysis needed to verify that all remaining (or analogous) sites in the OU meet the conceptual model for the waste group. If a waste site is significantly different from and fails to meet the contaminant distribution model and the selected remedy is not appropriate, the site will be reevaluated based on historical and any new information. Based on the specific characteristics, the waste site may be reassigned to a more appropriate OU or maintained in the current OU with a requirement for confirmatory sampling. Changes to the preferred alternative would be evaluated as needed based on confirmatory data. The analogous site approach focuses on the typical and worst case sites as representative sites; therefore, data from the representative sites should bound the analogous sites. Also, the ability to use data and information from representative sites outside the OU helps reduce the potential to reassign waste sites between OUs. A separate DQO process will be conducted to identify data needs and quality requirements to support the confirmatory sampling design. A permit modification also will be prepared to incorporate the corrective action of the RPP sites into the *Hanford Facility RCRA Permit* (WA7890008967).

## 1.4 WASTE SITE DESCRIPTION AND HISTORY

As defined in the 200 Areas Implementation Plan (DOE/RL-98-28), four representative sites were identified for the 200-PW-2 OU. The representative sites include three RPP sites (216-A-19 Trench, 216-B-12 Crib, and 216-U-8 Crib) and one RCRA TSD unit (216-U-12 Crib). In addition, two more RCRA TSD units (216-A-10 Crib and 216-A-36B Crib) were characterized as part of RCRA closure activities for this OU.

The 216-U-8 Crib was chosen as a worst case site because of its high inventory and the current level of characterization. The 216-A-19 Trench was chosen as the second worst case site because of its high contaminant inventory (and the highest uranium inventory) from a process waste stream. The 216-B-12 and 216-U-12 Cribs are typical waste sites for the OU. The 216-B-12 Crib was selected for its contaminant inventory and the fact that it received a second process condensate that added high inventories of fission products. The 216-U-12 Crib was selected for its typical uranium inventory and current level of characterization. It also is a

RCRA TSD unit. The remaining two sites (216-A-10 and 216-A-36B Cribs) also are RCRA TSD units and were characterized as part of the closure/post-closure activities.

The 200-PW-4 OU contains two RCRA TSD units, the 216-A-37-1 Crib and the 207-A South Retention Basin. Both were characterized as part of RCRA closure activities for the OU.

Most of the waste discharged to the soil column in the 200-PW-2 and 200-PW-4 OUs was generated at the U Plant, REDOX, PUREX, B Plant, and C Plant Facilities between 1952 and 1988 (DOE/RL-2000-60, Rev. 1).

Data from all the representative sites and TSD units discussed in the previous paragraphs were collected in FY 2003 and FY 2004 except the 216-U-8 and the 216-U-12 Cribs. According to the Work Plan (DOE/RL-2000-60, Rev. 1), an evaluation of existing data undertaken during the DQO process (BHI-01411) showed that no additional soil samples were required at the 216-U-8 and 216-U-12 Cribs. These sites were characterized in 1995 as part of 200-UP-2 OU characterization activities (DOE/RL-95-13). However, existing boreholes in the vicinity of these two sites were geophysically logged for comparison to historic records as a cost-efficient method of assessing potential changes in contaminant distribution.

Table 1-2 briefly describes representative waste sites and TSD units in the 200-PW-2 and 200-PW-4 OUs. The following sections describe the sites in detail. Information was obtained from the Work Plan (DOE/RL-2000-60, Rev. 1).

### 1.4.1 216-A-19 Trench

The 216-A-19 Trench is located in the 200 East Area about 800 m (2,625 ft) northwest of the 202-A (PUREX Plant) Building. It has dimensions of approximately 7.6 by 7.6 by 4.6 m (25 by 25 by 15 ft) deep (Waste Information Database System [WIDS]). When in operation, the trench had a surface elevation of 199 m (652 ft). It began operation in November 1955 and operated until January 1956. During that period it received cold (nonirradiated uranium) and PUREX startup waste (containing fission products) and condenser cooling water from the 241-A-431 Building.

Waste from the PUREX Facility entered the trench from aboveground piping that emptied into the trench. Condenser cooling water from the 241-A-431 Building may have reached the trench via the 216-A-34 Ditch that lies adjacent to the 216-A-19 Trench. An estimated 38,700 kg (85,317 lb) of uranium in about 1,100,000 L (291,000 gal) of waste were routed to the trench (DOE/RL-96-81; PNL-6456, *Hazard Ranking System Evaluation of CERCLA Inactive Waste Sites at Hanford*).

Nitrate salts were disposed of at the site. The radionuclide inventory included $^{60}$Co, $^{90}$Sr, $^{137}$Cs, $^{239/240}$Pu, and $^{238}$U (PNL-6456). The 216-A-19 Trench and 216-A-34 Ditch were backfilled following use and later were covered with several feet of fill (HW-41535, *Unconfined Underground Radioactive Waste and Contamination in the 200 Areas*; HW-43121, *Tabulation of Radioactive Liquid Waste Disposal Facilities*; and HW-57830, *Isolation of Abandoned or*

*Depleted Waste Disposal Sites*). The site was surface stabilized again in 1990 with additional fill material (WIDS).

For a construction diagram of the 216-A-19 Trench, see Chapter 2 of the Work Plan (DOE/RL-2000-60, Rev. 1).

### 1.4.2 216-B-12 Crib

The 216-B-12 Crib is located in the 200 East Area about 305 m (1,000 ft) northwest of the 221-B Building. The bottom surface area of the crib is 49 by 15 m (160 by 50 ft); the crib is approximately 8 m (26 ft) deep on one end and 9 m (30 ft) deep on the downgradient end (HW-43121; RHO-CD-673, *Handbook 200 Area Waste Sites*, Vol. I and II; and PNL-6456).

The unit consists of a series of three cascading, 5 by 5 by 3 m- (16- by 16- by 10-ft-) high wooden boxes made from 6- by 8-in. Douglas fir in a 9 m- (30-ft-) deep excavation. The bottom 4 m (12 ft) contains 1.3-cm (0.5-in.) gravel backfill, 1.2 m (4 ft) of which underlie the cribs. The excavation has side slopes of 1:1. It is unclear if the gravel backfill merely surrounds the boxes or also fills them. The unit is considered to have cave-in potential (, WHC-IP-0809, *B Plant Aggregate Area Management Study Technical Baseline Report*).

During its service history, the 216-B-12 Crib received process condensate from the 221-U and 224-U Buildings and the 221-B Building from November 1952 until December 1957. The cribs were inactive from December 1957 until May 1967. From May 1967 until November 1967, the crib received liquid waste from the 221-B Building. From November 1967 to November 1973, it received additional process condensate via a 15 cm (6-in.) vitrified clay pipe from the 221-B Building. The vitrified clay includes limestone that was used to neutralize the waste stream. The site was retired in November 1973. Radiation Occurrence Report 73-82 (found in the WIDS) suggests that the 216-B-12 Crib was abandoned in November 1973 when the ground above the crib started to subside, resulting in flow restrictions in the piping. The subsidence was backfilled and the fill line was blanked in 1973. In 1974 the crib was stabilized with layers of sand and gravel with a plastic liner to deter vegetation growth. An additional 0.6 m (2 ft) of clean soil was added in 1993 (RHO-CD-673 and WIDS).

The waste is low salt and neutral/basic. Records indicate that 180,000 kg (396,832 lb) of ammonium nitrate was disposed of at the site. The radionuclide inventory of the site includes $^{60}Co$, $^{90}Sr$, $^{137}Cs$, $^{239/240}Pu$, and $^{238}U$ (PNL-6456 and WHC-IP-0809). An estimated 21,000 kg (46,300 lb) of uranium, 374 g (1 lb) of plutonium, 716 Ci of $^{137}Cs$, and 79.3 Ci of $^{90}Sr$ may have been discharged to this site. The total volume of effluent discharged is estimated to be 520,000,000 L (140,000,000 gal) (PNL-6456 and DOE/RL-96-81).

For a construction diagram of the 216-B-12 Crib, see Chapter 2 of the Work Plan (DOE/RL-2000-60, Rev. 1).

### 1.4.3 216-U-8 Crib

The 216-U-8 Crib is located in the 200 West Area about 137 m (450 ft) west of Beloit Avenue and 229 m (750 ft) south of 16th Street.

The crib consists of three timbered cascading crib structures, referred to as a stack drain, with a bottom surface area that is 48 by 15 m (160 by 50 ft); the crib is 9 m (31 ft) deep (HW-57830 and PNL-6456). Surface elevation was 211 m (692 ft) and the bottom of the crib was at 202 m (662 ft) (HW-33305, *Radioactive Liquid Waste Disposal Facilities*). Each box-style crib measures 5 by 5 by 3 m (16 by 16 by 10 ft) high and was constructed of fir timbers resting on a 0.9 m- (3-ft-) thick gravel bed about 9 m (31 ft) below grade. It is unclear if the gravel backfill merely surrounds the boxes or also fills them. The cribs are 18 m (60 ft) apart and connected in a series by a 15 cm (6-in.) schedule 40 pipe. Each crib was vented by two 4-in. schedule 40 steel pipes that were capped below grade. A 15 cm- (6-in.-) diameter vitrified clay waste transfer line entered the crib and was partially protected by a concrete encasement (WHC-EP-0400, *200-UP-2 Operable Unit Technical Baseline Report*).

The crib operated from June 1952 to March 1960. The crib received process condensate via a 15 cm (6-in.) vitrified clay pipe from the 221-U and 224-U tanks and 291-U-1 stack drainage (HW-41535; DOE/RL-88-19, *Information on Hanford Site Cribs and Septic Systems*; DOE/RL-95-106). By July 1954 the crib had received 14,544 kg (32,064 lb) of uranium, 185 g (0.4 lb) of plutonium, and an estimated $1.54 \times 10^8$ L ($4.1 \times 10^7$ gal) of liquid materials (HW-33591, *Summary of Liquid Radioactive Wastes Discharged to the Ground – 200 Areas (July 1952 Through June 1954)*). By the end of 1956 the crib had received $3.34 \times 10^8$ L ($8.8 \times 10^7$ gal) of liquid, 23,800 kg (6,173 lb) of uranium, and 365 g (0.8 lb) of plutonium (HW-48518, *Radioactive Contamination in Liquid Wastes Discharged to Ground at Separations Facilities Through December 1956*). By 1958, it had received $3.63 \times 10^8$ L ($9.6 \times 10^7$ gal) of liquid materials and 367 g (0.8 lb) of plutonium (HW-59359, *Radioactive Contamination in Liquid Wastes Discharged to Ground at Separations Facilities Through December 1958*). In 1959 the crib received an additional $9.08 \times 10^6$ L ($2.4 \times 10^6$ gal) of waste (HW-63121, *Laboratory Studies of Hanford Waste Cribs*). During its operation, the crib received $3.79 \times 10^8$ L ($1.0 \times 10^8$ gal) of waste (DOE/RL-91-52 and DOE/RL-95-106).

In 1960 the crib was deactivated when it began to subside. Sinkholes were backfilled around the three cribs and the risers were cut off and capped below grade (RHO-CD-673). The incoming waste transfer line was blanked about 18 m (60 ft) north of the crib, and waste materials were diverted to the 216-U-12 Crib. In 1994 the area over the crib and the portion of the vitrified clay pipe from 16th Street south to the crib were stabilized with about 0.6 m (2 ft) of soil (DOE/RL-95-13).

The site was characterized in 1995 as part of 200-UP-2 OU characterization activities (DOE/RL-95-13). This included installation of a borehole through the crib, collection of soil and vegetation samples, and an in-line camera survey of a portion of the pipeline that led to the waste site. Waste in the site is acidic. Chemicals disposed of at the site include nitric acid. The radionuclide inventory includes $^{60}Co$, $^{90}Sr$, $^{137}Cs$, $^{239/240}Pu$, and $^{238}U$ (PNL-6456). This included an estimated $2.39 \times 10^4$ kg (52,700 lb) of uranium and 370 g (0.8 lb) of plutonium (DOE/RL-96-81).

For a construction diagram of the 216-U-8 Crib, see Chapter 2 of the Work Plan (DOE/RL-2000-60, Rev. 1).

### 1.4.4 216-U-12 Crib

The 216-U-12 Crib is the first of three RCRA TSD units in the 200-PW-2 OU. The original RCRA Part A permit application (Part A), Form 3 (Rev. 0), was submitted to Ecology in 1987 (DOE/RL-88-21, *Hanford Facility Dangerous Waste Part A Permit Application*; and BHI-00123, *216-U-12 Crib Supplemental Information to the Hanford Facility Contingency Plan (DOE/RL-93-75)* ).

The 216-U-12 Crib replaced the 216-U-8 Crib when it began to subside. The 216-U-12 Crib is located in the 200 West Area about 650 m (2,130 ft) south of the 221-U Building and 140 m (460 ft) north of Beloit Avenue. The crib was constructed in 1960. It was designed to receive mixed waste (corrosive, D002) from U Plant, via a 15 cm (6-in.) vitrified clay pipe, for approximately 5 minutes every hour, at the rate of 378 L/min (100 gal/min), and to dispose of the process condensate by percolation into the soil column (DOE/RL-95-13). The 46 m- (150-ft-) long gravel-filled crib has bottom dimensions of 30 m by 3 m (100 by 10 ft) with natural earth sides, a 2:1 slope, and no constructed internal structure. The crib is about 5 m (15 ft) below grade. The lower 2.1 m (7 ft) is filled with graduated layers of sand and gravels and covered with a polyethylene barrier. A 305 mm (12-in.) vitrified clay pipe extends the length of the crib 3 m (10 ft) below the surface. A vent riser, about 4 m (14 ft) long, extends from 3 m (10 ft) below the surface to 0.9 m (3 ft) above grade. Two 5.2 m- (17-ft-) long vitrified clay liquid-level gauge wells also extend 0.9 m (3 ft) above grade. A 15 cm- (6-in.-) diameter vitrified clay pipe delivered water to the crib from the point where the 216-U-8 Crib feed line was blanked off (WHC-EP-0400).

During its operational period beginning in April 1960 and continuing for 28 years, the crib received 150,000,000 L (40,000,000 gal) of liquid waste. From 1960 to 1967 it received 291-U-1 Stack drainage, 244 WR Vault waste, storm drain waste from the 224-U Building, and waste from the C-5 and C-7 tanks inside the 224-B Building. In October 1965, the crib received 31.4 kg (69 lb) of thorium from contaminated water and 3.1 kg (6 lb) of thorium from the 244-WR Vault (DOE/RL-91-52, *U Plant Source Aggregate Area Management Study Report*). From May 1967 to September 1972 the crib received occasional waste via tank C-7 inside the 244-U Building. From September 1972 to November 1981, the crib was out of service. From November 1981 to June 1988, the crib received corrosive (pH of 0.5 to 1.5) process condensate and miscellaneous storm drain runoff from the 224-U Building (RHO-CD-673, WHC-EP-0400, and BHI-00123). The crib received process condensate until January 1988 when it was replaced by the 216-U-17 Crib. The same year, the 216-U-12 Crib pipeline was cut and permanently capped. Approximately 6,440,000 L (1,701,268 gal) of process condensate was discharged to the crib annually (DOE/RL-88-21).

The site was characterized in 1995 as part of 200-UP-2 OU characterization activities (DOE/RL-95-13). This included installation of a borehole adjacent to the crib, collection of soil and vegetation samples, and an in-line camera survey of a portion of the pipeline that led to the waste site. The radionuclide inventory includes tritium, $^{90}$Sr, $^{241}$Am, $^{137}$, $^{239}$Pu, and $^{238}$U

(DOE/RL-88-19). This included an estimated 2.01 x $10^3$ kg (4,400 lb) of uranium (DOE/RL-96-81). The crib was stabilized with at least 0.6 m (2 ft) of soil.

For a construction diagram of the 216-U-12 Crib, see Chapter 2 of the Work Plan (DOE/RL-2000-60, Rev. 1).

### 1.4.5 216-A-10 Crib

The 216-A-10 Crib is the second of three RCRA units in the 200-PW-2 OU. The original RCRA Part A permit application (Part A), Form 3 (Rev. 0), was submitted to Ecology in 1987 (DOE/RL-88-21).

The 216-A-10 Crib is located in the 200 East Area approximately 82 m (270 ft) south of the southwest corner of the 202-A Building (PUREX Plant). The rock-filled crib is 84 by 14 by 14 m (275 by 45 by 45 ft) deep. Elevation at the surface was 218 m (714 ft) (HW-43121). A 203 mm (8-in.) vitrified clay distribution pipe was placed horizontally 9 m (30 ft) below grade 8 m (27 ft) east of the centerline. The crib was designed as a percolation unit for the disposal of liquid waste and was capable of receiving 272,550 L (72,000 gal) per day. Initially, it was a spare crib for the 216-A-5 Crib and received only water (HW-55176, *Index of CPD Crib Building Numbers Designs of CPD Radioactive Liquid Waste Disposal Sites*, and HW-57830). From 1956 to 1959, the crib received 2.34 x $10^8$ L of water (HW-44784, *Radioactive Contamination in Liquid Wastes Discharged to Ground at Separations Facilities Through June 1956*; HW-48518; HW-55593, *Radioactive Contamination in Liquid Wastes Discharged to Ground at Separations Facilities Through December 1957*; HW-57649, *Radioactive Contamination in Liquid Wastes Discharged to Ground at Separations Facilities Through June 1958*; and HW-64375, *Radioactive Contamination in Liquid Wastes Discharged to Ground at the Separations Facilities Through December 1959*). The 216-A-10 Crib replaced the 216-A-5 Crib in 1961, which was the year that contaminated liquid waste began being discharged into the crib (WIDS). Liquid waste included an acidic waste stream (D002) from the process distillate discharge from the PUREX Facility and corrosive/mixed waste (D002) process distillate (RHO-CD-673).

In 1962, the original 203 mm (8-in.) vitrified clay pipe was replaced with a 203 mm (8-in.) stainless steel effluent pipeline, because the acidic waste destroyed the integrity of the original vitrified clay pipe. The replacement pipe was placed on the east side of the crib. In 1967 some portions of the stainless steel pipe also were replaced. The crib was inactive from 1978 to 1981. From 1981 to 1986, it received acidic process condensate from the 202-A Building. The crib operated until 1987. Following operational use the crib was backfilled (BHI-00121, *216-A-36B Crib Supplemental Information to the Hanford Facility Contingency Plan (DOE/RL-93-75)*).

The total volume of liquid effluent discharged to the crib was 3.2 x $10^9$ L (8.5 x $10^8$ gal) (DOE/RL-96-81). The crib received tritium, $^{90}$Sr (82.5 Ci), $^{129}$I, $^{241}$Am (0.7 Ci), $^{137}$Cs (80.5 Ci), $^{147}$Pm, $^{238}$Pu, $^{239}$Pu, and $^{241}$Pu (350 g total plutonium), and 241 kg (530 lb) of uranium (DOE/RL-88-19 and DOE/RL-96-81).

For a construction diagram of the 216-A-10 Crib, see Chapter 2 of the Work Plan (DOE/RL-2000-60, Rev. 1).

### 1.4.6 216-A-36B Crib

The 216-A-36B Crib is the last of three RCRA TSD units in the 200-PW-2 OU. The original RCRA Part A permit application (Part A), Form 3 (Rev. 0), was submitted to Ecology in 1987 (DOE/RL-88-21).

The 216-A-36B Crib is located in the 200 East Area about 366 m (1,200 ft) south of the 202-A Building (PUREX Plant). The surface elevation is about 217 m (712 ft), and the subsurface elevation of the crib is about 211 m (691 ft). The gravel-filled crib has bottom dimensions of 152 m (500 ft) and a width that varies from 2 m to 3.4 m (7 to 11 ft). The first 7.6 m (25 ft) of the crib is 2 m (7 ft) wide, and the remainder is 3.4 m (11 ft) wide. The bottom of the crib is 7.3 m (24 ft) below grade (WHC-EP-0100, *Properties and Environmental Impact of Ammonia Scrubber Discharge Waste to the 216-A-36B Crib*). A 15 cm (6-in.) perforated pipe was placed horizontally 7 m (23 ft) below grade (DOE/RL-88-19).

The 216-A-36B Crib is the southern 152 m (500 ft) of a longer crib, originally known as the 216-A-36 Crib. The original crib received liquid effluent from September 1965 to March 1966. Over this period a substantial inventory of radionuclides was discharged to the crib and is assumed to have infiltrated sediments near the inlet to the crib. To continue discharge to the crib, the crib was reconfigured into two sections: 216-A-36A and 216-A-36B. Grout was injected into the gravel layer of the crib to form a barrier between the two sections.
The 216-A-36B Crib was extended southward from the 216-A-36A Crib by inserting a smaller diameter pipeline inside the original pipeline, effectively moving the discharge point farther south into the 216-A-36B Crib. Discharge to the 216-A-36B Crib resumed in March 1966 and continued until October 1972, when the crib was temporarily removed from service. In May 1970 about 14,000 Ci was discharged to the crib because of a leaking valve in the scrubber drain to the catch tank (SD-HS-SAR-001, *PUREX Plant Final Safety Analysis Report*, Revs. 3, 4, and 5). The crib was placed back in service in November 1982 for the restart of the PUREX Plant and remained active until the spring of 1988.

During its operational use, the 216-A-36 Crib received ammonia scrubber distillate waste, a state-only toxic dangerous waste (WT02) from the 202-A Building (RHO-CD-673). This resulted in the crib's designation as a RCRA TSD unit in the fall of 1987. A RCRA interim status indicator parameter evaluation program has been in operation at the crib since May 1988.

The ammonia scrubber distillate waste contained $^{241}$Am (0.2 Ci), $^{60}$Co, $^{239}$Pu (258 g), $^{90}$Sr (1,310 Ci), tritium, $^{113}$S, $^{129}$I, $^{137}$Cs (1,200 Ci), $^{147}$Pm, and $^{238}$U (262 kg). Chemical contaminants included ammonium fluoride, ammonium nitrate, and sodium dichromate (WHC-EP-0100; DOE/RL-88-19). Use of the crib was discontinued in the spring of 1988 and the facility was backfilled (BHI-00121). No stabilization actions have taken place at the waste site.

For a construction diagram of the 216-A-36B Crib, see Chapter 2 of the Work Plan (DOE/RL-2000-60, Rev. 1).

### 1.4.7 207-A South Retention Basin

The 207-A-South Retention Basin is one of two RCRA TSD units in the 200-PW-4 OU. The original RCRA Part A permit application (Part A), Form 3 (Rev. 0), was submitted to Ecology in 1987 (DOE/RL-88-21). The retention basin is located in the 200 East Area directly east of the 242-A Evaporator.

The 207-A South Retention Basin, which also was known as Process Condensate Basins 1, 2, and 3 (i.e., PC-1, PC-2, and PC-3), began operations in March of 1977. The 207-A South Retention Basin consists of three concrete cells, each with a 264,979 L (70,000-gal) design capacity for a total capacity of 794,937 L (210,000 gal). The bottom dimension of each cell is 16.8 m (55 ft) long, 3.0 m (10 ft) wide at the bottom, and 2.1 m (7 ft) deep. All three cells were coated to prevent constituents from penetrating the concrete. The 207-A-South Retention Basin was used for the interim storage of the 242-A Evaporator process condensate to allow for sampling and analysis before the condensate was discharged to the 216-A-37-1 Crib for final disposition. Discharge of 242-A Evaporator process condensate to the 207-A-South Retention Basin was terminated on April 12, 1989, when it was determined that the 242-A Evaporator process condensate contained mixed waste regulated under WAC 173-303. The basin was emptied and cleaned out in September 1989 and no longer is used to receive or store mixed waste.

The 242-A Evaporator process condensate was regulated as mixed waste because the waste was derived from a waste containing spent halogenated and nonhalogenated solvents (Waste Codes F001, F002, F003, F004, and F005), and for the toxicity of ammonia (WT02, state-only, toxic, dangerous waste). The estimated annual quantity of dangerous waste of 793,469 kg (1,749,300 lb) represented the maximum operating capacity of the 207-A South Retention Basin, and a specific gravity for the waste of 1.0, when the basin was operational.

For a construction diagram of the 207-A South Retention Basin, see Chapter 2 of the Work Plan (DOE/RL-2000-60, Rev. 1).

### 1.4.8 216-A-37-1 Crib

The 216-A-37-1 Crib is the second of two RCRA TSD units in the 200-PW-4 OU. The original RCRA Part A Permit application (Part A), Form 3 (Rev. 0), was submitted to Ecology in 1987 (DOE/RL-88-21). This TSD unit is located outside the 200 East Area perimeter fence about 610 m (2,000 ft) east of the 202-A Building. The gravel-filled crib has bottom dimensions of 213 m (700 ft) long and 3 m (10 ft) wide. A 254 mm (10-in.) galvanized steel distribution pipe was placed 2 m (7 ft) below grade along the centerline of the crib. The pipe was covered with a gravel and sand cover before backfill was used to fill the crib to the surface elevation. A valve station is at the south end of the crib, and a vent is located at the north end. The valve station is inside the crib perimeter fence and has surface radiation warning signs and a light chain barricade.

The 216-A-37-1 Crib began operation in March 1977 and was used to percolate the 242-A Evaporator process condensate to the soil column. The process design capacity of 327,000 L

(86,400 gal) per day was based on the daily output of the 242-A Evaporator process condensate discharged to the crib. Discharge of the evaporator process condensate to the crib was terminated on April 12, 1989, when it was determined that the evaporator process condensate contained or could have contained mixed waste regulated under WAC 173-303. The crib is out of service and will be closed under interim status.

The 242-A Evaporator process condensate later was confirmed to be regulated as a mixed waste because of the presence of spent halogenated and nonhalogenated solvents (F001, F002, F003, F004, and F005), and for the toxicity of ammonia (WT02, toxic state-only). The estimated annual quantity of dangerous waste of 4,912,000 kg (108,290,000 lb) represented the maximum annual output of 242-A Evaporator process condensate during operating campaigns. The site received 377,000,000 L (99,590,000 gal) of process condensate, thought to contain $^{241}$Am, $^{137}$Cs, tritium, $^{129}$I, $^{147}$Pm, $^{239}$Pu, $^{106}$Ru, $^{113}$Sn, and $^{90}$Sr from the 242-A Evaporator (*Hanford Site Waste Management Units Report* [Cramer 1987] and WHC-EP-0141-2, *Westinghouse Hanford Company Effluent Discharges and Solid Waste Management Report for 1989: 200/600 Areas*).

Wells 299-E25-19 and 299-E25-20 monitor this site and indicate, respectively, an increasing and decreasing tritium activity. The $NO_3$ concentration remains at two to five times the drinking water standards. A surface radiation survey performed in 1991 did not detect contamination (BHI-00033, *Surface and Near Surface Field Investigation Data Summary Report for the 200-UP-2 Operable Unit*).

For a construction diagram of the 216-A-37-1 Crib, see Chapter 2 of the Work Plan (DOE/RL-2000-60, Rev. 1).

Figure 1-1. Location of the Hanford Site and the 200-PW-2 and 200-PW-4 Operable Unit Waste Sites.

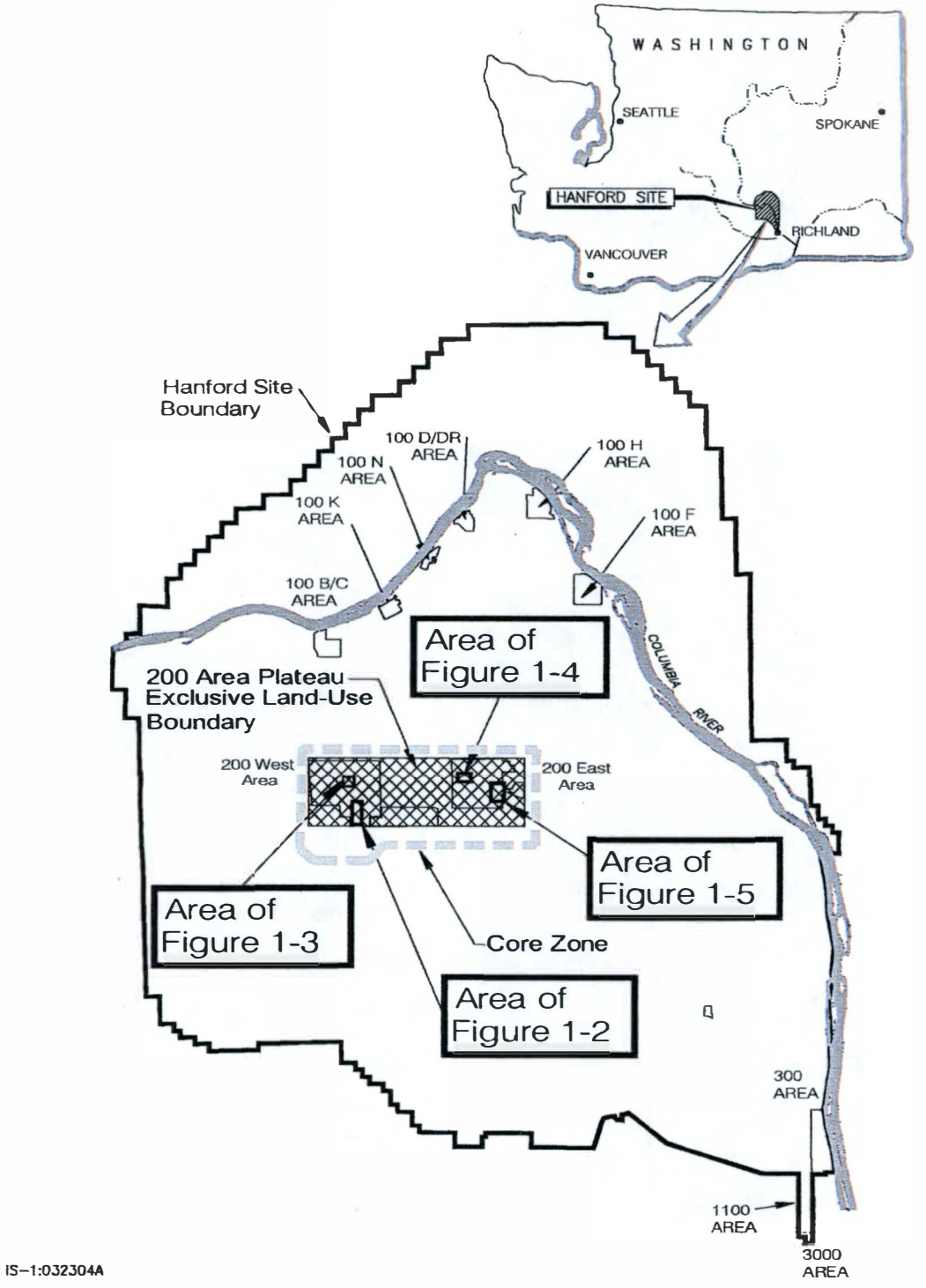

Figure 1-2. Location of the 200-PW-2 and 200-PW-4 Waste Sites Inside the 200 West Area.

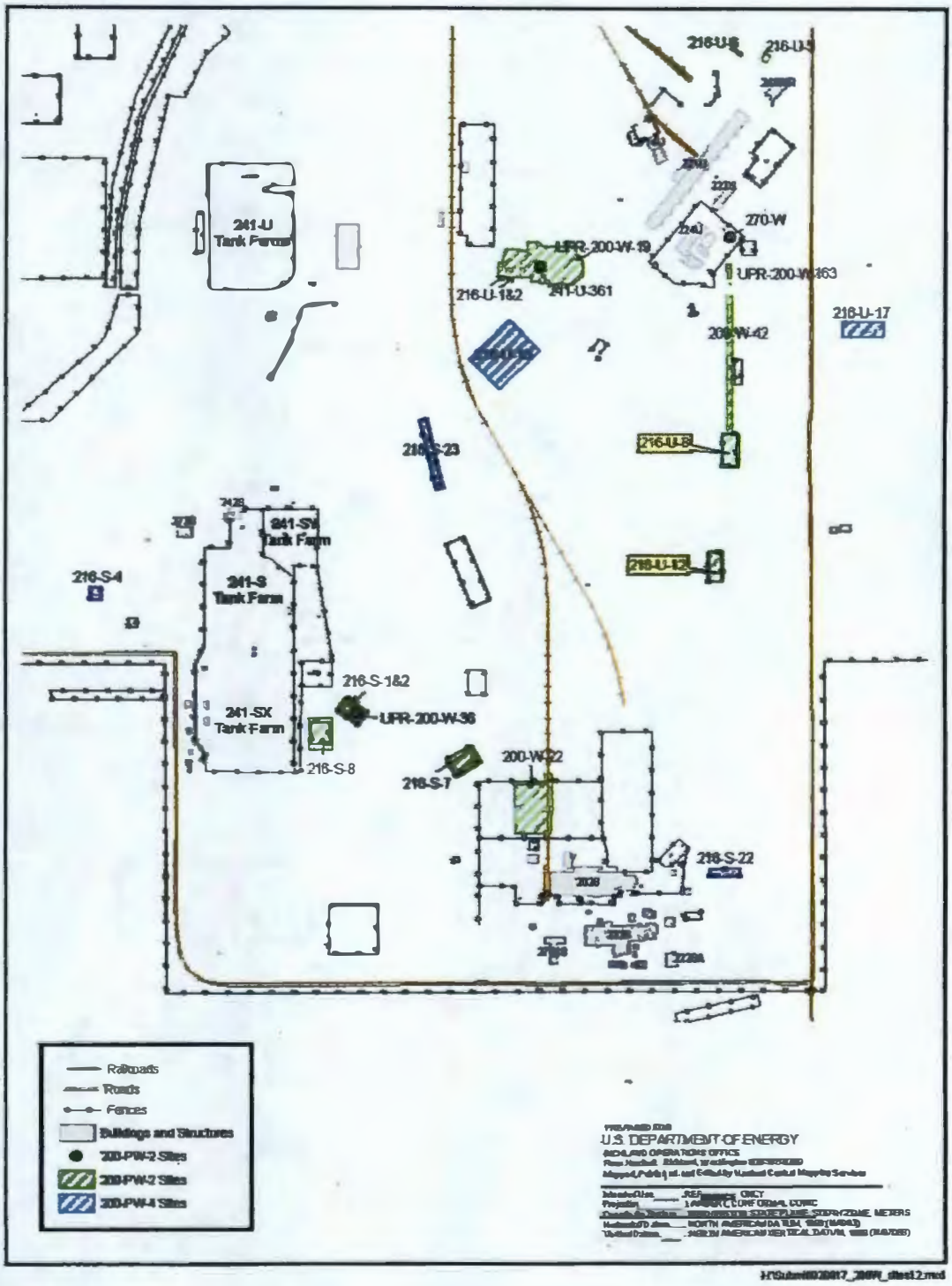

Figure 1-3. Location of Additional 200-PW-4 Waste Site Inside the 200 West Area.

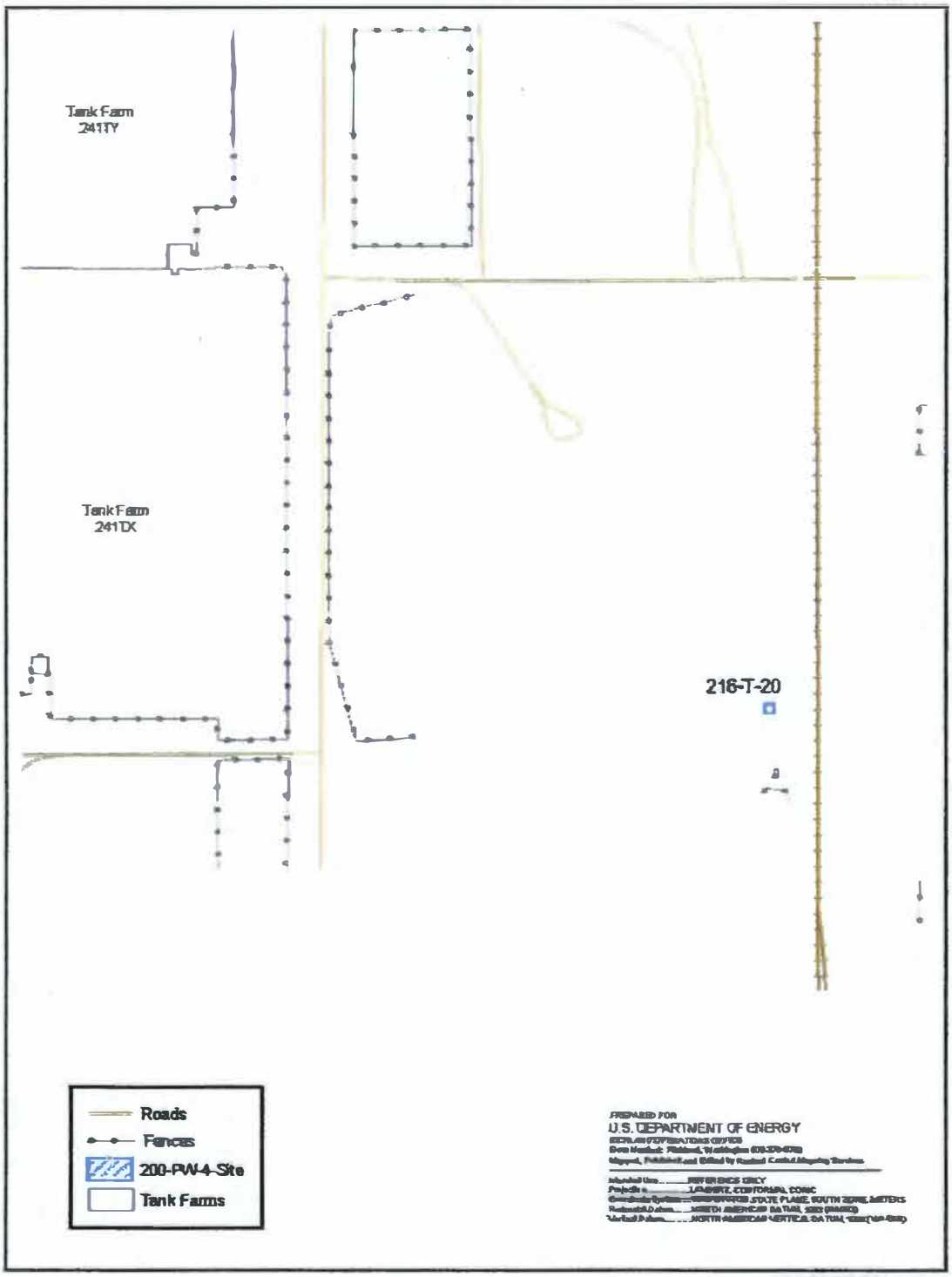

Figure 1-4. Location of 200-PW-2 Waste Sites on the West Side of the 200 East Area

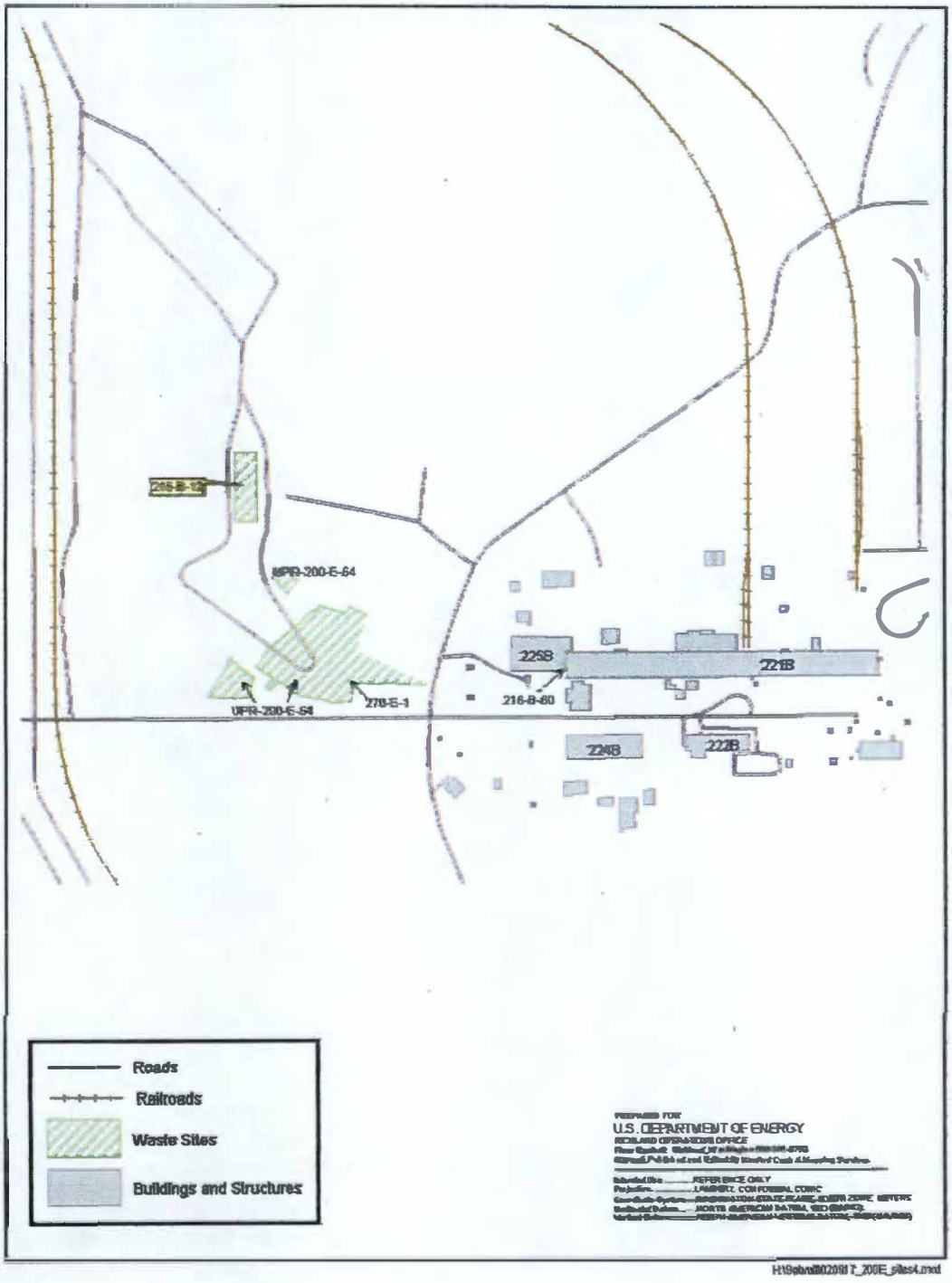

Figure 1-5. Location of 200-PW-2 and 200-PW-4 Waste Sites on the East Side of the 200 East Area.

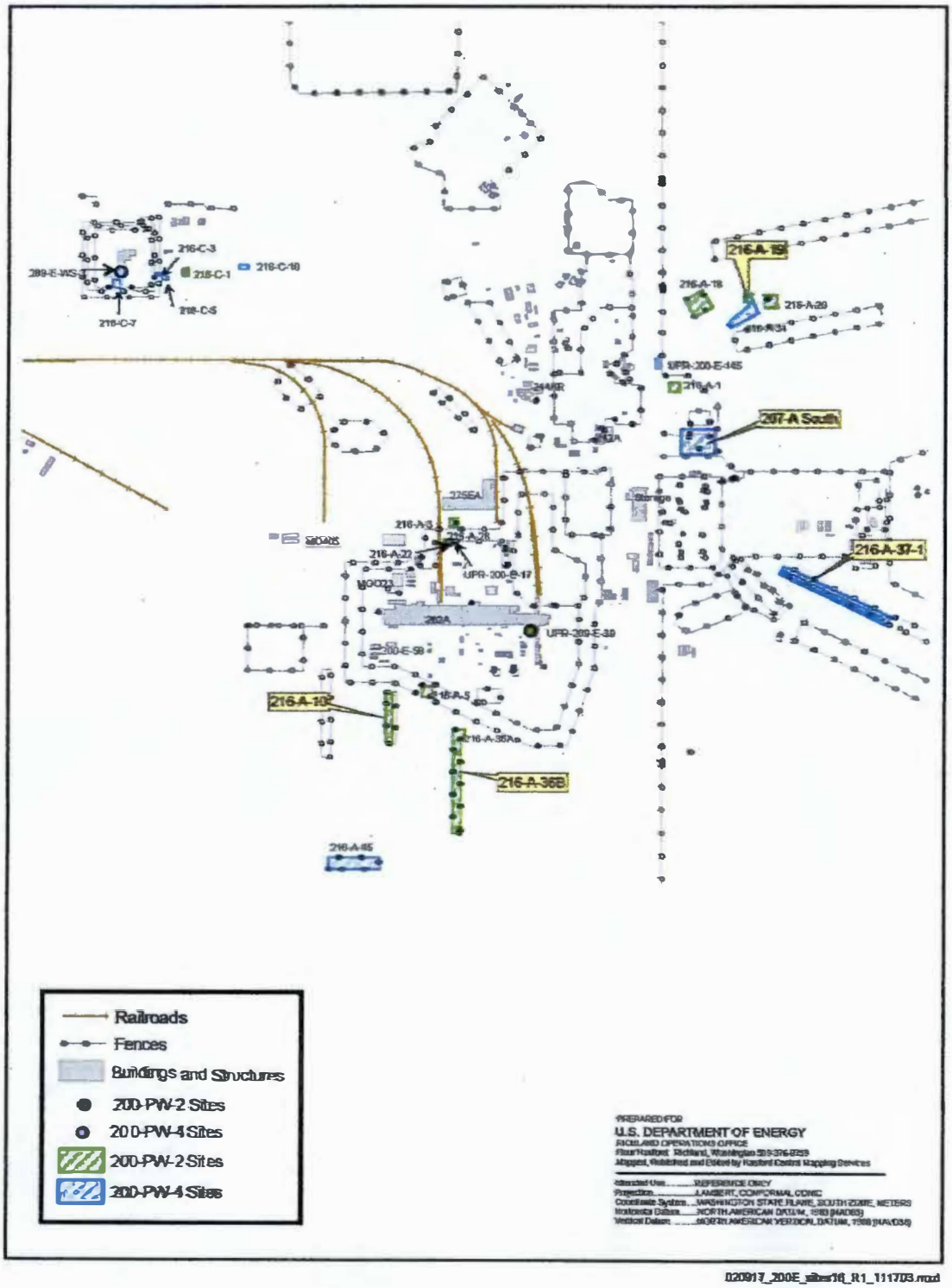


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Figure 1-6. Source Facilities Associated with 200-PW-2 and 200-PW-4 Operable Unit Representative Waste Sites and Treatment, Storage, and Disposal Units.

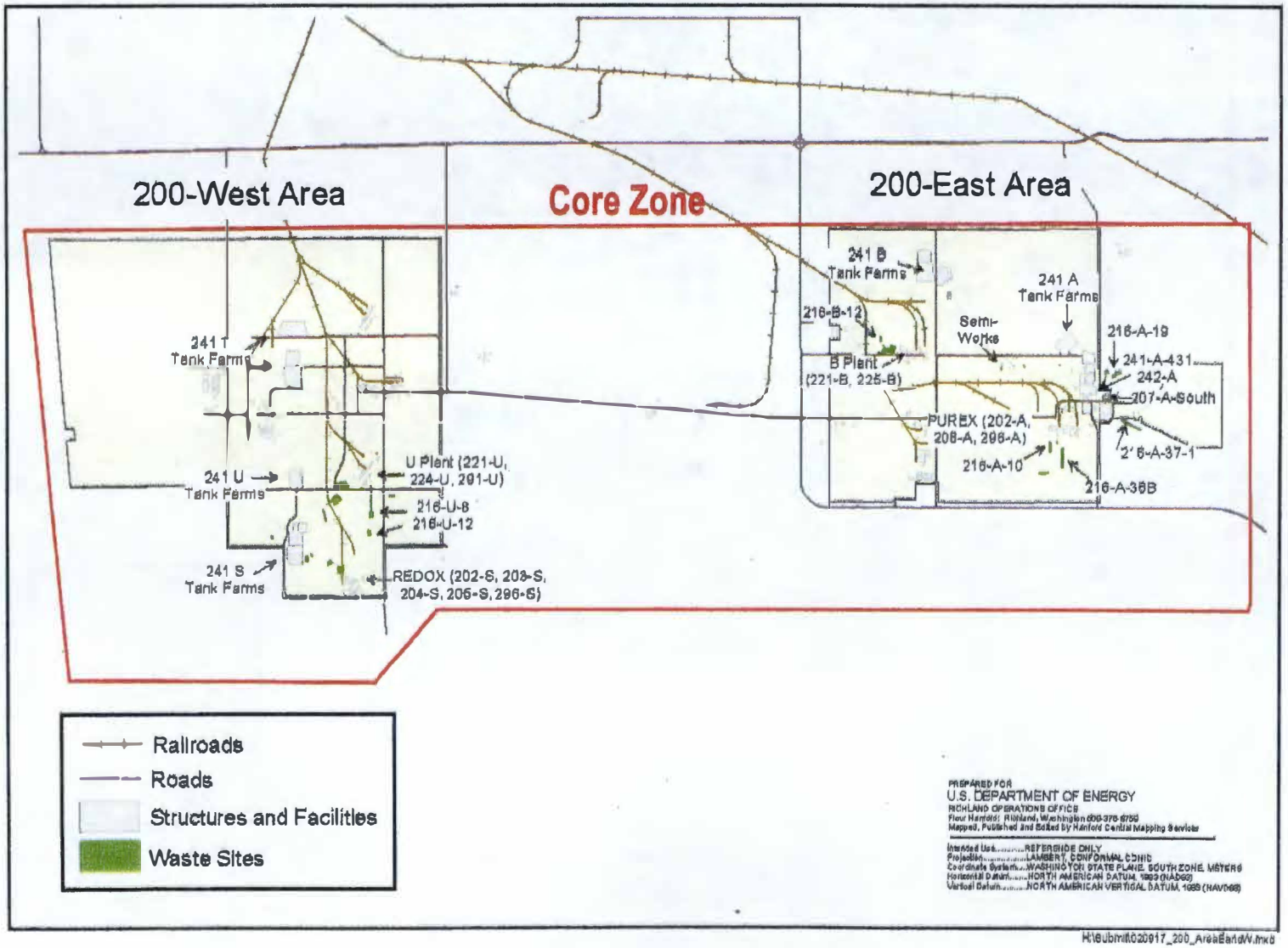

Figure 1-7. Data Evaluation Process.

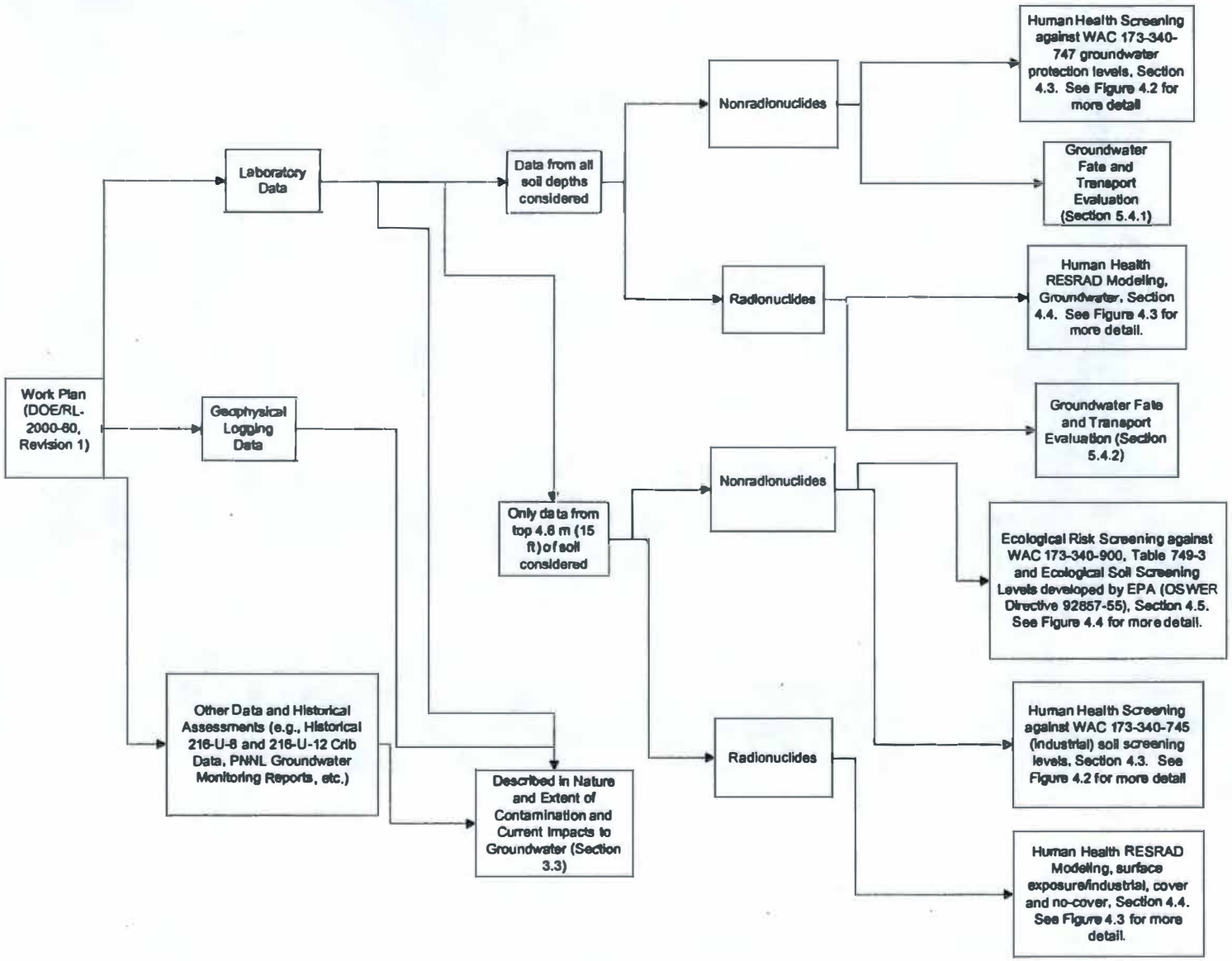

Table 1-1. List of Operable Unit Waste Sites (Data from DOE/RL-98-28 and DOE/RL-2000-60, Rev. 1) (2 sheets).

| Operable Unit | Site Code | Site Type | Category |
|---|---|---|---|
| 200-PW-2 | 200-E-58 | Neutralization tank | RPP |
| 200-PW-2 | 200-W-22 | Unplanned release | UPR |
| 200-PW-2 | 200-W-42* | Process sewer | RPP |
| 200-PW-2 | 203-S/205-S | Stabilized area | RPP |
| 200-PW-2 | 216-A-1 | Crib | RPP |
| 200-PW-2 | 216-A-3 | Crib | RPP |
| 200-PW-2 | 216-A-5 | Crib | RPP |
| 200-PW-2 | 216-A-10 | Crib | TSD |
| 200-PW-2 | 216-A-18 | Trench | RPP |
| 200-PW-2 | 216-A-19 | Trench | RPP |
| 200-PW-2 | 216-A-20 | Trench | RPP |
| 200-PW-2 | 216-A-22 | French Drain | RPP |
| 200-PW-2 | 216-A-28 | Crib | RPP |
| 200-PW-2 | 216-A-36A | Crib | RPP |
| 200-PW-2 | 216-A-36B | Crib | TSD |
| 200-PW-2 | 216-B-12 | Crib | RPP |
| 200-PW-2 | 216-B-60 | Crib | RPP |
| 200-PW-2 | 216-C-1 | Crib | RPP |
| 200-PW-2 | 216-S-1&2 | Crib | RPP |
| 200-PW-2 | 216-S-7 | Crib | RPP |
| 200-PW-2 | 216-S-8 | Trench | RPP |
| 200-PW-2 | 216-U-1&2* | Crib | RPP |
| 200-PW-2 | 216-U-5* | Trench | RPP |
| 200-PW-2 | 216-U-6* | Trench | RPP |
| 200-PW-2 | 216-U-8* | Crib | RPP |
| 200-PW-2 | 216-U-12* | Crib | TSD |
| 200-PW-2 | 216-U-361* | Settling tank | RPP |
| 200-PW-2 | 270-E-1 | Neutralization tank | RPP |
| 200-PW-2 | 270-W** | Neutralization tank | RPP |
| 200-PW-2 | UPR-200-E-17 | Unplanned release | UPR |
| 200-PW-2 | UPR-200-E-39 | Unplanned release | UPR |
| 200-PW-2 | UPR-200-E-40 | Unplanned release | UPR |
| 200-PW-2 | UPR-200-E-64 | Unplanned release | UPR |
| 200-PW-2 | UPR-200-W-19* | Unplanned release | UPR |
| 200-PW-2 | UPR-200-W-22 | Unplanned release | UPR |
| 200-PW-2 | UPR-200-W-36 | Unplanned release | UPR |
| 200-PW-2 | UPR-200-W-163* | Unplanned release | UPR |

Table 1-1. List of Operable Unit Waste Sites (Data from DOE/RL-98-28 and DOE/RL-2000-60, Rev. 1) (2 sheets).

| Operable Unit | Site Code | Site Type | Category |
|---|---|---|---|
| 200-PW-4 | 207-A SOUTH | Retention basin | TSD |
| 200-PW-4 | 209-E-WS-3 | Valve pit | RPP |
| 200-PW-4 | 216-A-34 | Ditch | RPP |
| 200-PW-4 | 216-A-37-1 | Crib | TSD |
| 200-PW-4 | 216-A-45 | Crib | RPP |
| 200-PW-4 | 216-C-3 | Crib | RPP |
| 200-PW-4 | 216-C-5 | Crib | RPP |
| 200-PW-4 | 216-C-7 | Crib | RPP |
| 200-PW-4 | 216-C-10 | Crib | RPP |
| 200-PW-4 | 216-S-4 | French drain | RPP |
| 200-PW-4 | 216-S-22 | Crib | RPP |
| 200-PW-4 | 216-S-23 | Crib | RPP |
| 200-PW-4 | 216-T-20 | Trench | RPP |
| 200-PW-4 | 216-U-16* | Crib | RPP |
| 200-PW-4 | 216-U-17* | Crib | RPP |
| 200-PW-4 | UPR-200-E-145 | Unplanned release | UPR |

* Per approval of Tri-Party Agreement Change Package C-03-01, this site will be addressed as part of Operable Unit 200-UW-1 in subsequent CERCLA documentation.

** Will be addressed as part of the 200-UW-1 Operable Unit via an engineering evaluation/cost estimate.

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

TSD = Treatment, storage, and disposal unit.

RPP = *Resource Conservation and Recovery Act of 1976* (RCRA) past-practice unit.

UPR = Unplanned release.

Table 1-2. Description of Representative Waste Sites and Treatment, Storage and Disposal Units in 200-PW-2 and 200-PW-4 Operable Units. (From DOE/RL-2000-60, Rev. 1). (4 sheets)

| Site_Code | Site Name | Location | Dates of Operation | Source Facility | Contaminant/Volume Released | Depth | Waste Site Dimensions | General Description |
|---|---|---|---|---|---|---|---|---|
| 207-A-SOUTH | 207-A-South, 207-A, 207-A Retention Basin, 207-A South Retention Basin, 207-A South | East of the 242-A Evaporator Building, adjacent to the 207-A-North Retention Basin. | 1977 to 1989 | 242-A Evaporator | Total capacity of 790,000 L (210,000 gal); process condensate waste containing mixed waste from spent halogenated and nonhalogenated solvents, and ammonia; estimated annual quantity of dangerous waste was 793,469 kg (1,749,300 lb) when operational. | 2.1 m (7 ft) | 3 concrete cells, each cell is 16.8 m (55 ft) long, 3.0 m (10 ft) wide at the bottom, and 2.1 m (7 ft) deep | All three cells were coated to prevent constituents from penetrating the concrete. The 207-A Basin was used for the interim storage of the 242-A Evaporator process condensate to allow for sampling and analysis before the condensate was discharged to the 216-A-37-1 Crib for final disposition. The site is a RCRA TSD unit. |
| 216-A-10 | 216-A-10, 216-A-10 Crib | South of 202_A Building | 1956 to 1987 | 202-A (PUREX) acidic process condensate | 3,210,000,000 L (848 million gal) of acidic waste containing uranium and nitrate | 9.1 m (30 ft) | 83.8 m x 13.7 m (275 ft x 45 ft) | The excavation is a wedge-shaped cross section. The unit has a 20 cm (8-in.) pipe placed horizontally 9 m (30 ft) below grade. It also has the original distribution pipe, two layers of vinyl plastic separating the gravel from the backfill, two vent structures, a vent box on a concrete pad, and three 15 cm (6-in.) risers extending from the bottom to the vent structure. The site was later backfilled. The site is a RCRA TSD unit. |

Table 1-2. Description of Representative Waste Sites and Treatment, Storage and Disposal Units in 200-PW-2 and 200-PW-4 Operable Units. (From DOE/RL-2000-60, Rev. 1). (4 sheets)

| Site_Code | Site Name | Location | Dates of Operation | Source Facility | Contaminant/Volume Released | Depth | Waste Site Dimensions | General Description |
|---|---|---|---|---|---|---|---|---|
| 216-A-19 | 216-A-19, 216-A-19 Test Hole, 216-A-19 Grave, 216-A-19 Sump, 216-A-19 Crib | East of the 200 East Area perimeter fence; north of 216-A-8 Crib | 1955 to 1956 | Startup waste and contact condenser cooling water from PUREX | 1,100,000 L (291,000 gal) of start-up waste containing uranium and nitric acid. | 4.6 m (15 ft) | 7.6 m x 7.6 m (25 ft x 25 ft) | The site received depleted uranium waste from the cold startup run at the 202-A Building. Later it received contact condenser cooling water from the 241-A-431 Building via the 216-A-34 Ditch. The site was deactivated by removing the above-ground piping and backfilling the excavation after the specific retention capacity was reached. The site was surface stabilized in 1990. |
| 216-A-36B | 216-A-36B, 216-A-36 Crib, PUREX Ammonia Scrubber Distillate (ASD) Crib | South of 202-A Building, west of Canton Avenue outside the security fence | 1966 to 1987 | Ammonia scrubber waste from PUREX | 317,000,000 L (84 million gal); low in salt and neutral to basic containing large amounts of uranium | 7.6 m (25 ft) | 152.4 m x 3.4 m (500 ft x 11 ft) (bottom) | The crib is a gravel structure separated from the 216-A-36A Crib by a concrete dam. The 216-A-36B Crib contains a 10 cm (4-in.) perforated pipe placed horizontally 7 m (23 ft) below grade inside a 15 cm (6-in.) pipe from the 216-A-36A segment. The crib includes a 20 cm (8-in.) gage well, a plastic barrier between gravel and backfill, and a 20 cm (8-in.) vent with a 5 cm (2-in.) drain. The site is a RCRA TSD unit. |

Table 1-2. Description of Representative Waste Sites and Treatment, Storage and Disposal Units in 200-PW-2 and 200-PW-4 Operable Units. (From DOE/RL-2000-60, Rev. 1). (4 sheets)

| Site Code | Site Name | Location | Dates of Operation | Source Facility | Contaminant/Volume Released | Depth | Waste Site Dimensions | General Description |
|---|---|---|---|---|---|---|---|---|
| 216-A-37-1 | 216-A-37-1, 216-A-37 Crib | Outside of the 200 East Area perimeter fence, east of the 202-A Building. | 1977 to 1989 | 242-A Evaporator | 377,000,000 L (99.6 million gal) of process condensate waste containing mixed waste from spent halogenated and nonhalogenated solvents, and ammonia; estimated annual quantity of dangerous waste was 793,469 kg (1,749,300 lb) when operational. | 2.4 – 4.3 m (8 - 14 ft) | 213 (700 ft) x 3 m (10 ft) | The crib received process condensate waste from the 242-A Evaporator facility. The unit is a gravel structure with a 25 cm (10-in) corrugated, galvanized, perforated pipe located horizontally, 2.1 m (7 ft) below grade. The excavation contains 1.5 m (5 ft) of gravel fill with a volume of 150 $m^3$ (5,300 $ft^3$) and has been backfilled over. The site is a RCRA TSD unit. |
| 216-B-12 | 216-B-12, 216-ER Crib, 216-ER-1,2,3 Cribs | Northwest of 221-B Building and north of 7th Street | 1952 to 1973 | Condensate waste from 221-U (U Plant), 224-U ($UO_3$), and 221-B Plant (B Plant) | 520,000,000 L (137 million gal) of low in salt, neutral to basic liquid containing larger amounts of uranium, fission products, and tributyl phosphate. | 9m (30 ft) | 48.8 m x 15.2 m (160 ft x 50 ft) | The unit consists of a series of three cascading 5- x 5- x 3-m (16- x 16- x 10-ft) wooden boxes. The bottom 4 m (12 ft) contains 1.3 cm (0.5 in.) gravel backfill, 1.2 m (4 ft) of which underlie the cribs. The cribs have subsided gradually to a final depression of 1.5 m (5 ft) in the past. The cribs were immediately backfilled and discharged ceased. The site was surface stabilized in 1993. The cribs continue to have a possible cave-in potential. |

Table 1-2. Description of Representative Waste Sites and Treatment, Storage and Disposal Units in 200-PW-2 and 200-PW-4 Operable Units. (From DOE/RL-2000-60, Rev. 1). (4 sheets)

| Site Code | Site Name | Location | Dates of Operation | Source Facility | Contaminant/Volume Released | Depth | Waste Site Dimensions | General Description |
|---|---|---|---|---|---|---|---|---|
| 216-U-12 | 216-U-12, 216-U-12 Crib | South of 16th Street, west of Beloit Avenue, south of 216-U-8 Crib | 1960 to 1988 | 291-U-1 stack drainage, 244-WR vault waste, 224-U process condensate | 150,000,000 L (40 million gal); acidic liquid containing thorium, uranium, Sr-90, Cs-137, nitrate, and TBP | 4.6 m (15 ft) | 30.5 m x 3 m (100 ft x 10 ft) | The 216-U-12 Crib was constructed when the 216-U-8 Crib began to subside. The pipe that delivered liquid materials to the U-8 Crib was blanked off, and a 15 cm (6-in.) VCP transported liquid waste to the U-12 Crib. A 30 cm (12-in.) perforated vitrified clay pipe extends horizontally the length of the crib. The crib contains a vent pipe and two gage wells. The vent pipe is 30 cm (12-in.) vitrified clay vent pipe. Gage wells were 45 cm (18 in.) and 20 cm (8 in.) diameter and believed to be vitrified clay pipe. The bottom 167 cm (66 in.) of the crib contains gravel. In 1995, one borehole was characterized as part of the 200-UP-2 LFI. In 1996, a section of the VCP was removed, and sealed within the pipeline with grout. This site is a RCRA TSD. |

Table 1-2. Description of Representative Waste Sites and Treatment, Storage and Disposal Units in 200-PW-2 and 200-PW-4 Operable Units. (From DOE/RL-2000-60, Rev. 1). (4 sheets)

| Site Code | Site Name | Location | Dates of Operation | Source Facility | Contaminant/Volume Released | Depth | Waste Site Dimensions | General Description |
|---|---|---|---|---|---|---|---|---|
| 216-U-8 | 216-U-8, 216-WR-1,2,3 Cribs, 216-U-9 | West of Beloit Avenue and south of 16th Street | 1952 to 1960 | Acidic process condensate from 221-U (U Plant) and 224-U ($UO_3$) Buildings and 291-U stack | 379,000,000 L (100 million gal); acidic waste, Cs-137, Eu-l 54, U-235, U-238, Sr-90 | 9.8 m (32 ft) | 48.8 m x 15.2 m (160 ft x 50 ft) | The crib consists of three timbered structures (each 4.9 x 4.9 x 3 m [16 x 16 x 10 ft]) that received process waste. In 1960, the crib was deactivated when it began to subside. Sinkholes were backfilled around the three cribs and the risers were cut off and capped below grade. In 1994, the crib and the portion of the vitrified clay pipe from 16th Street south to the crib were stabilized with about 0.6 m (2 ft) of soil. The site was characterized in 1995 as part of the 200-UP-2 LFI. One borehole was drilled through the crib. Surface and near-surface soil samples, vegetation samples, and a pipeline camera survey were completed for characterization. Groundwater has been impacted at this site. |

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

ASD = Ammonia Scrubber distillate
LFI = Limited field investigation.
PUREX = Plutonium Uranium Extraction (Facility or process)
RCRA = *Resource Conservation and Recovery Act of 1976*
TSD = Treatment, storage, and disposal.
VCF = Vitrified clay pipe.

# 2.0 INVESTIGATION APPROACH AND ACTIVITIES

This chapter summarizes the data collection activities performed during the 200-PW-2 and 200-PW-4 OU RI. These activities are described in detail in CP-18666, Rev. 0. The RI was conducted in accordance with the Sampling and Analysis Plan (SAP) associated with the Work Plan (DOE/RL-2000-60, Rev. 1). The RI needs for the 200-PW-2 and 200-PW-4 OUs were developed and presented in the DQO process summary reports (BHI-01411 and CP-14176). The DQO process is used to develop a data collection strategy consistent with data uses and needs. The objectives identified included the collection of data that will be used to define the nature and extent of radiological and chemical contamination, support evaluation of risks, and assist in the evaluation, selection, and design of remediation alternatives.

Data were collected to characterize the nature and vertical extent of chemical and radiological contamination and the physical conditions in the vadose zone underlying the historical boundaries of the 216-A-19 Trench, the 216-B-12 Crib, the 216-A-10 Crib, and the 216-A-36B Crib in the 200-PW-2 OU and the 216-A-37-1 Crib and the 207-A South Retention Basin in the 200-PW-4 OU. Borehole drilling and sampling, large-diameter push-hole (drive casing) installation, direct-push sampling, surface and borehole geophysical surveys, and sampling and analysis of soils were conducted during the field activities. All boreholes and test pits were completed, and all samples were collected and analyzed for COCs as identified in the DQO and SAP.

## 2.1 200-PW-2 AND 200-PW-4 OPERABLE UNIT REMEDIAL INVESTIGATION DRILLING

Five boreholes (C3245, C3246, C3247, C4106, and C4160) were drilled and sampled during the 200-PW-2 and 200-PW-4 OU RI. Boreholes were drilled through the 216-A-19 Trench, the 216-B-12 Crib, the 216-A-10 Crib, the 216-A-36B Crib and the 216-A-37-1 Crib from the ground surface to the water table at depths of approximately 78 m (256 ft), 93 m (306 ft), 97.2 m (319 ft), 97.6 m (320 ft), and 85 m (278 ft), respectively. Borehole C3248 in the 216-A-36B Crib hit refusal at a depth of 8 m (26 ft); however, the replacement borehole (C4160) was successfully installed about 1 m (3 ft) east of C3248. The boreholes were drilled to better define stratigraphy and to assess the nature and vertical extent of chemical and radiological contamination as well as the physical properties of the soil beneath these waste sites.

Cable-tool drilling with drive-barrel technology was used to construct all five boreholes. No water was added to aid the drilling process. Split-spoon sampling with stainless steel liners (4 each, 15.2 cm [6 in] long) was the primary method used for soil acquisition. Soil samples were collected for chemical and radiological analyses. One liner each from selected intervals was submitted for determination of physical properties. After reaching total depth, each borehole was decommissioned by removing the temporary casings and backfilling the borehole with silica sand from the bottom to the water table, granular bentonite up to 0.3 m to 1 m (1 to 3 ft) bgs, and a concrete surface seal in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells."

Five large-diameter push holes (C4107, C4108, C4110, C4111 and C4112) were installed in the 216-A-10 Crib to depths of 27.7 m (91 ft), 27.7 m (91 ft), 18.3 m (60 ft), 27.1 m (89 ft), and 24.4 m (80 ft), respectively. The temporary casing in these holes was 16.8 cm outer diameter (OD) and 15.2 cm inner diameter (ID) (6 5/8-in OD, 6-in ID). Planned push hole C4109 was not installed because the spatial distribution of the other five push holes was considered adequate to situate borehole C3247 (CP-18666, Rev. 0). During installation and removal of the drive casing at the C4111 push hole near the center of the crib a depression up to about 0.15 m (0.5 ft) deep was observed at the surface near the push hole. It is likely that the repeated impacts from the drive casing installation caused the near-surface sand to settle into the void space within the crib backfill (composed of 8 cm to 13 cm- [3- to 5-in.-] diameter rocks), which resulted in this minor subsidence. Borehole geophysical logs were run in each cased hole to determine where borehole C3247 could be drilled and sampled in the area of highest contamination in this crib. The push holes were decommissioned with granular bentonite and cement after reaching total depth, in accordance with WAC 173-160.

The 207-A South Retention Basin was investigated with push holes C4113 (West Basin), C4114 (Center Basin) and C4115 (East Basin). Planned push hole C4116 was not drilled because it was determined that no open cracks existed in the three basins. Push hole C4113 was sampled using a Geoprobe[1] and a large-diameter sampler; three push-hole attempts were made at this location to 4.3 m (14 ft) depth to obtain sufficient sample material for analysis. Push holes C4114 (center basin) and C4115 (east basin) were drilled using a combination of Guzzler[2] and hand-auger methods. Each of the sites used the Guzzler to remove (vacuum) soils down to the sample horizon while installing 15.2 cm (6-in.) polyvinyl chloride casing to keep the borehole walls from caving. At each sample interval, a hand auger was used to collect the soils, then the Guzzler was used to advance the hole to the next interval. The final sample interval, 3.8 m to 4.1 m (12.5 to 13.5 ft) bgs in both holes, was sampled using a scoop or spoon attached to a set of rods and lowered to the soils, where manual rotation and retraction permitted the samples to be collected. These three holes were decommissioned with granular bentonite and cement after reaching total depth, in accordance with WAC 173-160.

The borehole locations at the six waste sites investigated during the RI are shown in Figures 2-1 through 2-4. Although new boreholes were not installed in the 216-U-8 and 216-U-12 Cribs, a map showing the locations of boreholes at these sites is included as Figure 2-5.

### 2.1.1 200-PW-2 and 200-PW-4 Operable Unit Remedial Investigation Sampling and Analysis

Soil samples collected from the boreholes were screened in the field before sample collection for indications of contamination and to assist with determining discrete sample locations or depths. Samples were screened for volatile organic contamination, ammonia, and tributyl phosphate using several different hand-held vapor analyzers. Soil samples were screened for alpha and

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[1] Geoprobe® is a registered trademark of Geoprobe Systems, Salinas, Kansas.

[2] Guzzler is a trademark of Guzzler Manufacturing, Inc., Streator, Illinois.

beta-gamma radioactivity to assist in selecting sample points, support worker health and safety, and for sample shipping information. A radiation control technician performed the radiological screening using an E-600[3] ratemeter with a SHP380-A/B scintillation probe and a dose meter (where necessary). Radiological activity greater than two times background was used as an indicator of high contamination.

Soil samples were collected for chemical and radiological analysis and determination of physical properties. Sample collection was guided by the sample schedule in the Work Plan, Appendix B, "Sampling and Analysis Plan" (DOE/RL-2000-60, Rev. 1). The sampling approach generally required a greater sample frequency near the bottom of each waste site, which is the area of highest suspected contamination. Parameters for the sample analyses performed at each borehole are presented in Tables 2-1 through 2-7. Sample collection was always attempted at depths of 4.6 m and 7.6 m (15 and 25 ft) bgs to define contamination profiles for remedial designs. Sample intervals generally increased below depths of about 15.2 m to 27.4 m (50 to 90 ft) to intervals of 15.2 m to 30 m (50 to 100 ft).

A total of 175 samples were collected from the boreholes, including QA/QC and physical property samples.

Soil samples were selectively analyzed for ammonia, anions, hexavalent chromium, total cyanide, metals, nitrate/nitrite, oil and grease, pesticides and herbicides (for investigation-derived waste [IDW] characterization of near-surface soils), pH, polychlorinated biphenyls, semi-volatile organics, total petroleum hydrocarbons, radionuclides, volatile organics, moisture content, particle size distribution, and bulk density.

### 2.1.2 200-PW-2 and 200-PW-4 Operable Unit Remedial Investigation Borehole Geophysical Logging

A spectral gamma-ray logging system (SGLS) was used to capture the down-hole radiometric signature at the five boreholes and five push holes completed during the RI. As the SGLS system became saturated from high radiological counts or reached the top end of the reliability curve, a high-rate logging system (HRLS) was employed to determine the total activity of the material present. The logging system provided a continuous radiometric signature of the soils through a single thickness of casing to total drilled depth.

Existing boreholes in the vicinity of each waste site were SGLS logged before the drilling program began. These boreholes are listed in Table 2-8.

A neutron moisture-logging tool was employed to generate a moisture profile of the vadose zone in each borehole. The system uses a weak radioactive neutron source and detector to provide a

[3] E-600 and SHP380-A/B are trademarks of Eberline Instruments, a subsidiary of Thermo Electron Corporation, Waltham, Massachusetts.

direct reading of hydrogen atom distribution. Detailed reports of the borehole geophysical logging conducted in each borehole or push hole are provided in CP-18666.

## 2.2 OTHER 200-PW-2 AND 200-PW-4 OPERABLE UNIT ACTIVITIES

### 2.2.1 Surface Geophysical Surveys

Surface geophysical surveys were conducted at all borehole or push locations before drilling using ground-penetrating radar. The surveys were performed to verify the location of waste sites and identify potential underground hazards.

### 2.2.2 Air Monitoring

Air monitoring during the RI field activities was conducted in accordance with Environmental Restoration Program ALARACT Demonstration for Drilling – Drilling Activities Outside the Tank Farms Fence Line on the Hanford Site (CCN 0087338, "Environmental Restoration Program ALARACT Demonstration for Drilling – Drilling Activities Outside the Tank Farms Fence Line on the Hanford Site") to verify that the breathing zone remained free of contamination and that the drill crew was wearing the proper protective equipment.

### 2.2.3 Temperature Profile

A temperature profile was constructed for borehole C3247 at the 216-A-10 Crib after the geologist and drill crew noticed that the drilled soils were significantly warmer than those from the preceding borings. The soil temperature was noticed to increase with depth and was hot to the touch at a depth of 24 m (79 ft). A thermometer was brought to the site when the drilling was at a depth of 44 m (145 ft) bgs, and the temperature was recorded from there to 67 m (220 ft) bgs. On fresh drill cuttings, the temperature ranged from 37.8 °C to 47.8°°C (100 to 118°°F), in contrast to a normal temperature of around 15 °C to 18°C (low to mid 60s°°F) throughout the soil column in the vadose zone. After all geophysical logging had been completed; a thermal probe was used to establish a profile of the well. The probe recorded borehole temperatures from the surface to total depth and revealed temperatures to greater than 35°°C (95°°F) from 25 m to 78 m (82 to 256 ft) bgs. The probe did not indicate temperatures similar to the elevated readings observed with the thermometer in the field, probably because the hole had been equilibrating for several days, and the casing transmitted heat to the air circulating in the casing. CP-18666 discusses several different possible explanations for the anomalous temperatures measured in this borehole.

### 2.2.4 Geodetic Survey

The boreholes were surveyed in accordance with CP-GPP-EE-01-1.6, *Survey Requirements and Techniques*. Coordinates were recorded using NAVD88, *North American Vertical Datum of*

*1988* and the NAD83, *North American Datum of 1983*, for the Washington State Plane (South Zone) with the 1991 adjustment for horizontal coordinates. Survey data are presented in CP-18666.

### 2.2.5 Quality Assurance Surveillance

A QA surveillance was conducted on the direct push holes installed at the 216-A-10 Crib. The surveillance looked at placement of the holes, materials and equipment used, driller qualification, hole decommissioning, borehole geophysical logging, and document and record generation. The surveillance of these activities was found to be satisfactory.

Figure 2-1. Borehole Location Map for the 216-A-19 Trench.

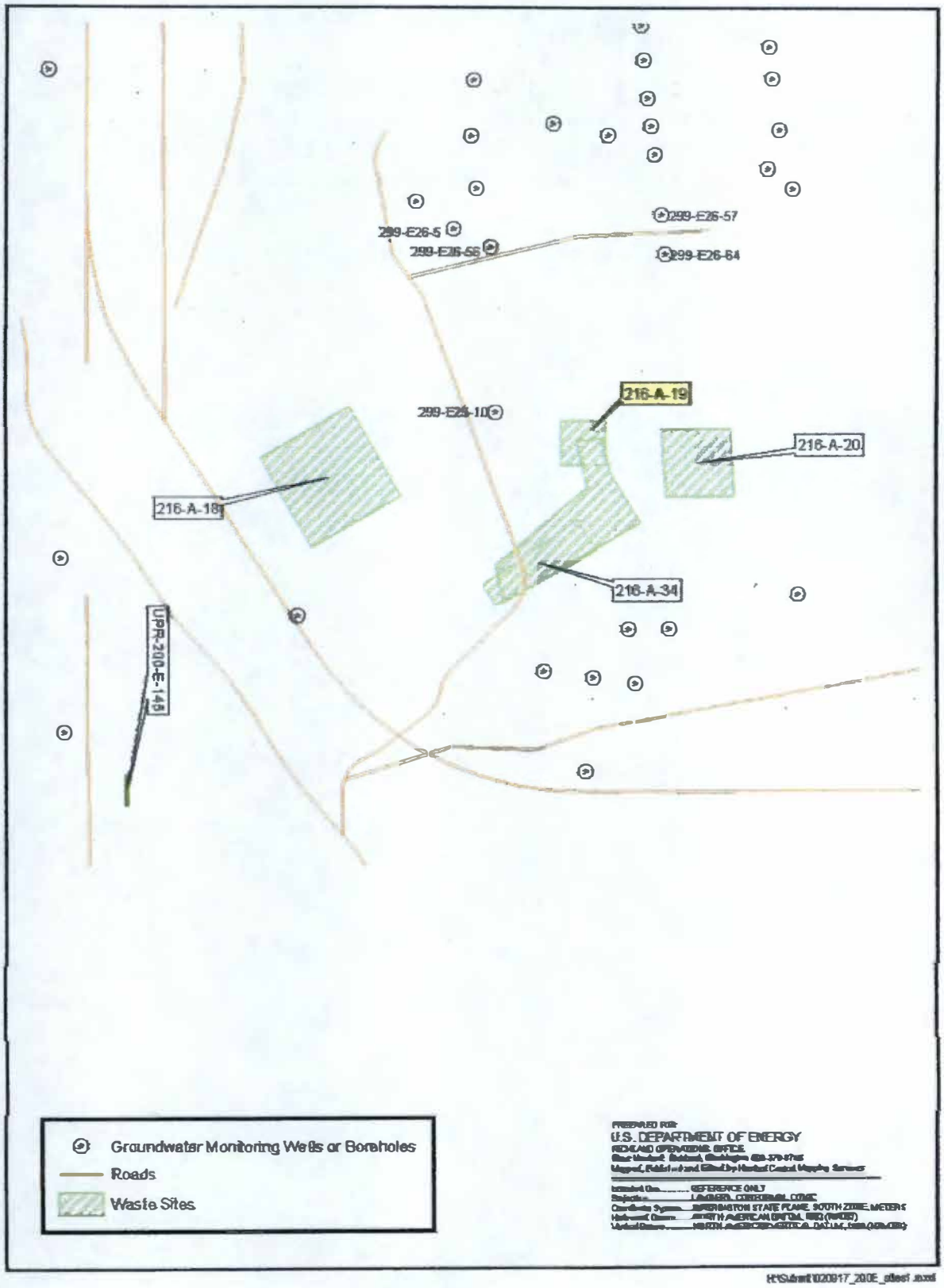

Figure 2-2. Borehole Location Map for the 216-B-12 Crib.

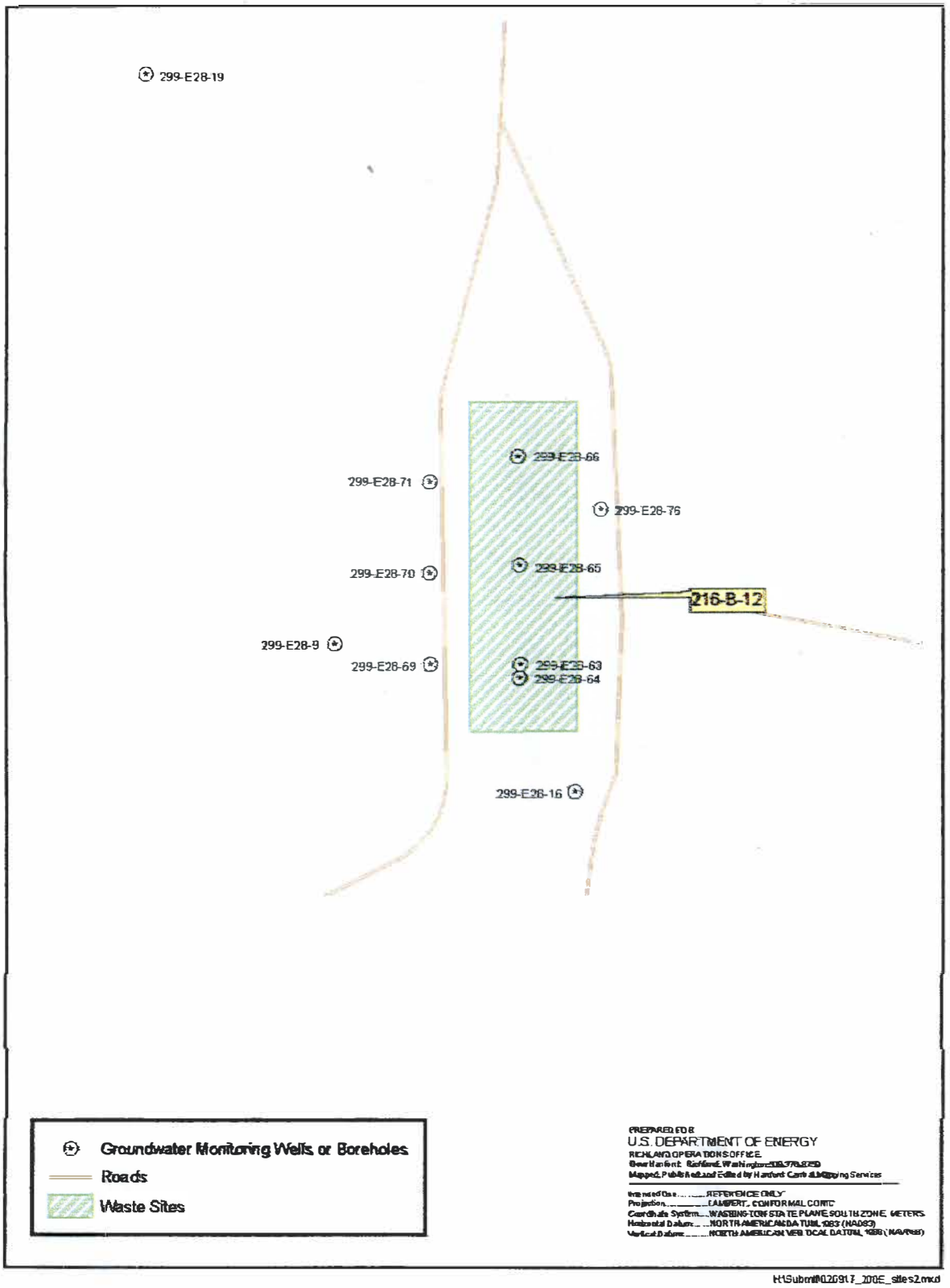


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Figure 2-3. Borehole Location Map for the 216-A-10 and 216-A-36B Cribs.

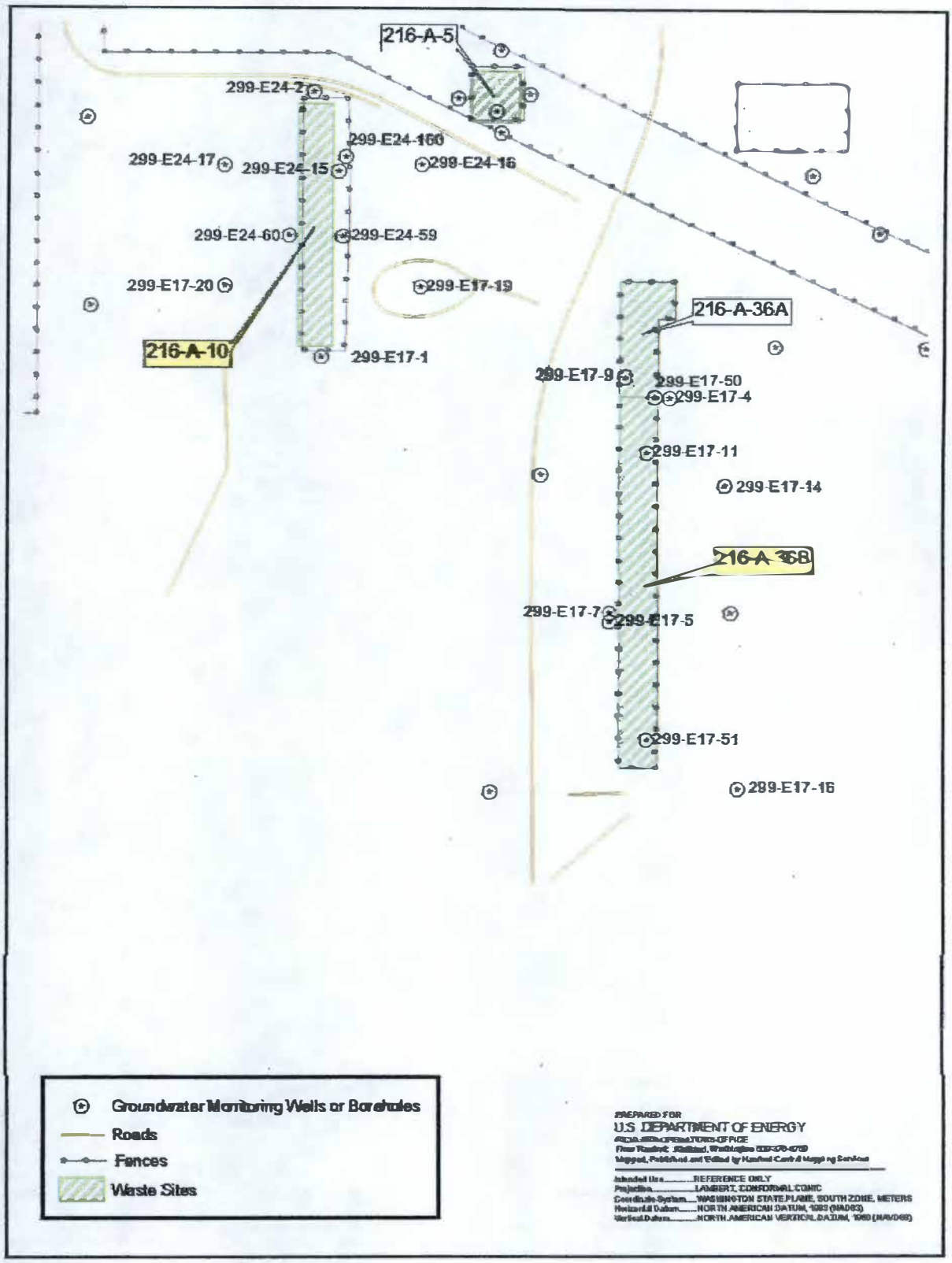


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Figure 2-4. Borehole Location Map for the 207-A South Retention Basin and the 216-A-37-1 Crib.

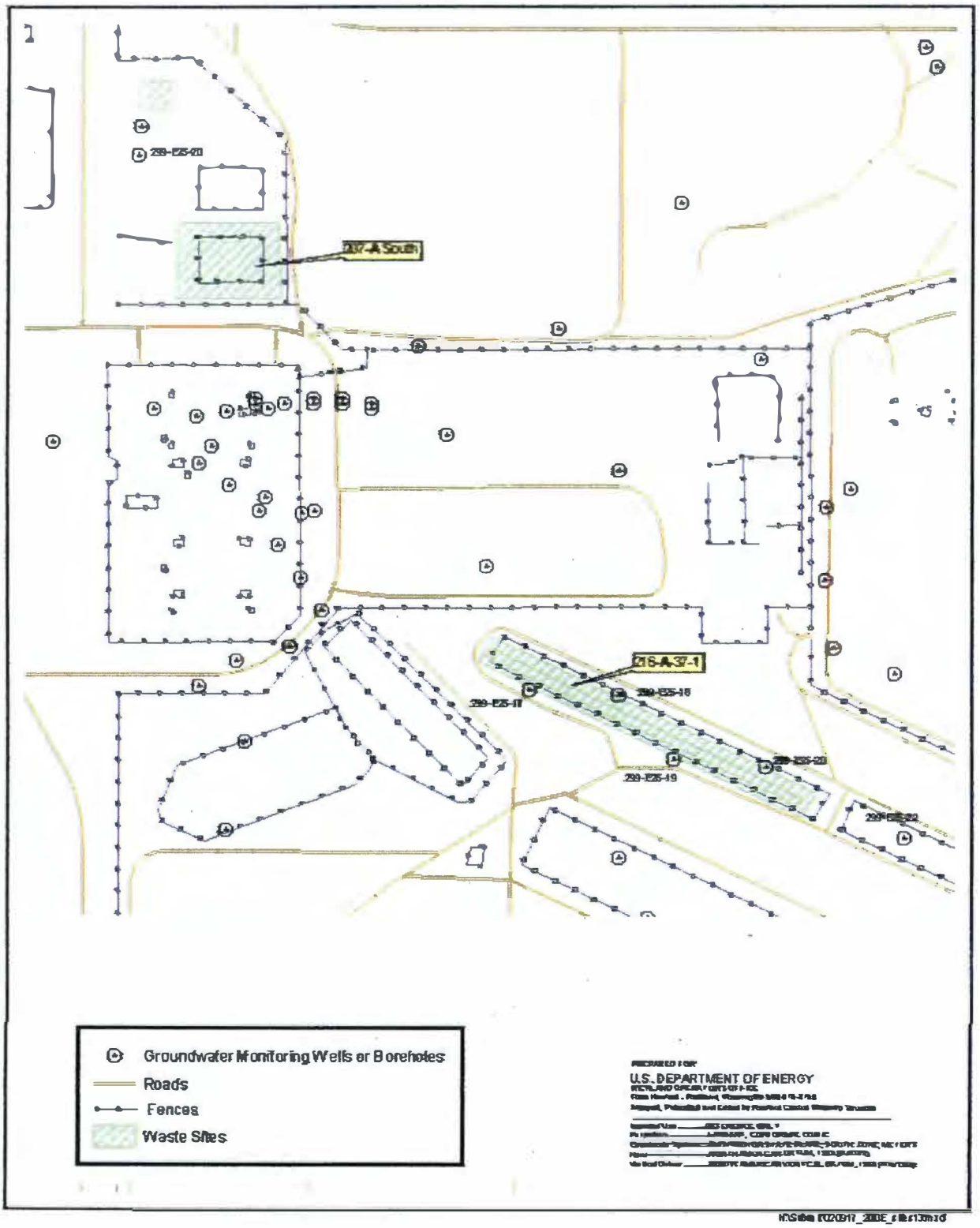

Figure 2-5. Borehole Location Map 216-U-8 and 216-U-12 Cribs.

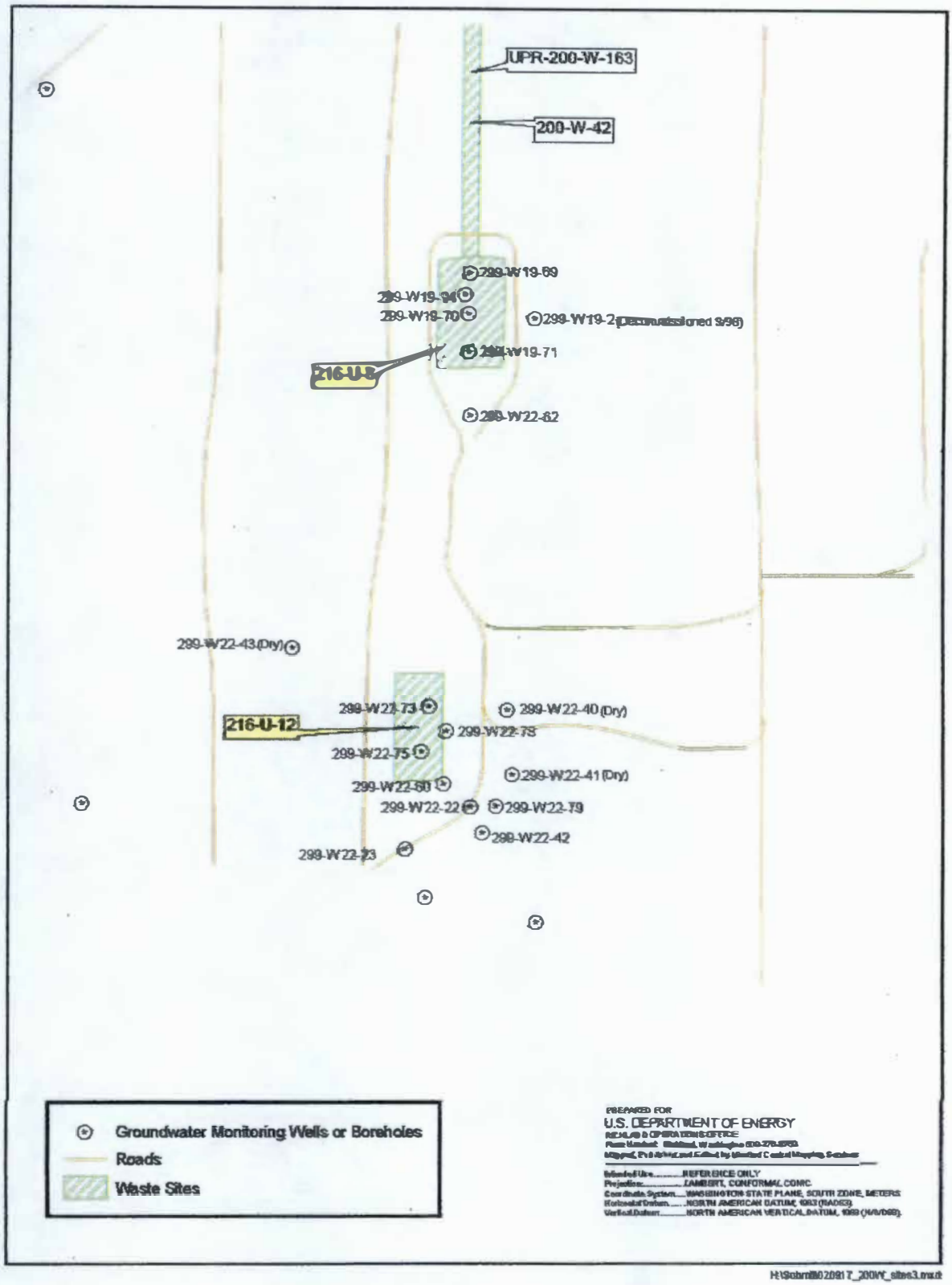

Table 2-1. Sample Data, 216-A-19 Trench (200-PW2 Borehole C3245). (3 sheets)

| HEIS | Date Collected | Data Package | Site | Depth Collected (ft bgs) | Depth Planned (ft bgs) | Lab | Sample Data Received | | | Sample Analyses Performed |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | WSCF | Eberline | Lionville | |
| B16RW4 | 4/4/03 | H2152 | C3245 | 0.5 | 0.5 | Eberline | | 5/30/03 | 5/27/03 | Pest/herb |
| B16RX6 | 4/4/03 | WSCF20030459 | C3245 | 14.5 | 14.5 | WSCF | 6/2/03 | | | Metals, general chemistry, VOA, SVOA, rad, TPH |
| B16RX6 | 4/4/03 | WSCF20031181 | C3245 | 14.5 | 14.5 | WSCF | 10/22/03 | | | Metals, general chemistry, VOA, SVOA, rad, TPH |
| B16RW5 | 4/4/03 | H2152 | C3245 | 14.5 | 14.5 | Eberline | | 5/30/03 | 5/27/03 | Nitrate/nitrite, $Cr^{+6}$, oil/grease, rad |
| B16RX7 | 4/4/03 | WSCF20030460 | C3245 | 17.5 | B16RX7 is a waste designation sample. | WSCF | 6/2/03 | | | Metals, general chemistry., VOA, SVOA, rad, TPH |
| B16RX7 | 4/4/03 | WSCF20031181 | C3245 | 17.5 | | WSCF | 10/22/03 | | | Metals, general chemistry, VOA, SVOA, rad, TPH |
| B16RW6 | 4/4/03 | H2152 | C3245 | 17.5 | 17.5 | Eberline | | 5/30/03 | 5/27/03 | Nitrate/nitrite, $Cr^{+6}$, oil/grease, rad |
| B16LD9 | 3/19/03 | H2111 | C3245 | B16LD9 is an equipment blank QC sample tied to B16RX7 | | Eberline | | 5/7/03 | 4/14/03 | Oil/grease, rad |
| B16LD9-A | 3/19/03 | WSCF20030361 | C3245 | B16LD9-A is an equipment blank QC sample tied to B16RW6. | | WSCF | 6/13/03 | | | Metal, general chemistry, VOA, PCB, SVOA, rad, TPH |
| B16RX8 | 4/4/03 | WSCF20030461 | C3245 | 22.5 | 22.5 | WSCF | 6/2/03 | | | Metals, general chemistry, VOA, SVOA, rad, TPH |
| B16RX9 | 4/4/03 | WSCF20030461 | C3245 | 22.5 | B16RX9 is a duplicate sample of B16RX8 | WSCF | 6/2/03 | | | Metals, general chemistry, VOA, SVOA, rad, TPH |
| B16RX8 | 4/4/03 | WSCF20031181 | C3245 | 22.5 | 22.5 | WSCF | 10/22/03 | | | Metals, general chemistry, VOA, SVOA, rad, TPH |
| B16RX9 | 4/4/03 | WSCF20031181 | C3245 | 22.5 | B16RX9 is a duplicate sample of B16RX8 | WSCF | 10/22/03 | | | Metals, general chemistry, VOA, SVOA, rad, TPH. |
| B16RW7 | 4/4/03 | H2152 | C3245 | 22.5 | 22.5 | Eberline | | 5/30/03 | 5/27/03 | Metals, general chemistry, VOA, SVOA, rad, TPH |
| B16RW8 | 4/4/03 | H2152 | C3245 | 22.5 | B16RW8 is a duplicate of B16RW7 | Eberline | | 5/30/03 | 5/27/03 | Nitrate/nitrite, $Cr^{+6}$, oil/grease, rad |
| B16RY0 | 4/7/03 | WSCF20030470 | C3245 | 27.5 | 27.5 | WSCF | 5/28/03 | | | Metals, general chemistry, VOA, SVOA, rad, TPH |
| B16RY0 | 4/7/03 | WSCF20031181 | C3245 | 27.5 | 27.5 | WSCF | 10/22/03 | | | Metals, general chemistry, VOA, SVOA, rad, TPH |
| B16RW9 | 4/7/03 | H2152 | C3245 | 27.5 | 27.5 | Eberline | | 5/30/03 | 5/27/03 | Nitrate/nitrite, $Cr^{+6}$, oil/grease, rad |

Table 2-1. Sample Data, 216-A-19 Trench (200-PW2 Borehole C3245). (3 sheets)

| HEIS | Date Collected | Data Package | Site | Depth Collected (ft bgs) | Depth Planned (ft bgs) | Lab | Sample Data Received | | | Sample Analyses Performed |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | WSCF | Eberline | Lionville | |
| B16RY8 | 4/7/03 | H2155 | C3245 | 27.5 | 27.5 | Maxim | | 6/16/03 | | % moisture, particle size |
| B16RY1 | 4/7/03 | WSCF20030470 | C3245 | 32.5 | 32.5 | WSCF | 5/28/03 | | | Metals, general chemistry, VOA, SVOA, rad, TPH |
| B16RY1 | 4/7/03 | WSCF20031181 | C3245 | 32.5 | 32.5 | WSCF | 10/22/03 | | | Metals, general chemistry, VOA, SVOA, rad, TPH |
| B16RX0 | 4/7/03 | H2152 | C3245 | 32.5 | 32.5 | Eberline | | 5/30/03 | 5/27/03 | Nitrate/nitrite, $Cr^{+6}$, oil/grease, rad |
| B16RY2 | 4/7/03 | WSCF20030470 | C3245 | 47.5 | 47.5 | WSCF | 5/28/03 | | | Metals, general chemistry, VOA, SVOA, rad, TPH |
| B16RY2 | 4/7/03 | WSCF20031181 | C3245 | 47.5 | 47.5 | WSCF | 10/22/03 | | | Metals, general chemistry, VOA, SVOA, rad, TPH |
| B16RX1 | 4/7/03 | H2152 | C3245 | 47.5 | 47.5 | Eberline | | 5/30/03 | 5/27/03 | Nitrate/nitrite, $Cr^{+6}$, oil/grease, rad |
| B16RY3 | 4/9/03 | WSCF20030492 | C3245 | 97.5 | 97.5 | WSCF | 5/28/03 | | | Metals, general chemistry., VOA, SVOA, rad, TPH |
| B16RY3 | 4/9/03 | WSCF20031181 | C3245 | 97.5 | 97.5 | WSCF | 10/22/03 | | | Metals, general chemistry., VOA, SVOA, rad, TPH |
| B16RX2 | 4/9/03 | H2163 | C3245 | 97.5 | 97.5 | Eberline | | 6/02/03 | 5/27/03 | Nitrate/nitrite, $Cr^{+6}$, oil/grease, rad |
| B16RY9 | 4/9/03 | H2168 | C3245 | 97.5 | 97.5 | Maxim | | 6/16/03 | | % moisture, particle size |
| B16RY4 | 4/16/03 | WSCF20030515 | C3245 | 207.5 | 207.5 | WSCF | 6/03/03 | | | Metals, general chemistry., VOA, SVOA, rad, TPH |
| B16RY4 | 4/16/03 | WSCF20031181 | C3245 | 207.5 | 207.5 | WSCF | 10/22/03 | | | Metals, general chemistry., VOA, SVOA, rad, TPH |
| B16RX3 | 4/16/03 | H2178 | C3245 | 207.5s | 207.5 | Eberline | | 6/06/03 | 5/27/03 | Nitrate/nitrite, $Cr^{+6}$, oil/grease, rad |
| B16RY5 | 4/17/03 | WSCF20030524 | C3245 | 242.5 | 242.5 | WSCF | 6/03/03 | | | Metals, general chemistry, VOA, SVOA, rad, TPH |
| B16RY5 | 4/17/03 | WSCF20031181 | C3245 | 242.5 | 242.5 | WSCF | 10/22/03 | | | Metals, general chem, VOA, SVOA, rad, TPH |
| B16RX4 | 4/17/03 | H2178 | C3245 | 242.5 | 242.5 | Eberline | | 6/06/03 | 5/27/03 | Nitrate/nitrite, $Cr^{+6}$, oil/grease, rad |
| B16T00 | 4/17/03 | H2185 | C3245 | 242.5 | 242.5 | Maxim | | 6/15/03 | | % moisture, particle size |
| B16VV9 | 4/17/03 | WSCF20030524 | C3245 | 248 | 248 | WSCF | 6/03/03 | | | Metals, general chemistry VOA, SVOA, rad, TPH, oil/grease |
| B16VV9 | 4/17/03 | WSCF20031183 | C3245 | 248s | 248 | WSCF | 10/22/03 | | | Metals, general chemistry VOA, SVOA, rad, TPH, oil/grease |
| B16RX5 | 4/17/03 | H2178 | C3245 | 248s | 248 | Eberline | | 6/06/03 | 5/27/03 | Nitrate/nitrite, $Cr^{+6}$, oil/grease, rad |

Table 2-1. Sample Data, 216-A-19 Trench (200-PW2 Borehole C3245). (3 sheets)

| HEIS | Date Collected | Data Package | Site | Depth Collected (ft bgs) | Depth Planned (ft bgs) | Lab | Sample Data Received | | | Sample Analyses Performed |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | WSCF | Eberline | Lionville | |
| B16T01 | 4/17/03 | H2185 | C3245 | 248 | 248 | Maxim | | 6/30/03 | | % moisture, particle size |

The analyses were performed by Eberline Services, Richmond, California; Maxim Technologies, Inc., St. Louis, Missouri; Lionville Laboratory, Inc., Exton, Pennsylvania; Severn Trent Laboratories, Inc., Earth City, Missouri; Shaw Group, Inc. – Geotechnical Laboratory, Oak Ridge, Tennessee, and WSCF – Hanford Site, Richland, Washington.

$Cr^{+6}$ (hexavalent chromium) is analyzed by EPA method 7196.

General chemistry analysis is done by any or all of the following EPA methods: 150.1 pH,; 300.0 Anions; 300.7 Ammonium; 335.2 Cyanide; 350.3 Ammonia; 353.1 or 353.2, Nitrate/Nitrite; 9010 Cyanide; 9040 or 9045 pH. Not all samples were analyzed for the same suite of general chemistry analyses.

Metals are analyzed by any or all of the following EPA methods: 200.8 Metals, 6010 Metals; 7196, Hexavalent Chromium; 7471 Mercury. Not all samples were analyzed for the same suite of metals.

Nitrate/nitrite is analyzed by EPA methods 353.1 or 353.2.

Oil/grease are analyzed by any or all of the following EPA methods: 413.1, 9071.

Particle size is analyzed by ASTM method D422.

Polychlorinated biphenyls, and are analyzed under EPA method 8082.

Percent moisture is analyzed by EPA SW 846 and ASTM D2216 methods.

Pesticides and herbicides; analyses are performed under EPA method 8081 for pesticides and 8151 for herbicides.

Radionuclide, include gamma count and specialized methods of analyses for some specific radionuclides. Not all samples were analyzed for the same suite of radionuclides.

Semi volatile organic analyses are performed under EPA method 8270. Not all samples were analyzed for the same suite of SVOAs.

Total petroleum hydrocarbons analyses are performed for both diesel and gasoline range.

Volatile organic analyses are performed by any or all of the following EPA methods: 8015 or 8260. Not all samples were analyzed for the same suite of VOAs.

Data packages WSCF20030459, H2152 and WSCF20030461 are for data validation.

ASTM D422-63 (1998), *Standard Test Method for Particle-Size Analysis of Soils.*

ASTM D2216-98, *Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.*

SW-846, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*

ASTM = American Society of Mechanical Engineers.
Bgs= Below ground surface.
EPA = U.S. Environmental Protection Agency
PCB = Polychlorinated biphenyl.
Pest/herb = Pesticides and/or herbicides
Rad = Radionuclides.
SVOA = Semivolatile organics analysis.
TPH = Total petroleum hydrocarbons.
VOA = Volatile organics analysis.

Table 2-2. Sample Data, 216-A-37-1 Crib (200-PW-4 Borehole C4106). (3 sheets)

| HEIS | Date Collected | Data Package | Site | Depth Collected (ft bgs) | Depth Planned (ft bgs) | Lab | Sample Data Received | | | Sample Analyses Performed |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | WSCF | Eberline | Lionville | |
| B16W91 | 4/28/03 | H2194 | C4106 | 0.5 | 0.5' | Eberline | | 6/27/03 | | Pest/herb |
| B16W93 | 4/28/03 | WSCF20030588 | C4106 | 12.5 | 12.5 | WSCF | 6/11/03 | | | Metals, general chem, PCB, VOA, SVOA, rad |
| B16W93 | 4/28/03 | WSCF20031183 | C4106 | 12.5 | 12.5 | WSCF | 9/22/03 | | | Metals, general chem, PCB, VOA, SVOA, rad |
| B16W79 | 4/28/03 | H2194 | C4106 | 12.5 | 12.5 | Eberline | | 6/18/03 | 6/27/03 | Metals, general chem, PCB, VOA, SVOA, rad, TPH, oil/grease |
| B16WB8 | 4/23/03 | H2184 | C4106 | B16WB8 is an equipment blank QC sample tied to B16W93. | | Eberline | | 6/11/03 | 5/27/03 | Ammonia, nitrate/nitrite, oil/grease, rad |
| B16WC0 | 4/23/03 | WSCF20030567 | C4106 | B16WC0 is an equipment blank QC sample tied to B16W79. | | WSCF | 6/11/03 | | | Metals, general chem, VOA, PCB, SVOA, rad, TPH |
| B16W94 | 4/28/03 | WSCF20030588 | C4106 | 17.5s | 17.5 | WSCF | 6/11/03 | | | Metals, general chem, PCB, VOA, SVOA, rad |
| B16W95 | 4/28/03 | WSCF20030588 | C4106 | 17.5 | 17.5 | WSCF | 6/11/03 | | | Metals, general chem, PCB, VOA, SVOA, rad |
| B16W94 | 4/28/03 | WSCF20031183 | C4106 | 17.5 | 17.5 | WSCF | 9/22/03 | | | Metals, general chem, PCB, VOA, SVOA, rad |
| B16W95 | 4/28/03 | WSCF20031183 | C4106 | 17.5 | B16W95 is a duplicate of B16W94 | WSCF | 9/22/03 | | | Metals, general chem, PCB, VOA, SVOA, rad |
| B16W80 | 4/28/03 | H2194 | C4106 | 17.5 | 17.5 | Eberline | | 6/18/03 | 6/27/03 | Metals, general chem, PCB, VOA, SVOA, rad, TPH, oil/grease |
| B16W90 | 4/28/03 | H2194 | C4106 | 17.5 | B16W90 is a duplicate of B16W80. | Eberline | | 6/18/03 | 6/27/03 | Metals, general chem, PCB, VOA, SVOA, rad, TPH, oil/grease |
| B16W96 | 4/29/03 | WSCF20030598 | C4106 | 27.5 | 27.5 | WSCF | 6/11/03 | | | Metals, general chem, PCB, VOA, SVOA, rad, TPH |
| B16W96 | 4/29/03 | WSCF20031183 | C4106 | 27.5 | 27.5 | WSCF | 9/22/03 | | | Metals, general chem, PCB, VOA, SVOA, rad, TPH |
| B16W81 | 4/29/03 | H2194 | C4106 | 27.5 | 27.5 | Eberline | | 6/18/03 | 6/27/03 | Metals, general chem, PCB, VOA, SVOA, rad, TPH, oil/grease |
| B16W97 | 4/29/03 | WSCF20030598 | C4106 | 37.5 | 37.5 | WSCF | 6/11/03 | | | Metals, general chem, PCB, VOA, SVOA, rad, TPH |
| B16W97 | 4/29/03 | WSCF20031183 | C4106 | 37.5 | 37.5 | WSCF | 9/22/03 | | | Metals, general chem, PCB, VOA, SVOA, rad, TPH |

Table 2-2. Sample Data, 216-A-37-1 Crib (200-PW-4 Borehole C4106). (3 sheets)

| HEIS | Date Collected | Data Package | Site | Depth Collected (ft bgs) | Depth Planned (ft bgs) | Lab | Sample Data Received | | | Sample Analyses Performed |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | WSCF | Eberline | Lionville | |
| B16W82 | 4/29/03 | H2194 | C4106 | 37.5 | 37.5 | Eberline | | 6/18/03 | 6/27/03 | Metals, general chem, PCB, VOA, SVOA, rad, TPH, oil/grease |
| B16W98 | 4/29/03 | WSCF20030598 | C4106 | 47.5 | 47.5 | WSCF | 6/11/03 | | | Metals, general chem, PCB, VOA, SVOA, rad, TPH |
| B16W98 | 4/29/03 | WSCF20031183 | C4106 | 47.5 | 47.5 | WSCF | 9/22/03 | | | Metals, general chem, PCB, VOA, SVOA, rad, TPH |
| B16W83 | 4/29/03 | H2194 | C4106 | 47.5 | 47.5 | Eberline | | 6/18/03 | 6/27/03 | Metals, general chem, PCB, VOA, SVOA, rad, TPH, oil/grease |
| B16W99 | 4/30/03 | WSCF20030613 | C4106 | 72.5 | 72.5 | WSCF | 6/17/03 | | | Metals, general chem, PCB, VOA, SVOA, rad, TPH |
| B16W99 | 4/30/03 | WSCF20031183 | C4106 | 72.5 | 72.5 | WSCF | 9/22/03 | | | Metals, general chem, PCB, VOA, SVOA, rad, TPH |
| B16W84 | 4/30/03 | H2195 | C4106 | 72.5 | 72.5 | Eberline | | 7/15/03 | 6/27/03 | Metals, general chem, PCB, VOA, SVOA, rad, TPH, oil/grease |
| B16WB9 | 4/30/03 | WSCF20030612 | C4106 | 72.5' bgs | 72.5 | WSCF | | Not Run | | B16WB9 was intended to be a trip blank QC sample tied to B16W99. However, this sample was cancelled. |
| B16WB0 | 4/30/03 | WSCF20030613 | C4106 | 97.5 | 97.5 | WSCF | 6/17/03 | | | Metals, general chem, PCB, VOA, SVOA, rad, TPH |
| B16WB0 | 4/30/03 | WSCF20031183 | C4106 | 97.5 | 97.5 | WSCF | 9/22/03 | | | Metals, general chem, PCB, VOA, SVOA, rad, TPH |
| B16W85 | 4/30/03 | H2195 | C4106 | 97.5 | 97.5 | Eberline | | 7/15/03 | 6/27/03 | Metals, general chem, PCB, VOA, SVOA, rad, TPH, oil/grease |
| B16WB1 | 5/5/03 | WSCF20030630 | C4106 | 147.5 | 147.5 | WSCF | 6/17/03 | | | Metals, general chem, PCB, VOA, SVOA, rad, TPH |
| B16WB1 | 5/5/03 | WSCF20031183 | C4106 | 147.5 | 147.5 | WSCF | 9/22/03 | | | Metals, general chem, PCB, VOA, SVOA, rad, TPH |
| B16W86 | 5/5/03 | H2195 | C4106 | 147.5 | 147.5 | Eberline | | 7/15/03 | 6/27/03 | Metals, general chem, PCB, VOA, SVOA, rad, TPH, oil/grease |
| B16WB5 | 5/5/03 | H2203 | C4106 | 147.5 | 147.5 | Maxim | | 6/30/03 | | % moisture |
| B16WB2 | 5/6/03 | WSCF20030642 | C4106 | 197.5 | 197.5 | WSCF | 6/17/03 | | | Metals, general chem, PCB, VOA, SVOA, rad, TPH |
| B16WB2 | 5/6/03 | WSCF20031183 | C4106 | 197.5 | 197.5 | WSCF | 9/22/03 | | | Metals, general chem, PCB, VOA, SVOA, rad, TPH |
| B16W87 | 5/6/03 | H2195 | C4106 | 197.5 | 197.5 | Eberline | | 7/15/03 | 6/27/03 | Metals, general chem, PCB, VOA, SVOA, rad, TPH, oil/grease |

Table 2-2. Sample Data, 216-A-37-1 Crib (200-PW-4 Borehole C4106). (3 sheets)

| HEIS | Date Collected | Data Package | Site | Depth Collected (ft bgs) | Depth Planned (ft bgs) | Lab | Sample Data Received | | | Sample Analyses Performed |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | WSCF | Eberline | Llonville | |
| B16WB6 | 5/6/03 | H2203 | C4106 | 197.5 | 197.5s | Maxim | | 6/30/03 | | % moisture |
| B16WB3 | 5/7/03 | H2208 | C4106 | 237 | 237 | Eberline | | 7/7/03 | | Rad |
| B16W88 | 5/7/03 | H2195 | C4106 | 237 | 237 | Eberline | | 7/15/03 | 6/27/03 | Metals, general chem, PCB, VOA, SVOA, rad, TPH, oil/grease |
| B16WB4 | 5/8/03 | H2208 | C4106 | 272.5 | 272.5 | Eberline | | 7/7/03 | | Metals, general chem, PCB, VOA, SVOA, rad, TPH |
| B16W89 | 5/8/03 | H2208 | C4106 | 272.5 | 272.5 | Eberline | | 7/7/03 | 7/02/03 | Nitrate/nitrite, $Cr^{+6}$, oil/grease, rad |
| B16WB7 | 5/8/03 | H2209 | C4106 | 272.5 | 272.5 | Maxim | | 6/30/03 | | % moisture |

The analyses were performed by Eberline Services, Richmond, California; Maxim Technologies, Inc., St. Louis, Missouri; Lionville Laboratory, Inc., Exton, Pennsylvania; Severn Trent Laboratories, Inc., Earth City, Missouri; Shaw Group, Inc. – Geotechnical Laboratory, Oak Ridge, Tennessee, and WSCF – Hanford Site, Richland, Washington.

$Cr^{+6}$ (hexavalent chromium) is analyzed by EPA method 7196.

General chemistry analysis is done by any or all of the following EPA methods: 150.1 pH,; 300.0 Anions; 300.7 Ammonium; 335.2 Cyanide; 350.3 Ammonia; 353.1 or 353.2, Nitrate/Nitrite; 9010 Cyanide; 9040 or 9045 pH. Not all samples were analyzed for the same suite of general chemistry analyses.

Metals are analyzed by any or all of the following EPA methods: 200.8 Metals, 6010 Metals; 7196, Hexavalent Chromium; 7471 Mercury. Not all samples were analyzed for the same suite of metals.

Nitrate/nitrite is analyzed by EPA methods 353.1 or 353.2.

Oil/grease are analyzed by any or all of the following EPA methods: 413.1, 9071.

Particle size is analyzed by ASTM method D422.

Polychlorinated biphenyls, and are analyzed under EPA method 8082.

Percent moisture is analyzed by EPA SW 846 and ASTM D2216 methods.

Pesticides and herbicides; analyses are performed under EPA method 8081 for pesticides and 8151 for herbicides.

Radionuclide, include gamma count and specialized methods of analyses for some specific radionuclides. Not all samples were analyzed for the same suite of radionuclides.

Semi volatile organic analyses are performed under EPA method 8270. Not all samples were analyzed for the same suite of SVOAs.

Total petroleum hydrocarbons analyses are performed for both diesel and gasoline range.

Volatile organic analyses are performed by any or all of the following EPA methods: 8015 or 8260. Not all samples were analyzed for the same suite of VOAs.

Data packages WSCF20030459, H2152 and WSCF20030461 are for data validation.

ASTM D422-63 (1998), *Standard Test Method for Particle-Size Analysis of Soils.*

ASTM D2216-98, *Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.*

SW-846, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ASTM | = | American Society of Mechanical Engineers. | PCB | = | Polychlorinated biphenyl. | SVOA | = | Semivolatile organics analysis. |
| Bgs | = | Below ground surface. | Pest/herb | = | Pesticides and/or herbicides | TPH | = | Total petroleum hydrocarbons. |
| EPA | = | U.S. Environmental Protection Agency | Rad | = | Radionuclides | VOA | = | Volatile organics analysis. |

Table 2-3. Sample Data, 216-B-12 Crib (200-PW-2 Borehole C3246). (3 sheets)

| HEIS | Date Collected | Data Package | Site | Depth Collected (ft bgs) | Depth Planned (ft bgs) | Lab | Sample Data Received | | | Sample Analyses Performed |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | WSCF | Eberline | Lionville (Severn Trent) | |
| B171B7 | 4/4/03 | H2250 | C3246 | 0.5 | 0.5 | Eberline | | NA | 7/14/03 | Pest/herb |
| B171B8 | 5/29/03 | H2250 | C3246 | 14.5 | 14.5 | Eberline | | 7/28/03 | 7/14/03 | Metals, general chem,, VOA, SVOA, oil/grease, rad, TPH |
| B171B9 | 5/30/03 | WSCF20030757 | C3246 | 35.5 | 30 | WSCF | 7/9/03 | | | Waste designation sample. Metals, general chem, PCB, VOA, SVOA, rad, TPH, oil/grease |
| B171B9 | 5/30/03 | WSCF20031183 | C3246 | 35.5 | 30 | WSCF | 9/22/03 | | | Metals, general chem, PCB, VOA, SVOA, rad, TPH, oil/grease |
| B171B9-B | 5/30/03 | H2255 | C3246 | 35.5 | 30 | Eberline | | 7/23/03 | | Rad |
| B171B9-A | 5/30/03 | W03975 | C3246 | 35.5 | 30 | Severn Trent | | | (6/30/03) | Nitrate/nitrite, $Cr^{+6}$, VOA, oil/grease |
| B171B1 | 5/21/03 | WSCF20030699 | C3246 | B171B1 is an equipment blank QC sample tied to B171B9-A. | | WSCF | 6/24/03 | | | Metals, general chem, PCB, VOA, SVOA, rad, TPH, oil/grease |
| B171B3 | 5/21/03 | H2230 | C3246 | B171B3 is an equipment blank QC sample tied to B171B9-B. | | Eberline | | 7/09/03 | 6/13/03 | Ammonia, Nitrate/nitrite, rad |
| B171C0 | 5/30/03 | WSCF20030757 | C3246 | 40 | 40 | WSCF | 7/9/03 | | | Metals, general chem, PCB, VOA, SVOA, rad, TPH, oil/grease |
| B171C0 | 5/30/03 | WSCF20031183 | C3246 | 40 | 40 | WSCF | 9/22/03 | | | Metals, general chem, PCB, VOA, SVOA, rad, TPH, oil/grease |
| B171C0-B | 5/30/03 | H2255 | C3246 | 40 | 40 | Eberline | | 7/23/03 | | Rad |
| B171C0-A | 5/30/03 | W03975 | C3246 | 40 | 40 | Severn Trent | | | (6/30/03) | Nitrate/nitrite, $Cr^{+6}$, oil/grease |
| B17216 | 5/31/03 | WSCF20030757 | C3246 | 50 | 50 | WSCF | 7/9/03 | | | Metals, general chem, 8015 VOA, SVOA, oil/grease, rad, TPH |
| B17216 | 5/31/03 | WSCF20031183 | C3246 | 50 | 50 | WSCF | 9/22/03 | | | Metals, general chem, 8015 VOA, SVOA, oil/grease, rad, TPH |
| B17216-B | 5/31/03 | H2255 | C3246 | 50 | 50 | Eberline | | 7/23/03 | | Rad |
| B17216-A | 5/31/03 | W03975 | C3246 | 50 | 50 | Severn Trent | | | (6/30/03) | Nitrate/nitrite, $Cr^{+6}$, VOA, oil/grease |
| B17217 | 5/31/03 | WSCF20030757 | C3246 | 62.5 | 62.5 | WSCF | 7/9/03 | | | Metals, general chem, 8015 VOA, |

Table 2-3. Sample Data, 216-B-12 Crib (200-PW-2 Borehole C3246). (3 sheets)

| HEIS | Date Collected | Data Package | Site | Depth Collected (ft bgs) | Depth Planned (ft bgs) | Lab | Sample Data Received | | | Sample Analyses Performed |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | WSCF | Eberline | Lionville (Severn Trent) | |
| | | | | | | | | | | SVOA, oil/grease, rad, TPH |
| B17217 | 5/31/03 | WSCF20031183 | C3246 | 62.5 | 62.5 | WSCF | 9/22/03 | | | Metals, general chem, 8015 VOA, SVOA, oil/grease, rad, TPH |
| B17217-B | 5/31/03 | H2255 | C3246 | 62.5 | 62.5 | Eberline | | 7/23/03 | | Rad |
| B17217-A | 5/31/03 | W03975 | C3246 | 62.5 | 62.5 | Severn Trent | | | (6/30/03) | Nitrate/nitrite, $Cr^{+6}$, 8015 VOA, oil/grease |
| B17218 | 6/3/03 | WSCF20030757 | C3246 | 94.5 | 94.5 | WSCF | 7/9/03 | | | Metals, general chem, SVOA, oil/grease, rad, TPH |
| B17218 | 6/3/03 | WSCF20031183 | C3246 | 94.5 | 94.5 | WSCF | 9/22/03 | | | Metals, general chem, SVOA, oil/grease, rad, TPH |
| B171C1 | 6/3/03 | WSCF20030757 | C3246 | 94.5 | B171C1 is a duplicate sample of B17218 | WSCF | 7/9/03 | | | Metals, general chem, SVOA, oil/grease, rad, TPH |
| B171C1 | 6/3/03 | WSCF20031183 | C3246 | 94.5 | 94.5 | WSCF | 9/22/03 | | | Metals, general chem, SVOA, oil/grease, rad, TPH |
| B17218-B | 6/3/03 | H2250 | C3246 | 94.5 | 94.5 | Eberline | | 7/28/03 | | Rad |
| B171C1-B | 6/3/03 | H2250 | C3246 | 94.5 | B171C1-B is a duplicate sample of B17218-B. | Eberline | | 7/28/03 | | Rad |
| B17218-A | 6/3/03 | W03975 | C3246 | 94.5 | 94.5 | Severn Trent | | | (6/30/03) | Nitrate/nitrite, $Cr^{+6}$, oil/grease |
| B171C1-A | 6/3/03 | W03975 | C3246 | 94.5 | B171C1-A is a duplicate of B17218-A. | Severn Trent | | | (6/30/03) | Nitrate/nitrite, $Cr^{+6}$, oil/grease |
| B171M8 | 6/03/03 | H2380 | C3246 | 94.5 | 94.5 | Shaw | | 10/10/03 | | % solids, % moisture, particle size |
| B161C2 | 6/11/03 | H2264 | C3246 | 197.5 | 197.5 | Eberline | | 8/5/03 | 7/30/03 | Metals, general chem, VOA, SVOA, oil/grease, rad, TPH |
| B172K2 | 6/11/03 | H2267 | C3246 | 197.5 | B172K2 is a trip blank QC sample tied to | Eberline | | | 7/14/03 | VOA |

Table 2-3. Sample Data, 216-B-12 Crib (200-PW-2 Borehole C3246). (3 sheets)

| HEIS | Date Collected | Data Package | Site | Depth Collected (ft bgs) | Depth Planned (ft bgs) | Lab | Sample Data Received | | | Sample Analyses Performed |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | WSCF | Eberline | Lionville (Severn Trent) | |
| | | | | | B161C2. | | | | | |
| B161C3 | 6/13/03 | H2268 | C3246 | 247.5 | 247.5 | Eberline | | 8/6/03 | 7/30/03 | Metals, general chem, VOA, SVOA, oil/grease, rad, TPH |
| B161C4 | 6/18/03 | H2268 | C3246 | 302 | 294.5 | Eberline | | 8/6/03 | 7/30/03 | Metals, general chem, VOA, SVOA, oil/grease, rad, TPH |
| B171M9 | 6/18/03 | H2380 | C3246 | 302 | 294.5 | Shaw | | 10/10/03 | | % solids, % moisture, particle size |

The analyses were performed by Eberline Services, Richmond, California; Maxim Technologies, Inc., St. Louis, Missouri; Lionville Laboratory, Inc., Exton, Pennsylvania; Severn Trent Laboratories, Inc., Earth City, Missouri; Shaw Group, Inc. – Geotechnical Laboratory, Oak Ridge, Tennessee, and WSCF – Hanford Site, Richland, Washington.

$Cr^{+6}$ (hexavalent chromium) is analyzed by EPA method 7196.

General chemistry analysis is done by any or all of the following EPA methods: 150.1 pH,; 300.0 Anions; 300.7 Ammonium; 335.2 Cyanide; 350.3 Ammonia; 353.1 or 353.2, Nitrate/Nitrite; 9010 Cyanide; 9040 or 9045 pH. Not all samples were analyzed for the same suite of general chemistry analyses.

Metals are analyzed by any or all of the following EPA methods: 200.8 Metals, 6010 Metals; 7196, Hexavalent Chromium; 7471 Mercury. Not all samples were analyzed for the same suite of metals.

Nitrate/nitrite is analyzed by EPA methods 353.1 or 353.2.

Oil/grease are analyzed by any or all of the following EPA methods: 413.1, 9071.

Particle size is analyzed by ASTM method D422.

Polychlorinated biphenyls, and are analyzed under EPA method 8082.

Percent moisture is analyzed by EPA SW 846 and ASTM D2216 methods.

Pesticides and herbicides; analyses are performed under EPA method 8081 for pesticides and 8151 for herbicides.

Radionuclide, include gamma count and specialized methods of analyses for some specific radionuclides. Not all samples were analyzed for the same suite of radionuclides.

Semi volatile organic analyses are performed under EPA method 8270. Not all samples were analyzed for the same suite of SVOAs.

Total petroleum hydrocarbons analyses are performed for both diesel and gasoline range.

Volatile organic analyses are performed by any or all of the following EPA methods: 8015 or 8260. Not all samples were analyzed for the same suite of VOAs.

Data packages WSCF20030459, H2152 and WSCF20030461 are for data validation.

ASTM D422-63 (1998), *Standard Test Method for Particle-Size Analysis of Soils.*

ASTM D2216-98, *Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.*

SW-846, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ASTM = | American Society of Mechanical Engineers. | PCB | = | Polychlorinated biphenyl. | SVOA = | Semivolatile organics analysis. |
| Bgs = | Below ground surface. | Pest/herb | = | Pesticides and/or herbicides | TPH = | Total petroleum hydrocarbons. |
| EPA = | U.S. Environmental Protection Agency | Rad | = | Radionuclides | VOA = | Volatile organics analysis. |

Table 2-4. Sample Data, 216-A-36B Crib (200-PW-2 Borehole C3248/C4160) (4 sheets).

| HEIS | Date Collected | Data Package | Site | Depth Collected (ft bgs) | Depth Planned (ft bgs) | Lab | Sample Data Received | | | Sample Analyses Performed |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | WSCF | Eberline | Lionville (Severn Trent) | |
| B173T4 | 6/30/03 | H2275 | C3248 | 0.5 | 0.5 | Eberline | | 8/27/03 | | Herb/pest |
| B173T7 | 7/1/03 | WSCF20030863 | C3248 | 12.5 | 12.5 | WSCF | 8/11/03 | | | Metals, general chem, PCB, VOA, SVOA, rad, TPH |
| B173T6 | 7/1/03 | H2275 | C3248 | 12.5 | 12.5 | Eberline | | 8/27/03 | | Nitrate/nitrite, $Cr^{+6}$, oil/grease, rad |
| B17486 | 7/1/03 | WSCF2003 | C3248 | 24 | 24 | WSCF | 8/11/03 | | | Metals, general chem, PCB, VOA, SVOA, rad, TPH |
| B17487 | 7/7/03 | 222S20030251 | C4160 | 25 | 24 | 222-S | 10/14/03 | | | Metals, general chem, PCB, VOA, SVOA, rad |
| B17D43 | 7/7/03 | H2328 | C4160 | 25 | 24 | Eberline | | 10/23/03 | | Rad |
| B17976 | 7/29/03 | 222S20030251 | C4160 | 27.5 | | 222-S | 10/14/03 | | | Rad |
| B17976 | 7/29/03 | 222S20030248 | C4160 | 27.5 | | 222-S | 8/05/03 | | | Rad |
| B17D44 | 7/29/03 | H2328 | C4160 | 27.5 | | Eberline | | 10/23/03 | | Rad |
| B17978 | 7/29/03 | W03979 | C4160 | 27.5s | | Severn T | | | (9/05/03) | Metals, general chem, VOA, SVOA, oil/grease, TPH |
| B174B4 | 7/29/03 | W03979 | C4160 | 30 | 30 | Severn T | | | (9/05/03) | Metals, general chem, VOA, SVOA, oil/grease, TPH |
| B17D45 | 7/29/03 | H2328 | C4160 | 30 | 30 | Eberline | | 10/23/03 | | Rad |
| B171B2 | 5/21/03 | WSCF20030699 | C4160 | B171B2 is an equipment blank QC samples tied to B174B4. | | WSCF | 6/24/03 | | | Metals, general chem, VOA, SVOA, rad, TPH |
| B171B4 | 5/21/03 | H2230 | C4160 | B171B4 is an equipment blank QC samples tied to B17D45. | | Eberline | | 7/09/03 | 6/13/03 | Ammonia, nitrate/nitrite, rad |
| B173V2 | 7/30/03 | WSCF20031045 | C4160 | 40 | 40 | WSCF | 9/9/03 | | | Metals, general chem., PCB, rad |
| B173V9 | 7/30/03 | H2310 | C4160 | 40' bgs | 40 | Eberline | | 9/29/03 | | Rad |
| B17BY9 | 7/30/03 | W04086 | C4160 | 40 | 40 | Severn T | | | (9/22/03) | Rad |
| B173V3 | 7/31/03 | WSCF20031045 | C4160 | 53.5 | 53.5 | WSCF | 9/9/03 | | | Metal, general chem. VOA, PCB, SVOA, rad, TPH |

Table 2-4. Sample Data, 216-A-36B Crib (200-PW-2 Borehole C3248/C4160) (4 sheets).

| HEIS | Date Collected | Data Package | Site | Depth Collected (ft bgs) | Depth Planned (ft bgs) | Lab | Sample Data Received | | | Sample Analyses Performed |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | WSCF | Eberline | Lionville (Severn Trent) | |
| B173V4 | 7/31/03 | WSCF20031045 | C4160 | 53.5 | B173V4 is a duplicate of B173V3 | WSCF | 9/9/03 | | | Metal, general chem. VOA, PCB, SVOA, rad, TPH |
| B173W0 | 7/31/03 | H2307 | C4160 | 53.5 | 53.5 | Eberline | | 9/22/03 | | Nitrate/nitrite, $Cr^{+6}$, oil/grease, rad |
| B173W1 | 7/31/03 | H2307 | C4160 | 53.5 | B173W1 is a duplicate of B173W0. | Eberline | | 9/22/03 | | Nitrate/nitrite, $Cr^{+6}$, oil/grease, rad |
| B173V5 | 8/4/03 | WSCF20031045 | C4160 | 89.5 | 89.5 | WSCF | 9/9/03 | | | Metal, general chem. VOA, PCB, SVOA, rad, TPH |
| B173W2 | 8/4/03 | H2307 | C4160 | 89.5 | 89.5 | Eberline | | 9/22/03 | | Nitrate/nitrite, $Cr^{+6}$, oil/grease, rad |
| B174B1 | 8/4/03 | H2380 | C4160 | 89.5 | 89.5 | Shaw | | 11/24/03 | | % solids, particle size |
| B173V6 | 8/13/03 | WSCF20031117 | C4160 | 197.5 | 197.5 | WSCF | 9/19/03 | | | Metal, general chem. VOA, PCB, SVOA, rad, TPH |
| B173W3 | 8/13/03 | H2314 | C4160 | 197.5s | 197.5 | Eberline | | 9/29/03 | 9/18/03 | Nitrate/nitrite, $Cr^{+6}$, oil/grease, rad |
| B173V7 | 8/22/03 | WSCF20031154 | C4160 | 287.5 | 287.5 | WSCF | 10/3/03 | | | Metal, general chem. VOA, PCB, SVOA, rad, TPH |
| B173W4 | 8/22/03 | H2320 | C4160 | 287.5 | 287.5 | Eberline | | 10/8/03 | 9/30/03 | Nitrate/nitrite, $Cr^{+6}$, oil/grease, rad |
| B174B2 | 8/22/03 | H2380 | C4160 | 287.5 | 287.5 | Shaw | | 11/24/03 | | % solids, particle size |
| B173V8 | 8/26/03 | WSCF20031165 | C4160 | 292 | 292 | WSCF | 10/3/03 | | | Metal, general chem. VOA, PCB, SVOA, rad, TPH |
| B173W5 | 8/26/03 | H2320 | C4160 | 292 | 292 | Eberline | | 10/8/03 | 9/30/03 | Nitrate/nitrite, $Cr^{+6}$, oil/grease, rad |
| B173W7 | 8/28/03 | WSCF20031193 | C4160 | 318.5 | 318.5 | WSCF | 10/3/03 | | | Metal, general chem. VOA, PCB, SVOA, rad, TPH |
| B173W6 | 8/28/03 | H2329 | C4160 | 318.5 | 318.5 | Eberline | | 10/23/03 | 9/30/03 | Nitrate/nitrite, $Cr^{+6}$, oil/grease, rad |

Table 2-4. Sample Data, 216-A-36B Crib (200-PW-2 Borehole C3248/C4160) (4 sheets).

| HEIS | Date Collected | Data Package | Site | Depth Collected (ft bgs) | Depth Planned (ft bgs) | Lab | Sample Data Received | | | Sample Analyses Performed |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | WSCF | Eberline | Lionville (Severn Trent) | |
| B174B3 | 8/28/03 | H2380 | C4160 | 318.5 | 318.5 | Shaw | | 11/24/03 | | % solids, particle size |

The analyses were performed by Eberline Services, Richmond, California; Maxim Technologies, Inc., St. Louis, Missouri; Lionville Laboratory, Inc., Exton, Pennsylvania; Severn Trent Laboratories, Inc., Earth City, Missouri; Shaw Group, Inc. – Geotechnical Laboratory, Oak Ridge, Tennessee, and WSCF – Hanford Site, Richland, Washington.

$Cr^{+6}$ (hexavalent chromium) is analyzed by EPA method 7196.

General chemistry analysis is done by any or all of the following EPA methods: 150.1 pH,; 300.0 Anions; 300.7 Ammonium; 335.2 Cyanide; 350.3 Ammonia; 353.1 or 353.2, Nitrate/Nitrite; 9010 Cyanide; 9040 or 9045 pH. Not all samples were analyzed for the same suite of general chemistry analyses.

Metals are analyzed by any or all of the following EPA methods: 200.8 Metals, 6010 Metals; 7196, Hexavalent Chromium; 7471 Mercury. Not all samples were analyzed for the same suite of metals.

Nitrate/nitrite is analyzed by EPA methods 353.1 or 353.2.

Oil/grease are analyzed by any or all of the following EPA methods: 413.1, 9071.

Particle size is analyzed by ASTM method D422.

Polychlorinated biphenyls, and are analyzed under EPA method 8082.

Percent moisture is analyzed by EPA SW 846 and ASTM D2216 methods.

Pesticides and herbicides; analyses are performed under EPA method 8081 for pesticides and 8151 for herbicides.

Radionuclide, include gamma count and specialized methods of analyses for some specific radionuclides. Not all samples were analyzed for the same suite of radionuclides.

Semi volatile organic analyses are performed under EPA method 8270. Not all samples were analyzed for the same suite of SVOAs.

Total petroleum hydrocarbons analyses are performed for both diesel and gasoline range.

Volatile organic analyses are performed by any or all of the following EPA methods: 8015 or 8260. Not all samples were analyzed for the same suite of VOAs.

Data packages WSCF20030459, H2152 and WSCF20030461 are for data validation.

ASTM D2216-98, *Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.*

SW-846, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ASTM | = | American Society of Mechanical Engineers. | PCB | = | Polychlorinated biphenyl. | SVOA | = | Semivolatile organics analysis. |
| Bgs | = | Below ground surface. | Pest/herb | = | Pesticides and/or herbicides | TPH | = | Total petroleum hydrocarbons. |
| EPA | = | U.S. Environmental Protection Agency | Rad | = | Radionuclides | VOA | = | Volatile organics analysis. |

Table 2-5. Sample Data, 216-A-10 Crib (200-PW-2 Borehole C3247) (3 sheets).

| HEIS | Date Collected | Data Package | Site | Depth Collected (ft bgs) | Depth Planned (ft bgs) | Lab | Sample Data Received | | | Sample Analyses Performed |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | WSCF | Eberline | Lionville (Severn Trent) | |
| B17112 | 5/15/03 | H2220 | C3247 | 0.5 | 0.5 | Eberline | | 7/7/03 | 7/7/03 | Pest/herb |
| B17113 | 5/15/03 | H2220 | C3247 | 12.5 | 12.5 | Eberline | | 7/7/03 | 7/7/03 | Metals, general chem., VOA, SVOA, rad, oil/grease, TPH |
| B17114 | 5/16/03 | H2220 | C3247 | 45 | 45 | Eberline | | 7/7/03 | 7/7/03 | Metals, general chem., VOA, SVOA, rad, oil/grease, TPH |
| B17110 | 5/14/03 | H2212 | C3247 | B17110 is a equipment blank QC sample tied to B17114. | | Eberline | | 7/7/03 | 7/2/03 | Metals, general chem., VOA, SVOA, rad, TPH |
| B17115 | 5/20/03 | H2242 | C3247 | 52 | 52 | Eberline | | 7/23/03 | 7/14/03 | Metals, general chem., VOA, SVOA, rad, oil/grease, TPH |
| B17124 | 5/20/03 | H2242 | C3247 | 54 | 54 | Eberline | | 7/23/03 | 7/14/03 | Metals, general chem., VOA, SVOA, rad, oil/grease, TPH |
| B17116 | 5/27/03 | H2242 | C3247 | 62.5 | 62.5 | Eberline | | 7/23/03 | 7/14/03 | Metals, general chem., VOA, SVOA, rad, oil/grease, TPH |
| B17123 | 5/27/03 | H2242 | C3247 | 62.5 | B17123 is a duplicate sample of B17116 | Eberline | | 7/23/03 | 7/14/03 | Metals, general chem., VOA, SVOA, rad, oil/grease, TPH |
| B17122 | 5/27/03 | H2250 | C3247 | 62.5 | 62.5 | Eberline | | 7/23/03 | 7/14/03 | B17122 was collected from soil in the drum. Analyzed for metals, general chem., VOA, SVOA, rad, oil/grease, TPH |
| B17117 | 9/18/03 | H2356 | C3247 | 72.5 | 72.5 | Eberline | | 10/27/03 | | Metals, general chem., VOA, SVOA, rad, oil/grease, TPH |
| B17125 | 9/18/03 | H2380 | C3247 | 72.5 | 72.5 | Shaw | | 11/24/03 | | % solids, % moisture, particle size |
| B17118 | 9/20/03 | H2356 | C3247 | 87.5 | 87.5 | Eberline | | 10/27/03 | | Metals, general chem., VOA, SVOA, rad, oil/grease, TPH |
| B17119 | 9/21/03 | H2356 | C3247 | 127.5 | 127.5 | Eberline | | 10/27/03 | | Metals, general chem., VOA, SVOA, rad, oil/grease, TPH |

Table 2-5. Sample Data, 216-A-10 Crib (200-PW-2 Borehole C3247) (3 sheets).

| HEIS | Date Collected | Data Package | Site | Depth Collected (ft bgs) | Depth Planned (ft bgs) | Lab | Sample Data Received | | | Sample Analyses Performed |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | WSCF | Eberline | Lionville (Severn Trent) | |
| B17120 | 9/25/03 | WSCF20031311 | C3247 | 197.5 | 197.5 | WSCF | 10/31/03 | | | Metals, general chem., VOA, SVOA, rad, oil/grease, TPH |
| B17111 | 9/25/03 | WSCF20031312 | C3247 | 197.5 | B17111 is a trip blank QC sample tied to B17120. | WSCF | 10/31/03 | | | SVOA |
| B17MH9 | 9/25/03 | H2365 | C3247 | 197.5 | 197.5 | Eberline | | 11/17/03 | 11/10/03 | Nitrate/nitrite, rad |
| B17121 | 10/1/03 | WSCF20031352 | C3247 | 287.5 | 287.5 | WSCF | 11/03/03 | | | Metals, general chem., VOA, SVOA, rad, oil/grease, TPH |
| B17MJ0 | 10/1/03 | H2395 | C3247 | 287.5 | 287.5 | Eberline | | 12/2/03 | 11/10/03 | % solids, % moisture |
| B172M8 | 10/1/03 | WSCF20031352 | C3247 | 292 | 292 | WSCF | 11/10/03 | | | Metals, general chem., VOA, PCB, SVOA, rad, oil/grease, TPH |
| B17MJ1 | 10/1/03 | H2395 | C3247 | 292 | 292 | Eberline | | 12/2/03 | 11/10/03 | Nitrate/nitrite, rad |
| B171B5 | 10/03/03 | WSCF20031349 | C3247 | 317 | 317 | WSCF | 11/06/03 | | | Metals, general chem., VOA, PCB, rad, oil/grease, TPH |
| B17MJ2 | 10/03/03 | H2395 | C3247 | 317 | 317 | Eberline | | 12/2/03 | 11/10/03 | Nitrate/nitrite, rad |

Table 2-5. Sample Data, 216-A-10 Crib (200-PW-2 Borehole C3247) (3 sheets).

| HEIS | Date Collected | Data Package | Site | Depth Collected (ft bgs) | Depth Planned (ft bgs) | Lab | Sample Data Received | | | Sample Analyses Performed |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | WSCF | Eberline | Lionville (Severn Trent) | |
| B17127 | 10/03/03 | H2394 | C3247 | 317 | 317 | Shaw | | 11/24/03 | | % solids, % moisture, particle size |

The analyses were performed by Eberline Services, Richmond, California; Maxim Technologies, Inc., St. Louis, Missouri; Lionville Laboratory, Inc., Exton, Pennsylvania; Severn Trent Laboratories, Inc., Earth City, Missouri; Shaw Group, Inc. – Geotechnical Laboratory, Oak Ridge, Tennessee, and WSCF – Hanford Site, Richland, Washington.

$Cr^{+6}$ (hexavalent chromium) is analyzed by EPA method 7196.

General chemistry analysis is done by any or all of the following EPA methods: 150.1 pH,; 300.0 Anions; 300.7 Ammonium; 335.2 Cyanide; 350.3 Ammonia; 353.1 or 353.2, Nitrate/Nitrite; 9010 Cyanide; 9040 or 9045 pH. Not all samples were analyzed for the same suite of general chemistry analyses.

Metals are analyzed by any or all of the following EPA methods: 200.8 Metals, 6010 Metals; 7196, Hexavalent Chromium; 7471 Mercury. Not all samples were analyzed for the same suite of metals.

Nitrate/nitrite is analyzed by EPA methods 353.1 or 353.2.

Oil/grease are analyzed by any or all of the following EPA methods: 413.1, 9071.

Particle size is analyzed by ASTM method D422.

Polychlorinated biphenyls, and are analyzed under EPA method 8082.

Percent moisture is analyzed by EPA SW 846 and ASTM D2216 methods.

Pesticides and herbicides; analyses are performed under EPA method 8081 for pesticides and 8151 for herbicides.

Radionuclide, include gamma count and specialized methods of analyses for some specific radionuclides. Not all samples were analyzed for the same suite of radionuclides.

Semi volatile organic analyses are performed under EPA method 8270. Not all samples were analyzed for the same suite of SVOAs.

Total petroleum hydrocarbons analyses are performed for both diesel and gasoline range.

Volatile organic analyses are performed by any or all of the following EPA methods: 8015 or 8260. Not all samples were analyzed for the same suite of VOAs.

Data packages WSCF20030459, H2152 and WSCF20030461 are for data validation.

ASTM D2216-98, *Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.*

SW-846, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ASTM = | American Society of Mechanical Engineers. | PCB | = | Polychlorinated biphenyl. | SVOA = | Semivolatile organics analysis. |
| Bgs = | Below ground surface. | Pest/herb | = | Pesticides and/or herbicides | TPH = | Total petroleum hydrocarbons. |
| EPA = | U.S. Environmental Protection Agency | Rad | = | Radionuclides | VOA = | Volatile organics analysis. |

Table 2-6. Sample Data, 207-A South Retention Basin (200-PW-4 Borehole C4113/C4114/C4115). (4 sheets)

| HEIS | Date Collected | Data Package | Site | Depth Collected | Depth Planned | Lab | Sample Data Received | | | Sample Analyses Performed |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | WSCF | Eberline | Lionville (Severn T) | |
| B17C43 | 8/13/03 | WSCF20031112 | C4113 | Concrete | Concrete | WSCF | 9/19/03 | | | Metals, general chem., VOA, PCB, SVOA, rad, TPH |
| B17C36 | 8/13/03 | H2317 | C4113 | Concrete | Concrete | Eberline | | 9/29/03 | 9/29/03 | Nitrate/nitrite, oil/grease, pest/herb, rad |
| B17C50 | 8/13/03 | W04103 | C4113 | Concrete | Concrete | Severn T | 9/29/03 | | | $Cr^{+6}$ |
| B174B6 | 8/13/03 | WSCF20031116 | C4113 | B174B6 is a trip blank QC sample that accompanied concrete samples B17C41, B17C42, and B17C43 | | WSCF | 9/11/03 | | | VOA |
| B17HR5 | 9/3/03 | WSCF20031219 | C4113 | 1-2' bgs | 1-2' bgs | WSCF | 10/9/03 | | | Metals, general chem., VOA, PCB, SVOA, rad, TPH |
| B17HR9 | 9/3/03 | H2329 | C4113 | 1-2' bgs | 1-2' bgs | Eberline | | 10/23/03 | 10/9/03 | Nitrate/nitrite, oil/grease, $Cr^{+6}$, pest/herb, rad |
| B17HR4 | 9/2/03 | WSCF20031204 | C4113 | B17HR3, B17HR4 and B17J04 are equipment blank QC samples tied to B17HR5 and B17HR9. | | WSCF | 10/13/03 | | | Metals, general chem., VOA, PCB, SVOA, rad, TPH |
| B17HR3 | 9/2/03 | H2330 | C4113 | | | WSCF | | 10/27/03 | 10/9/03 | Ammonia, Nitrate/nitrite, pest/herb, rad |
| B17J04 | 9/2/03 | W04111 | C4113 | | | WSCF | | | (9/09/03) | Metals, general chem., VOA, PCB, SVOA, rad, TPH |
| B17J01 | 9/6/03 | H2380 | C4113 | 1-2' bgs | 1-2' bgs | Shaw | | 11/24/03 | | % solids, % moisture |
| B17HR6 | 9/3/03 | WSCF20031219 | C4113 | 2-3' bgs | 2-3' bgs | WSCF | 10/9/03 | | | Metals, general chem., VOA, PCB, SVOA, rad, TPH |
| B17HT0 | 9/3/03 | H2329 | C4113 | 2-3' bgs | 2-3' bgs | Eberline | | 10/23/03 | 10/9/03 | Nitrate/nitrite, oil/grease, $Cr^{+6}$, rad |

Table 2-6. Sample Data, 207-A South Retention Basin (200-PW-4 Borehole C4113/C4114/C4115). (4 sheets)

| HEIS | Date Collected | Data Package | Site | Depth Collected | Depth Planned | Lab | Sample Data Received | | | Sample Analyses Performed |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | WSCF | Eberline | Lionville (Severn T) | |
| B17HR7 | 9/3/03 | WSCF20031219 | C4113 | 6-7' bgs | 7-8' bgs | WSCF | 10/9/03 | | | Metals, general chem., VOA, PCB, SVOA, rad, TPH |
| B17HT1 | 9/3/03 | H2329 | C4113 | 6-7' bgs | 7-8' bgs | Eberline | | 10/23/03 | 10/9/03 | Nitrate/nitrite, oil/grease, $Cr^{+6}$, rad |
| B17J07 | 9/6/03 | H2380 | C4113 | 7-8' bgs | 7-8' bgs | Shaw | | 11/24/03 | | % solids, % moisture |
| B17HR8 | 9/10/03 | WSCF20031244 | C4113 | 12.5-13.5' bgs | 13-14' bgs | WSCF | 10/14/03 | | | Metals, general chem., VOA, PCB, SVOA, rad, TPH |
| B17HT2 | 9/10/03 | H2335 | C4113 | 12.5-13.5' bgs | 13-14' bgs | Eberline | | 10/27/03 | 10/2/03 | Nitrate/nitrite, oil/grease, $Cr^{+6}$, rad |
| B17JM0 | 9/10/03 | H2380 | C4113 | 12.5-13.5' bgs | 13-14' bgs | Maxim | | 6/30/03 | | % solids, % moisture |
| B17C41 | 8/13/03 | WSCF20031112 | C4114 | Concrete | Concrete | WSCF | 9/19/03 | | | Metals, general chem., VOA, PCB, SVOA, rad, TPH |
| B17C34 | 8/13/03 | H2317 | C4114 | Concrete | Concrete | Eberline | | 9/29/03 | 9/29/03 | Nitrate/nitrite, oil/grease, pest/herb, rad |
| B17C48 | 8/13/03 | W04103 | C4114 | Concrete | Concrete | Severn T | 9/29/03 | | | $Cr^{+6}$ |
| B17HY0 | 9/3/03 | WSCF20031219 | C4114 | 1-2' bgs | 1-2' bgs | WSCF | 10/9/03 | | | Metals, general chem., VOA, PCB, SVOA, rad, TPH |
| B17HX4 | 9/3/03 | H2329 | C4114 | 1-2' bgs | 1-2' bgs | Eberline | | 10/23/03 | 10/9/03 | Nitrate/nitrite, oil/grease, $Cr^{+6}$, pest/herb, rad |
| B17HY1 | 9/3/03 | WSCF20031219 | C4114 | 2-3' bgs | 2-3' bgs | WSCF | 10/9/03 | | | Metals, general chem., VOA, PCB, SVOA, rad, TPH |
| B17HX5 | 9/3/03 | H2329 | C4114 | 2-3' bgs | 2-3' bgs | Eberline | | 10/23/03 | 10/9/03 | Nitrate/nitrite, oil/grease, $Cr^{+6}$, rad |
| B17HY2 | 9/4/03 | WSCF20031225 | C4114 | 6-7' bgs | 7-8' bgs | WSCF | 10/7/03 | | | Metals, general chem., VOA, PCB, SVOA, rad, TPH |
| B17HX6 | 9/4/03 | H2329 | C4114 | 6-7' bgs | 7-8' bgs | Eberline | | 10/23/03 | 10/9/03 | Nitrate/nitrite, oil/grease, $Cr^{+6}$, rad |
| B17HY3 | 9/10/03 | WSCF20031244 | C4114 | 12.5-13.5' bgs | 13-14' bgs | WSCF | 10/14/03 | | | Metals, general chem., VOA (8015 & 8260), PCB, SVOA, rad, TPH |
| B17HX7 | 9/10/03 | H2335 | C4114 | 12.5-13.5' bgs | 13-14' bgs | Eberline | | 10/27/03 | 10/2/03 | Nitrate/nitrite, oil/grease, $Cr^{+6}$, rad |

Table 2-6. Sample Data, 207-A South Retention Basin (200-PW-4 Borehole C4113/C4114/C4115). (4 sheets)

| HEIS | Date Collected | Data Package | Site | Depth Collected | Depth Planned | Lab | Sample Data Received | | | Sample Analyses Performed |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | WSCF | Eberline | Lionville (Severn T) | |
| B17C42 | 8/13/03 | WSCF20031112 | C4115 | Concrete | Concrete | WSCF | 9/19/03 | | | Metals, general chem., VOA, PCB, SVOA, rad, TPH |
| B17C35 | 8/13/03 | H2317 | C4115 | Concrete | Concrete | Eberline | | 9/29/03 | 9/29/03 | Nitrate/nitrite, oil/grease, pest/herb, rad |
| B17C49 | 8/13/03 | W04103 | C4115 | Concrete | Concrete | Severn T | 9/29/03 | | | $Cr^{+6}$ |
| B17HY6 | 9/4/03 | WSCF20031219 | C4115 | 1-2' bgs | 1-2' bgs | WSCF | 10/9/03 | | | Metals, general chem., VOA, PCB, SVOA, rad, TPH |
| B17HX8 | 9/4/03 | H2329 | C4115 | 1-2' bgs | 1-2' bgs | Eberline | | 10/23/03 | 10/9/03 | Nitrate/nitrite, oil/grease, $Cr^{+6}$, pest/herb, rad |
| B17J03 | 9/4/03 | WSCF20031219 | C4115 | 1-2' bgs | B17J03 is a duplicate of B17HY6. | WSCF | 10/9/03 | | | Metals, general chem., VOA, PCB, SVOA, rad, TPH |
| B17J02 | 9/4/03 | H2329 | C4115 | 1-2' bgs | B17J02 is a duplicate of B17HX8. | Eberline | | 10/23/03 | 10/9/03 | Nitrate/nitrite, oil/grease, $Cr^{+6}$, pest/herb, rad |
| B17HY7 | 9/4/03 | WSCF20031219 | C4115 | 2-3' bgs | 2-3' bgs | WSCF | 10/9/03 | | | Metals, general chem., VOA, PCB, SVOA, rad, TPH |
| B17HX9 | 9/4/03 | H2329 | C4115 | 2-3' bgs | 2-3' bgs | Eberline | | 10/23/03 | 10/9/03 | Nitrate/nitrite, oil/grease, $Cr^{+6}$, pest/herb, rad |
| B17HY8 | 9/4/03 | WSCF20031225 | C4115 | 6-7' bgs | 7-8' bgs | WSCF | 10/7/03 | | | Metals, general chem., VOA, PCB, SVOA, rad, TPH |
| B17HY4 | 9/4/03 | H2329 | C4115 | 6-7' bgs | 7-8' bgs | Eberline | | 10/23/03 | 10/9/03 | Nitrate/nitrite, oil/grease, $Cr^{+6}$, pest/herb, rad |
| B17HY9 | 9/10/03 | WSCF20031244 | C4115 | 12.5-13.5' bgs | 13-14' bgs | WSCF | 10/14/03 | | | Metals, general chem., VOA, PCB, SVOA, rad, TPH |

Table 2-6. Sample Data, 207-A South Retention Basin (200-PW-4 Borehole C4113/C4114/C4115). (4 sheets)

| HEIS | Date Collected | Data Package | Site | Depth Collected | Depth Planned | Lab | Sample Data Received | | | Sample Analyses Performed |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | WSCF | Eberline | Lionville (Severn T) | |
| B17HY5 | 9/10/03 | H2335 | C4115 | 12.5-13.5' bgs | 13-14' bgs | Eberline | | 10/27/03 | 10/2/03 | Nitrate/nitrite, oil/grease, $Cr^{+6}$, rad |

The analyses were performed by Eberline Services, Richmond, California; Maxim Technologies, Inc., St. Louis, Missouri; Lionville Laboratory, Inc., Exton, Pennsylvania; Severn Trent Laboratories, Inc., Earth City, Missouri; Shaw Group, Inc. – Geotechnical Laboratory, Oak Ridge, Tennessee, and WSCF – Hanford Site, Richland, Washington.

$Cr^{+6}$ (hexavalent chromium) is analyzed by EPA method 7196.

General chemistry analysis is done by any or all of the following EPA methods: 150.1 pH,; 300.0 Anions; 300.7 Ammonium; 335.2 Cyanide; 350.3 Ammonia; 353.1 or 353.2, Nitrate/Nitrite; 9010 Cyanide; 9040 or 9045 pH. Not all samples were analyzed for the same suite of general chemistry analyses.

Metals are analyzed by any or all of the following EPA methods: 200.8 Metals, 6010 Metals; 7196, Hexavalent Chromium; 7471 Mercury. Not all samples were analyzed for the same suite of metals.

Nitrate/nitrite is analyzed by EPA methods 353.1 or 353.2.

Oil/grease are analyzed by any or all of the following EPA methods: 413.1, 9071.

Particle size is analyzed by ASTM method D422.

Polychlorinated biphenyls, and are analyzed under EPA method 8082.

Percent moisture is analyzed by EPA SW 846 and ASTM D2216 methods.

Pesticides and herbicides; analyses are performed under EPA method 8081 for pesticides and 8151 for herbicides.

Radionuclide, include gamma count and specialized methods of analyses for some specific radionuclides. Not all samples were analyzed for the same suite of radionuclides.

Semi volatile organic analyses are performed under EPA method 8270. Not all samples were analyzed for the same suite of SVOAs.

Total petroleum hydrocarbons analyses are performed for both diesel and gasoline range.

Volatile organic analyses are performed by any or all of the following EPA methods: 8015 or 8260. Not all samples were analyzed for the same suite of VOAs.

Data packages WSCF20030459, H2152 and WSCF20030461 are for data validation.

ASTM D2216-98, *Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.*

SW-846, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ASTM = | American Society of Mechanical Engineers. | PCB | = | Polychlorinated biphenyl. | SVOA = | Semivolatile organics analysis. |
| Bgs = | Below ground surface. | Pest/herb | = | Pesticides and/or herbicides | TPH = | Total petroleum hydrocarbons. |
| EPA = | U.S. Environmental Protection Agency | Rad | = | Radionuclides | VOA = | Volatile organics analysis. |

Table 2-7. Sample Data, 207-A East, Middle and West Retention Basins (200-PW--4).

| HEIS | Date Collected | Data Package | Site | Depth Collected | Depth Planned | Lab | Sample Data Received | | | Sample Analyses Performed |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | WSCF | Eberline | Lionville (Severn Trent) | |
| B17107 | 5/13/03 | H2211 | East, middle, west basins | Soil in basin | Eberline | | 6/02/03 | 6/05/03 | Metals, rad | B17107 |
| B17109 | 5/13/03 | H2210 | East, middle, west basins | Water in basin | Eberline | | 6/02/03 | 6/05/03 | Metals, gross alpha, gross beta, pH, TOC | B17109 |

The analyses were performed by Eberline Services, Richmond, California; Maxim Technologies, Inc., St. Louis, Missouri; Lionville Laboratory, Inc., Exton, Pennsylvania; Severn Trent Laboratories, Inc., Earth City, Missouri; Shaw Group, Inc. – Geotechnical Laboratory, Oak Ridge, Tennessee, and WSCF – Hanford Site, Richland, Washington..

Metals are analyzed by any or all of the following EPA methods: 6010 Metals; 7040/7471 Mercury.

Radionuclide, are measured for gamma count only.

Gross alpha and gross beta were measured under EPA method 900.0.

pH was measured under EPA method 9040.

Total organic carbon was measured under EPA method 9060.

These samples were to characterize wind-blown soils and precipitation contained in the basins for waste designation. Both samples represent composite samples of all three basins.

EPA = U.S. Environmental Protection Agency.
TOC = Total organic carbon.

Table 2-8. List of Boreholes That Were Spectral Gamma-Ray Logged.

| Borehole Number | Approximate Location | Coordinates (Wash. State Plane, NAD83[91] | |
|---|---|---|---|
| | | Northing | Easting |
| A6816 (299-E28-65) | Within the boundaries of the 216-B-12 Crib | 136600.469 | 573127.558 |
| A6817 (299-E28-66) | Within the boundaries of the 216-B-12 Crib | 136618.537 | 573127.34 |
| A6794 (299-E28-16) | South of the 216-B-12 Crib | 136562.635 | 573136.748 |
| C3246 | 216-B-12 Crib | 136589.76 | 573128.81 |
| A4728 (299-E17-1) | Southern edge of the 216-A-10 Crib | 135386.153 | 574977.079 |
| A4755 (299-E24-2) | Northern edge of the 216-A-10 Crib | 135493.023 | 574973.639 |
| A5916 (299-E24-59) | Eastern edge of the 216-A-10 Crib | 135435.478 | 574985.793 |
| A5917 (299-E24-60) | Western edge of the 216-A-10 Crib | 135435.779 | 574964.093 |
| C3247 | 216-A-10 Crib | 135438.80 | 574979.08 |
| C4107 | 216–A-10 Crib | 135481.19 | 574978.22 |
| C4108 | 216–A-10 Crib | 135456.04 | 574982.48 |
| C4110 | 216-A-10 Crib | 135417.16 | 574980.89 |
| C4111 | 216-A-10 Crib | 135438.80 | 574977.33 |
| C4112 | 216-A-10 Crib | 135402.70 | 574977.78 |
| A4739 (299-E17-5) | Western edge of the 216-A-36B Crib | 135278.548 | 575093.967 |
| A5883 (299-E17-11) | Within the boundaries of the 216-A-36B Crib | 135347.191 | 575109.138 |
| A5886 (299-E17-51) | Within the boundaries of the 216-A-36B Crib | 135230.501 | 575109.364 |
| C3248 | 216-A-36B Crib | 135355.10 | 575104.55 |
| C4160 | 216-A-36B Crib | 135355.28 | 575106.04 |
| A6301 (299-E25-17) | South of the 216-A-37-1 Crib | 135702.51 | 575760.245 |
| A4764 (299-E25-18) | North of the 216-A-37-1 Crib | 135699.304 | 575817.379 |
| A4765 (299-E25-19) | South of the 216-A-37-1 Crib | 135659.027 | 575852.333 |
| A4767 (299-E25-20) | North of the 216-A-37-1 Crib | 135654 | 575910.942 |
| C4106 | 216-A-37-1 Crib | 135640.23 | 575917.54 |
| A4967 (299-W22-22) | 216-U-12 Crib | 134464.315 | 567617.274 |
| A7874 (299-W22-23) | 216-U-12 Crib | 134444.974 | 567586.716 |
| A4969 (299-W22-28) | 216-U-12 Crib | 134465.777 | 567433.699 |
| A7879 (299-W22-75) | 216-U-12 Crib | 134490.42 | 567595.19 |
| C3245 | 216-A-19 Trench | 136269.73 | 575660.99 |
| A7770 (299-W19-70) | 216-U-8 Crib, Center | 134697.757 | 567615.853 |
| A7771 (299-W19-71) | 216-U-8 Crib, Southern Third | 134679.76 | 567616.01 |

NAD83 (91), *North American Datum of 1983.*

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# REMEDIAL INVESTIGATION RESULTS

This chapter describes the hydrogeologic framework in the 200-PW-2 and 200-PW-4 OUs and the nature and vertical extent of contamination at the six waste sites investigated during the RI. The information in this chapter is based on site-specific data (e.g., geologic logs, depth to water, soil chemistry) collected during the RI and on existing information contained in DOE/RL-98-28, DOE/RL-2000-60, Rev. 1, CP-18666, DOE/RL-95-13, and other 200 Area reports.

## 3.1 HYDROGEOLOGIC FRAMEWORK

This section summarizes the hydrogeologic framework in the 200-PW-2 and 200-PW-4 OUs and incorporates site-specific data obtained during the RI with historical data from the 200 Areas. Additional information on the hydrogeologic setting of the OU can be found in the Implementation Plan (DOE/RL-98-28), the Work Plan (DOE/RL-2000-60, Rev. 1), and other documents noted in the text.

## 3.2 TOPOGRAPHY

The 200-PW-2 and 200-PW-4 OUs are located on the Central Plateau, which is a broad, relatively flat, prominent terrace (Cold Creek Bar) near the center of the Hanford Site (Figure 3-1). The Cold Creek Bar was formed about 13,000 years ago during the last cataclysmic flood from glacial Lake Missoula. The Cold Creek Bar trends generally east-west with elevations between 197 m and 225 m (647 to 740 ft) above mean sea level. The plateau drops off rather steeply to the north and northwest into a former flood channel with elevation changes of between 15 m and 30 m (50 and 100 ft). The plateau decreases more gently in elevation to the south into the Cold Creek valley and to the east toward the Columbia River. Most of the 200 West Area and the southern half of the 200 East Area are situated on the Cold Creek Bar, while the northern half of the 200 East Area lies within the former flood channel. A secondary flood channel running south from the main channel bisects the 200 West Area. More detail on the physical setting of the 200 Areas and vicinity is provided in the Implementation Plan, Appendix F (DOE/RL-98-28).

The 200-PW-2 and 200-PW-4 OU representative and TSD sites are located in the 200 West and 200 East Areas on the plateau. Surface elevations in the vicinity of the 200 West Area sites range from approximately 205 to 217 m (673 to 712 ft). Surface elevations in the vicinity of the 200 East Area sites range from approximately 200 m to 220 m (656 to 722 ft).

### 3.2.1 Geology

The 200-PW-2 and 200-PW-4 OUs are located in the Pasco Basin, one of several structural and topographic basins of the Columbia Plateau. Basalts of the Columbia River Basalt Group and a sequence of suprabasalt sediments underlie the 200-PW-2 and 200-PW-4 OU waste sites. From oldest to youngest, the major geologic units of interest are the Elephant Mountain Member,

the Ringold Formation, the Cold Creek unit, the Hanford formation, and surficial deposits. Figure 3-2 shows a generalized stratigraphic column for the 200 Areas.

**Elephant Mountain Member**. The Elephant Mountain Member is the uppermost basalt unit (i.e., bedrock) in the 200 Areas (DOE/RL-98-28, Rev. 0, Appendix F). Except for a small area north of the 200 East Area boundary where it has been eroded away, the Elephant Mountain Member is laterally continuous throughout the 200 Areas. The RI field investigations did not penetrate to the basalt. Based on previous investigations and nearby wells, the top of basalt is approximately 170 m (558 ft) deep at the 216-U-8 and 216-U-12 Cribs, 99 m (326 ft) deep at the 216-A-19 Trench, 114 m (375 ft) deep at the 216-B-12 Crib, 143 m (468 ft) deep at the 216-A-10 Crib, 147 m (482 ft) deep at the 216-A-36B Crib, 128 m (419 ft) deep at the 216-A-37-1 Crib, and 112 m (369 ft) deep at the 207-A South Retention Basin (CP-18666, PNNL-12261 and PNNL-13858). The basalt is overlain by the Ringold Formation at the 216-U-8 and 216-U-12 Cribs, and by the Hanford formation at the waste sites in the 200 East Area (CP-18666).

**Ringold Formation**. The Ringold Formation consists of an interstratified fluvial-lacustrine sequence of unconsolidated to semiconsolidated clay, silt, sand, and granule-to-cobble gravel deposited by the ancestral Columbia River (PNNL-12261, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-East Area and Vicinity, Hanford Site, Washington*, and PNNL-13858, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-West Area and Vicinity, Hanford Site, Washington*). These sediments, shown in Figure 3-2, consist of four major units (from oldest to youngest): the fluvial gravel and sand of unit 9 (basal coarse), the buried soil horizons, overbank, and lake deposits of unit 8 (lower mud), the fluvial sand and gravel of unit 5 (upper coarse), and the lacustrine mud of unit 4 (upper fines). Units 9 and 5 consist of a silty-sandy gravel with secondary lenses and interbeds of gravelly sand, sand, and muddy sands to silt and clay. Unit 8 (lower mud) consists mainly of silt and clay. Unit 4 (upper fines) consists of silty over-bank deposits and fluvial sand. Units 6 and 7 are not present beneath the 200 West and 200 East Areas (PNNL-12261 and PNNL-13858). The Ringold Formation is overlain by the Cold Creek unit in the 200 West Area and parts of the 200 East Area.

**Cold Creek Unit**. The Cold Creek unit is the new standardized name for several post-Ringold Formation and pre-Hanford formation units present beneath the 200 East and West Areas (DOE/RL-2002-39, *Standardized Stratigraphic Nomenclature for Post-Ringold Formation Sediments Within the Central Pasco Basin*). The Cold Creek unit includes the formations formerly described as the Plio-Pleistocene unit, caliche, early Palouse soil, Pre-Missoula gravels, and sidestream alluvial facies described in previous site reports. The Cold Creek unit has been divided into five lithofacies: fine-grained, laminated to massive (fluvial-overbank and/or eolian deposits, formerly the early Palouse soil); fine- to coarse-grained, calcium-carbonate cemented (calcic paleosol, formerly the caliche); coarse-grained, multilithic (mainstream alluvium, formerly the Pre-Missoula gravels); coarse-grained, angular, basaltic (colluvium); and coarse-grained, rounded, basaltic (sidestream alluvium, formerly sidestream alluvial facies) (DOE/RL-2002-39). The Cold Creek unit present beneath the 200 West Area waste sites (216-U-8 and 216-U-12 Cribs) includes the overbank/eolian and the calcic paleosol facies (DOE/RL-95-13).

**Hanford Formation**. The Hanford formation is the informal stratigraphic name used to describe the Pleistocene cataclysmic flood deposits in the Pasco Basin (DOE/RL-2002-39). The Hanford formation consists predominantly of unconsolidated sediments that range from boulder-size gravel to sand, silty sand, and silt. The sorting ranges from poorly sorted (for gravel facies) to well sorted (for fine sand and silt facies). The Hanford formation is divided into three main lithofacies: interbedded sand- to silt-dominated (formerly called the Touchet beds or slackwater facies); sand-dominated (formerly called the sand-dominated flood facies); and gravel-dominated (formerly called the Pasco gravels) that have been further subdivided into 11 textural-structural lithofacies (DOE/RL-2002-39). Beneath the 200-PW-2 and 200-PW-4 OU waste sites the Hanford formation includes the gravel-dominated and sand-dominated facies. The gravel-dominated facies are cross-stratified, coarse-grained sands and granule-to-boulder gravel. The gravel is uncemented and matrix-poor. The sand-dominated facies are well-stratified fine- to coarse-grained sand and granule gravel. Silt in these facies is variable and may be interbedded with the sand. Where the silt content is low, an open-framework texture is common. Clastic dikes are common in the Hanford formation but rare in the Ringold Formation (DOE/RL-98-28 and DOE/RL-2002-39). They appear as vertical to subvertical sediment-filled structures especially within sand- and silt-dominated units. The Hanford formation is locally overlain by veneers of surficial deposits.

**Surficial Deposits**. Surficial deposits include Holocene eolian sheets of sand that form a thin veneer over the Hanford formation across the site, except in localized areas where the deposits are absent. Surficial deposits consist of very fine- to medium-grained sand to occasionally silty sand. Silty deposits less than 1 m (approximately 3 ft) thick also have been documented at waste sites where fine-grained, wind-blown material has settled out through standing water over many years (DOE/RL-98-28, Rev. 0, Appendix F). Fill material was placed in and over representative waste sites during construction and for contamination control. The fill consists of reworked Hanford formation sediments and/or surficial sand and silt. The thickness of the fill material varies from 3.8 m to 13.7 m (12.5 to 45 ft) at the representative waste sites (CP-18666 and DOE/RL-95-13).

### 3.2.2 Hydrostratigraphy

The focus of the RI was on the distribution of contaminants within the vadose zone beneath the representative waste sites. Vadose zone hydrostratigraphic units in the 200-PW-2 and 200-PW-4 OUs include the Ringold Formation, the Cold Creek unit, the Hanford formation, and surficial deposits (see Figure 3-2). The unconfined aquifer hydrostratigraphic units in the 200-PW-2 and 200-PW-4 OUs consist of the Ringold Formation and the Hanford formation. The base of the unconfined aquifer is the top of the Ringold Formation unit 8 (lower mud) at the 200 West Area waste sites and the top of basalt (Elephant Mountain Member) at the 200 East Area waste sites.

**Vadose Zone**. The vadose zone is the area between the ground surface and water table. At the 200 East Area representative sites, the vadose zone varies from 78.2 m (256.4 ft) thick at the 216-A-19 Trench to 97.4 m (319.6 ft) thick at the 216-A-36B Crib. The vadose zone is entirely within Hanford formation sediments at the 200 East Area representative sites.

At the 200 West Area representative sites, the vadose zone is about 76 m (249 ft) thick at the 216-U-8 and 216-U-12 Cribs. Sediments within the vadose zone at these waste sites include the Hanford formation, the Cold Creek unit, the Ringold Formation unit 4, and part of the Ringold Formation unit 5 (DOE/RL-95-13).

Moisture content in the 200 Areas vadose zone typically ranges between 2 and 10 percent under ambient conditions (DOE/RL-98-28), but historically has ranged widely from 10 percent to saturation (perched water) at liquid waste disposal sites. Before 1995, liquid waste sites provided a significant driving force for contaminant transport. With the reduction of artificial recharge in the 200 Areas since 1995, the downward flux of liquid in the vadose zone beneath waste sites has been decreasing. Moisture content in the vadose zone is expected to remain elevated over preoperational conditions for some time near waste sites. In the absence of artificial recharge, recharge from natural precipitation becomes the dominant driving force for moving contamination remaining in the vadose zone to groundwater.

Moisture content in the 200 Areas vadose zone typically ranges between 2 and 10 percent under ambient conditions (DOE/RL-98-28), but historically has ranged widely from 10 percent to saturation (perched water) at liquid waste disposal sites. Before 1995, liquid waste sites provided a significant driving force for contaminant transport. With the reduction of artificial recharge in the 200 Areas since 1995, the downward flux of liquid in the vadose zone beneath waste sites has been decreasing. Moisture content in the vadose zone is expected to remain elevated over preoperational conditions for some time near waste sites. In the absence of artificial recharge, recharge from natural precipitation becomes the dominant driving force for moving contamination remaining in the vadose zone to groundwater.

A limited number of soil samples were collected to determine moisture content, grain-size distribution, and bulk density. Laboratory moisture content ranged from 1.7 to 17.2 percent. Bulk densities ranged from 1.49 g/cm$^3$ to 2.03 g/cm$^3$. The physical property testing data collected during the RI are summarized in Table 3-1. The laboratory results are presented in CP-18666.

**Unconfined Aquifer**. Figures 3-3 and 3-4 show March 2002 water table maps of the 200 East and 200 West Areas, respectively. Groundwater in the 200 West Area occurs primarily in the Ringold Formation. Beneath the 216-U-8 and 216-U-12 Cribs, the only two representative sites located in the 200 West Area, depth to water measures approximately 76 m (249 ft) and groundwater flow is to the east-southeast. From March 2001 to March 2002 the surface of the water table declined an average of 0.36 m (1.18 ft) in the 200 West Area as part of the long-term decline caused by reduction of wastewater discharges to ground since the peak in 1984 (PNNL-14187, *Hanford Site Groundwater Monitoring for Fiscal Year 2002*). A pump-and-treat system associated with technetium-99 and uranium contamination from the 216-U-1 and 216-U-2 Cribs has operated since 1994 as part of the remediation activities at the 200-UP-1 Groundwater OU. The extraction wells for this system are located about 300 m (1,000 ft) northeast of the 216-U-8 Crib.

Depth to the water table in the vicinity of the 200 East Area ranges from about 54 m (177 ft) near B Pond to more than 100 m (328 ft) at the BC Cribs. This entire area is within a region that is bound predominantly by the 122.5 m (401.8-ft) hydraulic contour (Figure 3-3). The water table

surface in the 200 East Area is very flat. Groundwater elevation changes across the 200 East Area are very small, so groundwater flow direction is difficult to determine based on historic plume distributions. Groundwater flows primarily in two directions; to the northwest through Gable Gap (located between Gable Mountain and Gable Butte [see Figure 3-1]), and to the southeast. However, the location of the divide between the flow to the northwest and the flow to the southeast is difficult to identify because of the nearly flat water table. From March 2001 to March 2002 the surface of the water table declined an average of 0.19 m (0.62 ft) in the 200 East Area (PNNL-14187).

## 3.3 OPERABLE UNIT CONTAMINATION

This section describes the nature and extent of contamination at the 200-PW-2 and 200-PW-4 OU of two representative sites (216-A-19 Trench and the 216-B-12 Crib) and four RCRA TSD units (216-A-10 Crib, 216-A-36B Crib, 216-A-37-1 Crib, and the 207-A South Retention Basins, which comprises the 207-A East, Middle, West Retention Basins). All of these sites were characterized in FY 2003 to FY 2004.

Two other representative sites, the 216-U-8 Crib and the 216-U-12 Crib, were characterized in the mid 1990s. Their characterization is described in detail in DOE/RL-95-106 and summarized in Section 3.3.7.

Data collected from the RI representative sites are presented in Appendix B. Except for the 207-A South Retention Basin, the sites have both geophysical logging and laboratory characterization data available. The contamination found at each representative waste site and TSD unit is discussed generally in this section. A more detailed comparison of the characterization data against regulatory standards and background levels and a detailed residual radioactivity (RESRAD) risk model discussion based on the characterization data is found in Chapter 4.

The geophysical logging results and observations described in the following sections were made during drilling activities at the 200-PW-2 and 200-PW-4 OUs. The probe runs, data collection, and reduction were conducted by Stoller Geophysical Services, Grand Junction, Colorado. The geophysical log data reports and analyses are provided at http://www.gjo.doe.gov/programs/hanf/HTFVZ.html and in Appendix F of CP-18666. The spectral gamma logs supplement the analytical radionuclide data; they present a vertical distribution of radionuclides in the vadose zone beneath the waste sites and aid in geological interpretation of subsurface stratigraphy. Spectral gamma logging equipment is calibrated annually. The calibration data are used to calculate casing attenuation factors that convert measured peak area count rates to radionuclide concentrations.

Borehole geophysical logging was conducted both in existing boreholes in the vicinity of each waste site and in the boreholes and push holes installed as part of the remedial investigation. The boreholes that were geophysically logged are listed in Table 2-8. Laboratory data collected are summarized in Tables 2-1 through 2-7, and are presented in Appendix B. Note that results for $^{90}Sr$ are based on analysis of total radioactive strontium except for some sample material from the 216-A-36B Crib.

### 3.3.1 Nature and Extent of Contamination in the 216-A-19 Trench Area

This section describes the nature and extent of contamination in the 216-A-19 Trench area. The 216-A-19 Trench is located just outside the eastern perimeter fence of the 200 East Area and is surrounded by, clockwise from the south, the 216-A-34 Ditch, 216-A-18 Trench, 216-A-24 Crib, and 216-A-20 Crib.

#### 3.3.1.1 Geophysical Logging Summary for the 216-A-19 Trench

The borehole was begun on April 4, 2003, with the final decommissioning on the April 23, 2003. It was collared in 15 cm (6 in.) of drill pad construction gravel, then penetrated 5.2 m (17 ft) of trench backfill materials consisting of sand, sporadic gravel, and disseminated silt/clay lenses. A 0.15 m- (0.5-ft-) thick clay horizon that may have been an engineered barrier above the active part of the trench was located at 2.7 m (9.0 ft). The trench was built into the Hanford formation sand-dominant facies.

The Hanford formation consists of a basalt-rich, fine- to medium-grain sand with sporadic thin silt lenses to a depth of 21.8 m (71.5 ft) bgs, where the unit becomes gravelly sand to a depth of 39.6 m (130 ft) bgs. These two sediment types are gradational from one to another to a depth of 59.7 m (196 ft) bgs, where it transitions into a gray silty sandy gravel at 63.1 m (207 ft) bgs; this layer is basalt rich and is the top of the gravel-dominant unit. From 71.9 m to 76.5 m (236 to 251 ft) bgs, a coarse sand lies between the gravel beds and continues to the capillary fringe of the water table (78.2 m [256.4 ft] bgs). The unit exhibited varying amounts of calcium carbonate ($CaCO_3$) as intergranular cement; carbonate concentrations increased where finer grain sediments were more prevalent. Iron oxides were seen as stains on some particles and as matrix in sporadic cemented nodules.

No significant paleosol horizons were encountered. No radiological or organic vapor anomalies were detected during field screening.

Geophysical logging was performed with the SGLS and Neutron-Moisture Logging System (NMLS) for Borehole C3245 on April 7, 2003, and April 10, 2003. Cesium-137, $^{238}U$, and $^{235}U$ were the only man-made radionuclides detected in this borehole. CP-18666 stated that $^{137}Cs$ was detected near the ground surface and again at the depths of 7 m, 58.1 m, and 58.8 m (23 ft, 191 ft, and 193 ft) bgs. The concentrations of this radionuclide were found to range between 0.4 and 40 pCi/g in the top 0.3 m to 3.4 m (1 to 11 ft) bgs. The presence of higher concentrations of $^{137}Cs$ at relatively shallow depths may be from the influx of waste discharged to the 216-A-34 Ditch, which at one time may have overflowed into the 216-A-19 Trench. At the lower depths the estimated concentration was at or below the minimum detection level (MDL) of 0.2 pCi/g.

Samples were obtained from the borehole, but no $^{137}Cs$ data from the sample were taken at the surface and no samples were taken between 29.7 m and 63.5 m (97.5 and 207.5 ft) bgs so no comparison can be made directly with the logging results. Samples at depths of approximately 4.6 m (15 ft) and below provided $^{137}Cs$ results less than the sample minimum detectable activity (MDA) of 0.015 pCi/g.

The geophysical logging results show that $^{238}U$ was encountered within the interval of 2 m (6.5 ft) through 9.3 m (30.5 ft) bgs, with concentrations ranging between 18 and 560 pCi/g. The maximum concentrations for both $^{137}Cs$ and $^{238}U$ were found at 2.4 m (8 ft) bgs. During a repeat log of this borehole, $^{235}U$ also was detected at 2.4 m (8 ft) bgs at a concentration of 8 pCi/g. The $^{238}U$ MDA ranges from about 10 to 20 pCi/g.

Samples were obtained from the borehole from 4.4 m to 75.6 m (14.5 to 248 ft) bgs. The maximum concentration of $^{238}U$ in any sample was 51 pCi/g at 4.4 m (14.5 ft) bgs with the range in the 4.4 m to 9.9 m (14.5 to 32.5 ft) bgs interval being 7.4 to 51 pCi/g. The range of results in the remaining depth of the sampled borehole (9.9 m to 75.6 m [32.5 to 248 ft bgs]) ranges from 0.1 to 7.4 pCi/g. The 90 percent upper confidence level for Hanford Site soils is about 1.1 pCi/g; thus, the levels are only slightly above background at deeper depths.

The only other man-made radionuclides that were consistently found in the samples above the MDA were $^{208}Tl$ and $^{90}Sr$. The concentrations of $^{208}Tl$ were relatively constant throughout the borehole ranging from 0.135 to 0.182 pCi/g. Strontium-90 was concentrated in the area 4.4 m to 6.9 m (14.5 to 22.5 ft) bgs and ranged from 7.73 to 20 pCi/g. Strontium-90 was not found at deeper levels. The maximum $^{90}Sr$ concentration of 20 pCi/g was in the 5.3 m-(17.5-ft-) bgs sample.

Radon was believed to be inside the borehole casing as the logging was being performed because concentrations of $^{238}U$ were approximately 0.5 pCi/g higher on the 609 keV photopeak (a photon energy level of a specific range indicating a particular atom or ion) than those based on the 1,764 keV photopeak. Radon is derived naturally through the decay of nonprocessed uranium. As a gas, radon can move easily through the subsurface of the Hanford Site, which consists of mostly sand. Concentrations of radon and its associated progeny can change quickly. Radon occurs naturally on the Hanford Site; it also may be associated with the decay of the approximately 38,700 kg (85,317 lb) of nonirradiated uranium received at the Site (DOE/RL-2000-60, Rev. 1).

Recognizable changes in the potassium-uranium-thorium logs also occurred in this borehole. A 4 pCi/g decrease in $^{40}K$ at approximately 3.7 m (12 ft bgs) and a 0.4 pCi/g decrease in $^{232}Th$ indicate the base of the trench at this depth. At 57.9 m (190 ft) bgs, another decrease of $^{40}K$ was encountered and was believed to indicate a lithology change.

Neutron moisture logs showed no major areas of wetness and were reported to be within acceptable repeatability limits. Analytical sample results were provided at three depths. The percent moisture results were 4 percent (8.4 m [27.5 ft] bgs), 1.7 percent (29.7 m [97.5 ft] bgs) and 2.8 percent (73.9 m [242.5 ft] bgs) and support the logging results.

#### 3.3.1.2 216-A-19 Trench Contamination – Laboratory Data

When actively receiving waste, this trench was 4.6 m (15 ft) deep. It received startup waste and contact condenser cooling water containing uranium and nitric acid from the PUREX Facility.

Contamination was detected in the vadose zone beneath the 216-A-19 Trench in Borehole C3245 to a depth of 75.6 m (248 ft) bgs.

All detected radionuclides with levels of over 1 pCi/g were found at 4.4 m to 5.3 m (14.5 to 17.5 ft) bgs (the ditch bottom was at 4.6 m [15 ft bgs]).

- Nickel-63 17.6 pCi/g at 4.4 m (14.5 ft) bgs
- Strontium-90 20.0 pCi/g at 5.3 m (17.5 ft) bgs
- Thorium-234 56.8 pCi/g at 4.4 m (14.5 ft) bgs
- Uranium-233/234 6.0 pCi/g at 4.4 m (14.5 ft) bgs
- Uranium-238 51 pCi/g at 4.4 m (14.5 ft) bgs
- Uranium, total 130 mg/kg at 6.9 m (22.5 ft) bgs.

No other radiological contaminants were detected in the upper zone of contamination (to 4.4 m [14.5 ft] bgs) at more than 1 pCi/g, nor were they detected at more than 1 pCi/g at any other depth.

The contaminant distribution of uranium is anomalous in that it is elevated at the 10.7 m to 15.2 m (35 to 50 ft) bgs levels, lower at 19.1 m (62.5 ft) bgs, higher again at 28.2 m (92.5 ft) bgs, then drops off again at either 60.2 m (197.5 ft) or 75.4 m (247.5 ft) bgs. This is true of total uranium and of all measured isotopes. A geologic structure may be located beneath the crib that is causing this distribution or it may simply be an anomaly.

Residual concentrations of pesticides and herbicides used to kill vegetation on the trench surface were tested for at 0.15 m (0.5 ft) bgs; none were detected.

Nitrate, nitrogen in nitrate and nitrite, boron, manganese, and uranium exceeded screening levels in soil samples collected from Borehole C3245. Nitrite (as nitrogen) was detected at 4.4 m to 74.5 m (14.5 to 248 ft) bgs with the maximum concentration of 9,860 mg/kg at a depth of 8.3 m (27.5 ft) bgs. Concentrations generally decrease throughout the depth. Nitrogen in nitrate and nitrite was detected at 4.4 m to 74.5 m (14.5 to 248 ft) bgs with the maximum concentration of 1,120 mg/kg at a depth of 9.9 m (32.5 ft) bgs. Concentrations generally decrease throughout the depth.

Boron was detected at 4.4 m to 6.9 m (14.5 to 22.5 ft) bgs with the maximum concentration of 38.9 mg/kg at a depth of 4.4 m (14.5 ft) bgs. All of the detected boron at this site was modified with an "E" flag indicating the result is an estimate because of interference. Boron was undetected below 6.9 m (22.5 ft) bgs. Manganese was detected at 4.4 m to 74.5 m (14.5 to 248 ft) bgs with the maximum concentration of 538 mg/kg at a depth of 5.3 m (17.5 ft) bgs. Concentrations generally decrease throughout the depth.

The contaminant distribution model (DOE/RL-2000-60, Rev. 1) indicates that highest contamination will be found at about 6.1 m to 19.8 m (20 to 65 ft), medium amounts of contamination to 29.6 m (97 ft) bgs, and low contamination below 29.6 m (97 ft). In general, this is the distribution shown by the data, although many naturally occurring materials are present throughout the length of the borehole.

#### 3.3.1.3 Summary for the 216-A-19 Trench

Existing soil samples indicate that contamination is present in the 216-A-19 Trench. The surrounding waste sites, the 216-A-34 Ditch (200-PW-4), 216-A-18 Trench (200-PW-2), 216-A-24 Crib (200-PW-3), and 216-A-20 Crib (200-PW-2), are likely to contain similar contamination. Waste from the 216-A-34 Ditch (241-A-431 Building condenser cooling water) is believed to have reached the 216-A-19 Trench. The 216-A-18 Trench and the 216-A-20 Crib have nearly identical waste receipt histories. The 216-A-24 Crib is not covered under this RI because it is in the 200-PW-03 OU.

The nitrates found at the 216-A-19 Trench are consistent with the site history. According to the Work Plan (DOE/RL-2000-60, Rev. 1), nitrate salts were disposed of at the site. The radiological contaminants found at the 216-A-19 Trench also are consistent with the site history. About 38,700 kg (85,719 lb) of uranium are believed to have been discharged to the trench. According to the Work Plan (DOE/RL-2000-60, Rev. 1), the historical radionuclide inventory included $^{60}$Co, $^{90}$Sr, $^{137}$Cs, $^{239/240}$Pu and $^{238}$U. All these isotopes were detected except for $^{60}$Co, which has a fairly short (5.3-year) half-life and may have decayed to undetectable levels.

A stratigraphy diagram for the 216-A-19 Trench is shown in Figure 3-5. Stratigraphy and data are shown in Figure 3-6. Vertical profile plots of contaminants are shown in Figure 3-7.

### 3.3.2 Nature and Extent of Contamination in the 216-A-10 Crib

This section describes the nature and extent of contamination in the 216-A-10 Crib. The 216-A-10 Crib is located in the 200 East Area, south of the 202-A Building. It is next to the 216-A-36B Crib.

Five large-diameter push holes for logging and a borehole were installed (CP-18666).

**C4107**. This large-diameter push hole (20.2 cm [6 5/8-in.] OD, 18.3 [6-in.] ID) was installed April 15 and 16, 2003, to a depth of 27.8 m (91 ft) bgs and was geophysically logged.

**C4108**. This large-diameter push hole was installed on April 15, 2003, to a depth of 27.8 m (91 ft) bgs, then logged geophysically.

**C4109**. Although the Work Plan (DOE/RL-2000-60, Rev. 1) specified this push hole, it was not installed because the spatial distribution of the other five push holes was adequate to cover the waste site.

**C4110**. The third of the large-diameter push holes was completed on April 8, 2003, at a depth of 18.3 m (60 ft) bgs, then was logged geophysically.

**C4111**. Large-diameter push hole C4111 was installed on April 9, 2003, to a depth of 27.1 m (89 ft) bgs, where it was geophysically logged.

**C4112.** This large-diameter push hole was installed on April 8, 2003, to a depth of 24.4 m (80 ft) bgs. Geophysical logging was performed on completion of the drilling.

**C3247.** Borehole C3247 was begun on May 15, 2003. The first indication of radionuclides and organic vapors was at approximately 15.8 m (52 ft) bgs. At the depth of 18.3 m (60 ft) the Industrial Health technician was consistently reading organic vapors at 20 p/m. A sample was collected, and overnight analysis revealed the compound to be n-butyl ether. A radiological screen sample result indicated 3 nCi of alpha from plutonium or americium or both. The work crews were placed under respiratory protection controls and suited up in anti-contamination clothing. The borehole was drilled to a depth of 19.8 m (65 ft) bgs on May 27, 2003, when drilling was temporarily suspended. Drilling resumed on September 16, 2003, and was concluded on October 3, 2003, at a drilled depth of 98.8 m (324 ft) bgs.

### 3.3.2.1 Geophysical Logging Summary for the 216-A-10 Crib

**C4107.** Cesium-137 and $^{154}$Eu are the man-made radionuclides detected in this borehole. Cesium-137 was found from 11.6 m to 27.4 m (38 to 90 ft) bgs in concentrations from 0.2 to 1300 pCi/g, with the maximum at 17.5 m (57.5 ft) bgs. The $^{154}$Eu was detected at 19.4 m (63.5 ft), and 25.6 m to 27 m (84 to 88.5 ft) bgs, with the maximum of 5.6 pCi/g at 26.2 m (86 ft) bgs.

**C4108.** Cesium-137 and $^{154}$Eu are the man-made radionuclides detected in this borehole. The $^{137}$Cs was found from 12 m (39.5 ft) to 27.6 m (90.5 ft) bgs in concentrations from 0.03 to 3,100 pCi/g, with the maximum at a depth of 18.6 m (61 ft) bgs. The $^{154}$Eu was detected at 12.5 m to 14.0 m (41 to 46 ft), 19.0 m to 21.2 m (62.5 to 69.5 ft), and 25.5 m to 26.5 m (83.5 to 87 ft) bgs in concentrations of from 0.4 to 2.0 pCi/g. The maximum was at 21 m (69 ft) bgs.

**C4110.** Cesium-137 is the only man-made radionuclide detected in this borehole. It was found at 14.5 m to 18.3 m (47.5 to 60 ft) bgs in concentrations ranging from 0.4 to 1,500 pCi/g, with the maximum at 17.5 m (57.5 ft) bgs. Near the MDL of 0.2 pCi/g, traces of $^{137}$Cs were found at depths of 2.1 m (7 ft), 4 m (13 ft), and 9.1 m (30 ft) bgs.

**C4111.** Cesium-137 and $^{154}$Eu are the man-made radionuclides detected in this borehole. Cesium-137 was found from 12.5 to 26.8 m (41 to 88 ft) bgs in concentrations from the MDL to 3,600 pCi/g, with the highest concentrations detected at 14 m (46 ft) bgs. The $^{154}$Eu was detected at 25.3 m to 26.2 m (83 to 86 ft) bgs at concentrations from 0.7 to 1.0 pCi/g.

**C4112.** Cesium-137 is the only man-made radionuclide detected in this borehole. It was found in the interval from 13.5 m through 24.4 m (44 through 80 ft) bgs in concentrations of from 0.4 to 3,000 pCi/g. The maximum concentration was measured at 14.5 m (47.5 ft) bgs

**C3247.** Temporary casings were set at 23.8 m, 43.2 m, and 96.6 m (77.9, 141.5, and 316.7 ft) bgs. The push hole with the highest geophysical logging result was used to site the boring. The crib bottom was exited at a depth of 13.7 m (45 ft) bgs after penetrating 4.6 m (15 ft) of 7.6 cm to 15.2 cm (3- to 6-in.) pebbles and cobbles that had been placed at the bottom of the crib to facilitate distribution of the solutions discharged to the crib. The formational fine- and medium-grain sand has a 0.3 m (1-ft) thick silt layer (paleosol) from 16.2 to 16.5 m (53 to

54 ft) bgs, then extends to 31.7 m (104 ft) bgs, where a 0.9 m- (3-ft-) thick sandy silt layer is located. The next 32.6 m to 82.6 m (107 to 271 ft) bgs alternate from sandy silt to silty sand with gradational contacts. The soils from 82.6 m to 88.5 m (271 to 290.5 ft) bgs are primarily gravelly sand, where the particle size is generally less than 5.1 cm (2 in.) From 88.5 m to 89.3 m (290.5 to 293 ft) bgs, a paleosol unit of brown clayey silt overlies a sandy gravel in the bottom of the hole. The water table was found at 97.3 m (319 ft) bgs.

Geophysical logging of Borehole C3247 was completed in three stages, after the installation of each string of temporary casing. The composite of the three runs indicates that $^{137}$Cs and $^{154}$Eu are the man-made radionuclides detected. The $^{137}$Cs was detected from 48 to 84 ft bgs in concentrations ranging from 0.3 to 2,800 pCi/g, with the maximum measured at a depth of 18.9 m (62 ft) bgs; $^{137}$Cs also was detected at or near the MDL (0.3 pCi/g) at 9.4 m, 30 m, 36.4 m, 69.1 m, and 73.9 m (31, 99, 120, 228, and 244 ft) bgs. The $^{154}$Eu was detected at 25.1 m to 25.8 m (83 to 85 ft) bgs at concentrations from 0.4 to 1.5 pCi/g.

Analytical results for $^{137}$Cs from Borehole C3247 show significant activity (1,080 pCi/g) at the first sampled depth (15.8 m [52 ft] bgs). The $^{137}$Cs increases with depth and the maximum activity (2,950 pCi/g) occurs at 18.9 m (62.5 ft) bgs. The next sample (at 22 m [72.5 ft] bgs) and all subsequent samples to 96.1 m (317 ft) bgs showed no detectable $^{137}$Cs. No detectable $^{154}$Eu was found at any depth. The borehole logging data and analytical sample data indicate a band of $^{137}$Cs contamination from about 14.5 m to 21.8 m (48 ft to 72 ft) bgs with the peak of the contamination at about 18.8 m (62 ft).

The analytical results also reported peak concentrations of several other man-made radionuclides in that same depth range of 15.8 m to 22 m (52 to 72.5 ft) bgs. These included $^{241}$Am (1320 pCi/g), $^{238}$Pu (316 pCi/g), $^{239/240}$Pu (7110 pCi/g), and $^{99}$Tc (0.796 pCi/g). Strontium-90 peak concentration occurred lower in the soil column (44.7 pCi/g at 43.8 m (144.4 ft) bgs) as did tritium (375 pCi/g at 96.1 m [317 ft] bgs). Carbon-14 occurred at a single depth (18.9 m [62.5 ft] bgs) at a concentration (7.5 pCi/g) more than twice the reported MDA.

Recognizable changes in the natural potassium-uranium-thorium logs occurred in this borehole. The potassium-uranium-thorium logs observed decreases in $^{40}$K and increases in $^{232}$Th, which are associated with the different geometry near the base of the borehole, because the borehole was logged in stages. In CP-18666, Appendix F-1, the decrease in $^{40}$K specifically around 10 m to 12.1 m (33 to 40 ft) bgs is thought to correspond with the rock fill that is located near the base of the crib.

The neutron moisture logs showed a wetter area peaking at about 18.8 m (62 ft) which corresponds to the peak $^{137}$Cs concentration. Another similar size peak was seen at 31.5 m (104 ft) bgs but does not correlate to any radiological results. Analytical sample results for percent moisture at depths of 22 m (72.5 ft) and 96.1 m (317 ft) bgs provide percent moisture estimates for those depths of 4 percent and 3.3 percent respectively.

**Lateral Spread of Contamination.** The logging data indicate that the only man-made radionuclides found in the push holes are $^{137}$Cs and $^{154}$Eu. The cesium concentrations stay within the same order of magnitude in all push holes (about 1,300 to 3,600 pCi/g) and are distributed depth-wise similarly in all of them. The maximum $^{137}$Cs concentration in the Borehole C3247

(2,950 pCi/g) is similar. The $^{154}$Eu concentrations are low in all boreholes and push holes. This suggests that $^{137}$Cs and low amounts of $^{154}$Eu may have spread laterally and fairly evenly throughout the site, but other man-made radionuclides have not.

### 3.3.2.2 216-A-10 Crib Contamination–Laboratory Data

Contamination was detected in the vadose zone beneath the 216-A-10 Crib in Borehole C3247 to a depth of 96.1 m (317 ft) bgs for radionuclides. Of the contaminants whose concentrations are over 2.5 pCi/g, maximum concentrations are present in the 15.8 m to 18.9 m (52 to 62.5 ft) depth interval of the soil column with two exceptions (tritium and $^{90}$Sr). When actively receiving effluent, the crib was about 13.6 m (45 ft) deep.

The following radionuclides were detected at the given maximum concentrations in the 15.8 m to 18.9 m- (52 to 62.5-ft-) bgs zone.

- Americium-241 1,320 pCi/g
- Carbon-14 7.5 pCi/g
- Cesium-137 2,950 pCi/g
- Iodine-129 38.8 pCi/g
- Plutonium-238 316 pCi/g
- Plutonium-239/240 7,110 pCi/g
- Potassium-40 27.0 pCi/g
- Strontium-90 11.1 pCi/g
- Tritium 319 pCi/g

The concentration of the major radioactive contaminants generally decreased with depth beneath the crib bottom. Additional radioisotopes such as $^{228}$Ac, $^{212}$Bi, $^{214}$Bi, $^{154}$Eu, $^{155}$Eu, $^{212}$Pb, $^{214}$Pb, $^{237}$Np, $^{63}$Ni, $^{226}$Ra, $^{228}$Ra, $^{208}$Tl, $^{228}$Th, $^{230}$Th, $^{232}$Th, $^{234}$Th, $^{233/234}$U, $^{235}$U and $^{238}$U also were detected in the borehole above 18.9 m (62.5 ft) bgs. However, concentrations were equal to or less than 2.5 pCi/g.

With few exceptions, radionuclides either were not detected or were detected at concentrations of less than about 2.0 pCi/g at depths greater than 18.9 m (62.5 ft). Americium-241 (5.25 pCi/g at 26.5 m [87.5 ft] bgs), $^{40}$K (20 pCi/g at 22 m and 38.6 m [72.5 and 127.5 ft] bgs), $^{90}$Sr (44.7 pCi/g at 38.6 m [127.5 ft] bgs), and tritium (835 pCi/g at 96.1 m [317 ft] bgs) are sporadically present in the vadose zone at depths greater than 18.9 m (62.5 ft) bgs.

The effluent discharged to the 216-A-10 Crib was acidic process condensate from the PUREX Facility containing uranium and nitrate (DOE/RL-2000-60, Rev. 1). The crib contained a maximum total uranium concentration of 2.8 mg/kg at 18.9 m (62.5 ft) bgs. Nitrates did not exceed screening levels.

Residual concentrations of pesticides and herbicides used to kill vegetation on the surface of the crib were tested for at 0.15 m (0.5 ft) bgs. Beta-1,2,3,4,5,6-hexachlorocyclohexane was found in one sample (of one analyzed) at a concentration of 7.0 μg/kg. This compound is compared to its screening level, which was exceeded, in Chapter 4.

Besides the pesticide, other analytes from Borehole C3247 soil samples that exceeded screening levels included methylene chloride (29.1 μg/kg), diesel hydrocarbons (10,000 mg/kg), and pentachlorophenol (20.4 μg/kg). Maximum concentrations were detected solely in the 16.4 m to18.9 m (54 to 62.5 ft) bgs depth interval.

In general, the contaminant distribution model is well supported by the data. The model indicates that high contamination is in the 9.1 m to 27.3 m- (30- to 90-ft-) bgs range and medium contamination is to be found in the 27.3 m to 39.4 m- (90- to 130-ft-) bgs range. The data support this.

A stratigraphy diagram for the 216-A-10 Crib is shown in Figure 3-8. Stratigraphy and data are shown in Figure 3-9. Vertical profile plots of contaminants are shown in Figure 3-10.

### 3.3.3 Nature and Extent of Contamination in the 216-A-36B Crib

This section describes the nature and extent of contamination in the 216-A-36B Crib. The 216-A-36B Crib is located in the 200 East Area, south of the 202-A Building. It is next to the 216-A-10 Crib. Drilling of borehole C4160 began July 2, 2003, and was completed September 9, 2003.

#### 3.3.3.1 Geophysical Logging Summary for the 216-A-36B Crib

The crib was backfilled with native materials from the Hanford formation sand-dominant unit excavated at the surface. The crib bottom was breached at a depth of 8 m (26.5 ft) bgs, where the sediments were undisturbed Hanford formation. The sand unit extended from 7.9 m to 29.4 m (26 to 97 ft) bgs. Immediately below the bottom of the crib, the radiological control technician field screening detected greater than 100,000 c/min beta-gamma and 20,000 d/min alpha on contact with the soils; this had an associated dose rate of 70 mR/hr gamma and 518 mR/hr beta. The dose rate decreased to 5 mR/hr at a depth of 10.9 m (36 ft) bgs, then dropped off to background levels past 17 m (56 ft) bgs. No other radiological anomalies were detected during the drilling phase.

Industrial hygiene monitoring of the drill cuttings and the breathing zone detected ammonia vapors in the soils at a depth of about 20.9 m (69 ft) bgs, at a concentration of 3 p/m. The formation graded into a silty sand from a depth of 29.4 m to 51.5 m (97 to 170.5 ft) bgs. The silty sand contains calcium carbonate cement as intergranular masses and coatings on individual grains; carbonate accumulations tend to be greater where the silt content increases. An observation was that the ammonia content rose with an increase in carbonate cement and fine-grained particles; conversely, the ammonia content decreased where the sand content increased.

At 51.5 m (170.5 ft) bgs the formation grades back into medium- and coarse-grained sand that contains sporadic silt and rare gravel. The sand layer continues to a depth of 77 m (254 ft) bgs, where it becomes a 3 m- (10-ft-) thick layer of gravelly sand, before returning to a sand layer with minor silt that extends to 87.1 m (287.5 ft) bgs.

A paleosol was encountered from 87.1 m to 89.2 m (287.5 to 294.5 ft) bgs. The 0.15 m (0.5 ft) immediately above the paleosol exhibited rip-up mud clasts in a sand matrix. The paleosol was light to medium brown silt and clay with a small clastic dike through the upper third of the unit. Immediately below the paleosol was a silty gravelly sand to 91.8 m (301 ft) bgs that graded into

a silty sandy gravel to the bottom of the hole. The water table was established at 97.5 m (319.6 ft) bgs, where the hole was terminated and decommissioned.

Geophysical logging (CP 18666, Appendix F-8) was performed for this borehole using the SGLS, HRLS, and NMLS between August 5, 2003, and September 2, 2003. Cesium-137 and $^{60}$Co were the only man-made radionuclides found in the borehole. Cesium-137 was detected near the ground surface between 0 m and 1.5 m (0 and 5 ft) bgs, at less than 10 pCi/g. It was detected again between 6.1 m and 29.0 m (20 and 95 ft) bgs with a maximum overall concentration of approximately 2,000,000 pCi/g at a depth of 8.2 m (27 ft) bgs, a large change over the surface concentration. The highest concentrations of $^{137}$Cs contamination were found in the zones of 7.3 m to 11.2 m (24 to 37 ft) bgs and 14.5 m to 15.5 m (48 to 51 ft) bgs.

Cobalt-60 was detected between 11.5 m and 18.2 m (38 and 60 ft) bgs and in sporadic locations to 35.1 m (116 ft) bgs. The maximum concentration of $^{60}$Co was detected at about 15.2 m (50 ft) bgs, at 1.5 pCi/g. The logging summary suggests that $^{60}$Co also may exist within the 7.3 m to 11.2 m- (24- to 37-ft-) bgs zone of $^{137}$Cs contamination, because the MDL for $^{60}$Co is greatly increased at this interval. It is also theorized that drag-down of material on the outside of the carbon steel temporary casing may have caused cross contamination while the borehole was being drilled. This is postulated because the $^{137}$Cs contamination ends at approximately 28.4 m (93 ft) bgs, the same depth at which the first string of temporary casing (10 in.) stops; however, $^{60}$Co contamination extends past the 28.4 m (93-ft) point deeper into the borehole. This suggests that man-made contamination caused by smearing could now reside within the other shallow zones.

The sample results for $^{137}$Cs from this borehole confirm its presence. At 7.6 m (25 ft) bgs, the sample results were 2,650,000 pCi/g. The $^{137}$Cs concentrations at 8.3 m and 9.1 m (27.5 and 30 ft) bgs were 95,100 and 68,200 pCi/g, respectively. The $^{137}$Cs results at 12.1 m (40 ft) bgs are markedly lower (5.08 pCi/g) and decrease at greater depths. These data support the suggestion in the logging report that $^{137}$Cs may have been drug down during borehole drilling and casing activities. Cobalt-60 was reported in the 7.6 m- (25-ft-) bgs samples at 623 pCi/g. Like $^{137}$Cs, the concentration decreases rapidly with depth. Its concentration is 1.35 pCi/g at 12.1 m (40 ft) bgs.

The other radionuclides found in samples in concentrations greater than two times the reported MDA were $^{63}$Ni (695 pCi/g) at 9.1 m (30 ft) bgs, and $^{239/240}$Pu (0.42 pCi/g) found at 16.2 m (53.5 ft) bgs. Strontium-90 was found at depths of 9.1 m to 16.2 m (30 to 53.5 ft) bgs in concentrations ranging from 102 to 86,700 pCi/g. The maximum concentration occurred at 9.1 m (30 ft) bgs. Tritium was found at depths of 12.1 m to 96.5 m (40 to 318.5 ft) bgs and ranged in concentration from 3.61 to 76.5 pCi/g. The maximum concentration of tritium occurred at 87.1 m (287.5 ft) bgs.

The natural $^{238}$U in the potassium-uranium-thorium gamma log exhibited a relatively higher concentration between the depths of 0 m and 28.2 m (0 and 93 ft) bgs than in the remainder of the borehole. It was surmised in the logging report that this concentration suggests that enhanced radon could be present in the first string of temporary casing.

Based on the neutron moisture logging, the soil column contains no notable wet areas except at a depth of around 87.6 m (289 ft) bgs where the neutron counts per second increases from about 125 c/sec to over 260 c/sec. The logging report notes this depth coincides with a relatively higher $^{232}$Th concentration, suggesting that a clayey material exists at this depth. The sample data confirm that this depth (87.1 m [287.5 ft] bgs) has a higher percent moisture (14.7 percent) than shallower (2.9 percent at 27.1 m [89.5 ft0 bgs) or deeper (3.8 percent at 96.5 m [318.5 ft] bgs) depths.

### 3.3.3.2 216-A-36B Crib Contamination–Laboratory Data

The effluent discharged to the 216-A-36B Crib was ammonia scrubber waste from the PUREX Facility, low in salt and neutral to basic, which contained large amounts of uranium (DOE/RL-2000-60, Rev. 1). When actively receiving effluent, the crib was about 7.6 m (25 ft) deep.

A soil sample from the 25 ft bgs level of Borehole C4160 (Hanford Environmental Information System [HEIS] sample number B17487) was sent to the Hanford Site's 222-S Laboratory for analysis because of its highly elevated levels of several radionuclides. The data from this analysis are presented in Appendix B.

Contamination was detected in the vadose zone beneath the 216-A-36B Crib in Borehole C4160 to a depth of 96.5 m (318.5 ft) bgs for radionuclides. Maximum contaminant concentrations are present in the crib to a depth of 87.1 m (287.5 ft) bgs. Of the contaminants whose concentrations are over 3 pCi/g, maximum concentrations, with two exceptions (tritium and $^{40}$K) are present in the 7.6 m to 9.1 m (25 to 30-ft) depth interval of the soil column.

The following radionuclides were detected at the given maximum concentrations in the 7.6 m to 9.1 m (25 to 30 ft) bgs zone.

| | | | |
|---|---|---|---|
| • $^{241}$Am | 40,000 pCi/g | • $^{90}$Sr | 208,000 pCi/g |
| • $^{14}$C | 116 pCi/g | • $^{99}$Tc | 41.9 pCi/g |
| • $^{137}$Cs | 2,650,000 pCi/g | • $^{230}$Th | 11.4 pCi/g |
| • $^{60}$Co | 623 pCi/g | • $^{232}$Th | 4.8 pCi/g |
| • $^{154}$Eur | 1,800 pCi/g | • $^{233/234}$U | 41.2 pCi/g |
| • $^{63}$Ni | 181,000 pCi/g | • $^{235}$U | 3.3 pCi/g |
| • $^{239/240}$Pu | 98,000 pCi/g | • $^{236}$U | 4.5 pCi/g |
| • Total radioactive strontium | 92,100 pCi/g | • $^{238}$U | 70.9 pCi/g |

The maximum concentration of tritium (121 pCi/g) is found at 287.5 ft bgs. Two elevated (above 70 pCi/g) readings were found at the 87.1 m to 88.5 m (287.5 to 292 ft) bgs interval; the other readings were in the 3 to 30 pCi/g range relatively constant. Tritium was reported as a nondetect at 0.022 pCi/g at 3.8 m (12.5 ft) bgs.

Tritium and potassium are mobile contaminants whose distribution commonly occurs throughout the soil column. Additional radioisotopes such as $^{228}$Ac, $^{125}$Sn, $^{212}$Bi, $^{214}$Bi, $^{212}$Pb, $^{214}$Pb, $^{238}$Pu, $^{226}$Ra, $^{228}$Ra, and $^{208}$Tl also were detected in the upper 4.5 m (15 ft) bgs, and in some cases deeper. However, concentrations were less than 1 pCi/g.

With few exceptions, radionuclides either were not detected or were detected at concentrations of less than about 2.0 pCi/g at depths greater than 12.1 m (40 ft). Cesium-137 (4.1 pCi/g at 16.2 m [53.5 ft] bgs), $^{90}$Sr (102 pCi/g at 16.2 m [53.5 ft] bgs), and, as discussed earlier, tritium and $^{40}$K are present in the vadose zone at depths greater than 19.0 m (12.1 m [40 ft]) bgs.

The radioactive contaminants at the 216-A-36B Crib are markedly elevated at the 7.6 m (25-ft) bgs depth (i.e., the historical base of the crib). When the 12.1 m- (40-ft-) bgs depth is reached, the concentration falls again; by the time the 15.2 m- to 18.2 m- (50- to 60-ft-) bgs depth is reached, the concentration levels return to those seen at the surface. This behavior is true of $^{241}$Am, $^{14}$C, $^{60}$Co, $^{137}$Cs, $^{63}$Ni, $^{239/240}$Pu, $^{99}$Tc, $^{90}$Sr, and all uranium isotopes plus total uranium. This pattern is consistent with the conceptual contaminant distribution model shown in DOE/RL-2000-60, Rev. 1.

The high levels of $^{239/240}$Pu and $^{241}$Am in waste sample B17487 indicate the possibility that some of the soil from this crib may designate as transuranic waste.

Residual concentrations of pesticides and herbicides used to kill vegetation on the surface of the crib were tested for at 0.15 m (0.5 ft) bgs. None were detected.

Analytes from Borehole C4160 soil samples that exceeded screening levels included nitrate (as nitrogen) (289 mg/kg at 16.2 m [53.5 ft] bgs), nitrite (as nitrogen) (18.8 mg/kg at 7.6 m [25 ft] bgs), nitrogen in nitrate and nitrite (287 mg/kg at 16.2 m [53.5 ft] bgs) and total uranium (36.8 mg/kg at 9.1 m [30 ft] bgs).

Unusually high (~50 mg/kg) nickel detects at 7.3m to 7.6 m (24 to 25 ft) bgs are surrounded by below-background detects of from 4 mg/kg to 19 mg/kg. The high detects are likely related to the large amounts of $^{63}$Ni in this region of the borehole. Besides uranium, no other metal shows the distinctive distribution pattern of contamination at 7.6 m (25 ft) bgs.

Ammonia shows a high concentration (40 mg/kg to 60 mg/kg at 16.2 m [53.5 ft] bgs), which is to be expected for sites that received ammonia scrubber waste.

Sodium dichromate and ammonium fluoride are chemical contaminants associated with ammonia scrubber waste. Fluoride did not exceed background for this site; total chromium exceeded background, but did not exceed screening levels. More details are presented in Chapter 5.

A stratigraphy diagram for the 216-A-36B Crib is shown in Figure 3-11. Stratigraphy and data are shown in Figure 3-12. Vertical profile plots of contaminants are shown in Figure 3-13.

### 3.3.4 Nature and Extent of Contamination in the 216-A-37-1 Crib

This section describes the nature and extent of contamination in the 216-A-37-1 Crib. The 216-A-37-1 Crib is located outside the 200 East Area perimeter fence, east of the 202-A Building. It received process condensate waste from the 242-A Evaporator.

The condensate contained mixed waste from spent halogenated and nonhalogenated solvents and ammonia. Drilling of Borehole C4106 commenced April 28, 2003, and was completed May 13, 2003, after attaining a depth of 84.8 m (278 ft) bgs.

### 3.3.4.1 Geophysical Logging Summary for the 216-A-37-1 Crib

Borehole C4106 is the single hole drilled for the purpose of characterizing the 200-PW-4 OU. The borehole was drilled to a total depth of 84.8 m (278 ft) bgs, and the water table was found at 84.1 m (277.5 ft) bgs. The crib was excavated into the Hanford formation sand-dominant unit; the bottom of the crib was 3.8 m (12.5 ft) below the collar of the borehole. During drilling no anomalous elevated readings were taken on the sediments from either the industrial hygiene or radiological control technician monitoring the soils and breathing zone. All soil cuttings were containerized and stored on Site awaiting analytical results that will determine their final disposition.

The sand-dominant unit consists of fine- to medium-grained sand from 3.8 m to 19.7 m (12.5 to 65 ft) bgs, where it grades into a silty sand to 36.2 m (119.5 ft) bgs. The silty sand grades into a gravelly sand to 40 m (132 ft) bgs. From 40 m to 71.8 m (132 to 237 ft) bgs the unit transitions from sand to silty sand to silty sandy gravel and back until it contacts the Hanford formation gravel-dominant unit at 71.8 m (237 ft) bgs.

The pebble-cobble dominant silty sandy gravel extends to the bottom of the boring. This unit consists of basaltic and metamorphic granules, pebbles, and cobbles in a moderately carbonate cemented sand matrix with light iron oxide staining disseminated over the grains.

Radiological field surveys revealed background-level counting rates throughout the length of the borehole. No organic vapors were detected.

Geophysical logging was performed for this borehole using the SGLS and the NMLS between April 30, 2003, and May 12, 2003 (CP-18666, Appendix F-1). Cesium-137 was the only man-made radionuclide found in the borehole (CP-18666, Appendix F-1.). It was detected near the ground surface at concentrations of 0.3 pCi/g. Cesium-137 was observed again between 2.7 m and 11.0 m (9 and 36 ft) bgs, at concentrations ranging from 0.2 to 30 pCi/g. The maximum concentration was measured at 3 m (10 ft) bgs. Cesium-137 was detected again at 18.9 m, 19.8 m, and 50.9 m (62, 65, and 167 ft) bgs at its MDL of 0.2 pCi/g. The samples show no evidence of a photopeak at 662 keV and the reported peaks probably were results of statistical fluctuation (CP-18666, Appendix F-1).

The sample data obtained from this borehole provide two results above the MDA for $^{137}$Cs. At 3.8 m (12.5 ft) bgs, the result is 0.113 pCi/g (MDA of 0.014) and at 5.3 m (17.5 ft) bgs, the result is 0.018 pCi/g (MDA of 0.012). Results at 8.3 m (27.5 ft) bgs were below the MDA of 0.003 pCi/g and would have been expected to be around 10 pCi/g based on the logging. The concentration of $^{137}$Cs from logging at 10.9 m (36 ft) bgs was around 0.2 pCi/g, which is the approximate MDA reported for logging. A sample at 11.4 m (37.5 ft) was reported below the MDA of 0.01 pCi/g.

The other nonnatural radionuclides that were reported above the MDA in samples from this borehole were $^{241}$Am (0.02 pCi/g) at 45.0 m (147.5 ft) bgs, $^{154}$Eu (0.043 pCi/g) at 29.5 m (97.5 ft) bgs, $^{63}$Ni (14.4 pCi/g) at 11.4 m (37.5 ft) bgs, $^{239/240}$Pu (0.012 and 0.006 pCi/g) at 14.5 m and 29.7 m (47.5 and 97.5 ft) bgs respectively, and $^{90}$Sr (1.7 pCi/g) at 3.8 m (12.5 ft) bgs. Tritium was detected at depths from 5.3 m to 83.1 m (17.5 to 272.5 ft) bgs. Reported soil concentrations ranged from 50 to 267 pCi/g, with the maximum concentration occurring at 14.5 m (47.5 ft).

The potassium-uranium-thorium log showed some discontinuities with regard to uranium and was not consistent from run to run. The behavior of the $^{238}$U log may be the result of radon and its daughter $^{214}$Bi also being present in the borehole casing (CP-18666, Appendix F). Sample results for $^{238}$U from 3.8 m to 83.1 m (12.5 to 272.5 ft) bgs ranged from 0.111 to 0.0.396 pCi/g, less than the Hanford Site soil background of 1.1 pCi/g.

Neutron moisture logging showed a slightly moister level from about 21.4 m to 32.6 m (70 to 107 ft) bgs. No laboratory percent-moisture measurements were reported in that depth range. At depths of 45.0 m, 60.2 m, and 83.1 m (147.5, 197.5, and 272.5 ft) bgs the percent-moisture results ranged from 3.2 to 4.1 percent.

### 3.3.4.2 216-A-37-1 Crib Contamination–Laboratory Data

Contamination was detected in the vadose zone beneath the 216-A-37-1 Crib in Borehole C4106 to a depth of 83.1 m (272.5 ft) bgs for radionuclides. Of the COCs whose concentrations are over 1 pCi/g, maximum concentrations are present in the 3.8 m to 14.4 m- (12.5- to 47.5-ft-) depth interval of the soil column. When actively receiving effluent, the crib was about 2.4 m to 4.3 m (8 to 14 ft) deep.

The following radionuclides were detected at the given maximum concentrations in the 0 m to 14.4 m (0 to 47.5 ft) bgs zone.

- $^{63}$Ni 14.4 pCi/g
- $^{90}$Sr 1.7 pCi/g
- Tritium 267 pCi/g.

The concentration of the major radioactive contaminants stayed relatively constant throughout the depth of the borehole. The data do not strongly support the presence of any radionuclide with concentrations of over 1 or 2 pCi/g, nor do they support a discernible distribution pattern. The exception is tritium, which clearly is present throughout the borehole, and whose concentration decreases slightly with depth. The high $^{63}$Ni number appears to be an anomaly when compared to the balance of the laboratory data, although it is corroborated by the gamma logging results.

Additional radioisotopes such as $^{228}$Ac, $^{212}$Bi, $^{214}$Bi, $^{137}$Cs, $^{212}$Pb, $^{214}$Pb, $^{226}$Ra, $^{228}$Ra, $^{208}$Tl, $^{228}$Th, $^{232}$Th, $^{233/234}$U, $^{235}$U, and $^{238}$U also were detected in this upper zone. However, concentrations were equal to or less than 1 pCi/g.

Residual concentrations of pesticides and herbicides used to kill vegetation on the surface of the crib were tested for at 0.15 m (0.5 ft) bgs. None were detected.

Maximum concentrations were detected at various depths in concentrations above screening levels beneath the 216-A-37-1 Crib. Nitrate (as nitrogen) (385 mg/kg at 3.8 m [12.5 ft] bgs), nitrogen in nitrate and nitrite (489 mg/kg at 3.8 m [12.5 ft] bgs), aluminum (15,000 mg/kg at 22 m [72.5 ft] bgs), manganese (652 mg/kg at 15.2 m [50 ft] bgs) and thallium (1.54 mg/kg at 29.5 m [97.5 ft ] bgs) exceeded screening levels in soil samples collected from Borehole C4102.

The effluent discharged to the 216-A-37-1 Crib was process condensate from the 242-A Evaporator. The process condensate contained mixed waste from spent halogenated and nonhalogenated solvents and ammonia (DOE/RL-2000-60, Rev. 1).

The contaminant distribution model for this site indicates that high contamination may be expected from 3.3 m to about 9.1 m (11 to 30 ft) and medium contamination may be expected from 9.1 m to about 12.1 m (30 to 40 ft) bgs. The characterization data are well correlated with this model.

A stratigraphy diagram for the 216-A-37-1 Crib is shown in Figure 3-14. Stratigraphy and data are shown in Figure 3-15. Vertical profile plots of contaminants are shown in Figure 3-16.

### 3.3.5 Nature and Extent of Contamination in the B-12 Crib

This section describes the nature and extent of contamination in the 216-B-12 Crib. The 216-B-12 Crib is located in the 200 East Area about 305 m (1,000 ft) northwest of the 221 B Building. Drilling of Borehole C3246 commenced May 29, 2003, and was completed June 24, 2003.

#### 3.3.5.1 Geophysical Logging Summary for the 216-B-12 Crib

The 216-B-12 Crib was constructed into the Hanford formation sand-dominant facies beneath a veneer of surface stabilization materials. The bottom of the crib was filled with sized 10 cm to 15 cm (4- to 6-in.) pebbles and cobbles to effect a distribution of the discharge solutions. The bottom of the crib was exited at a depth of 9.8 m (32.5 ft) below the collared borehole. The sand and intercalated sporadic silt and minor gravel lenses containing weak to moderate calcium carbonate cement extended from the bottom of the crib to 56.8 m (187 ft) bgs, where the sediments transitioned to a gravelly sand and sandy gravel to a depth of 63.9 m (211 ft) bgs. The sediment was sand with moderate carbonate cement from 63.9 m to 74.2 m (211 to 245 ft) bgs, at the top of the gravel-dominant facies. The water table was at 92.7 m (306 ft) bgs, and the total drilled depth was 93.3 m (308 ft).

The gravel-dominant facies consists of sandy pebble-cobble gravel where the maximum particle size ranges to 12.7 cm x 7.6 cm x 10.1 cm (5 in x 3 in x 4 in), and the sand is medium to coarse grained. The unit contains carbonate cement that reacts moderately to strongly with

10 percent hydrochloric acid. The iron oxide staining is seen locally as a component of the matrix in the intergranular cement.

Field screening of the soils during drilling indicated measurable radioactivity from the bottom of the crib to a depth of 28.8 m (95 ft) bgs. The counts ranged to a high of $1.6 \times 10^6$ counts per minute at 26.5 m (87.5 ft) bgs, with an associated dose rate of 1.2 mR/hr. The dose rates from the bottom of the crib to 25.8 m (85 ft) bgs ranged to a high of 10 mR/hr at a depth of 17.4 m (57.5 ft) bgs; the total counts for this interval were not available.

Industrial hygiene monitoring of the borehole revealed ammonia and other organic vapors in the drill cuttings. All the cuttings were contained in plastic sleeves as they were removed from the borehole. The vapors were controlled and contained via the engineered controls applied in the form of an exhaust head for the borehole and exhauster vents and fans for the breakdown table. These controls prevented the vapors from getting into the breathing zone. Ammonia was detected at 31 p/m through a slit in the sleeved sediments at a depth of 13.6 m (45 ft). At approximately 22.7 m (75 ft) bgs the organic vapors no longer were detectable.

Geophysical logging was performed in Borehole C3246 using the SGLS, the HRLS, and the NMLS on June 5, 2003, June 9, 2003, and June 19, 2003. Cesium-137, $^{238}U$ and $^{154}Eu$ were the only man-made radionuclides present in this borehole. CP-18666, Appendix F, stated that $^{137}Cs$ was detected near the ground surface and up to 2.1 m (7 ft) bgs, ranging in concentration from 0.3 to 14 pCi/g. The $^{137}Cs$ was again encountered in the interval of 9.1 m to 33.6 m (30 to 111 ft) bgs, at concentrations ranging from 0.6 to 121,000 pCi/g. The maximum concentration was seen at 10.6 m (35 ft) bgs. It also was detected at 7.6 m, 36.1 m, 36.4 m, and 81.2 m (25, 119, 120, and 268 ft) bgs at concentrations of 0.3, 0.3, 0.9, and 0.2 pCi/g, respectively.

The sample data obtained from this borehole do not report any detectable $^{137}Cs$ results from the 4.4 m- (14.5-ft-) bgs samples. At 10.8 m (35.5 ft) bgs the $^{137}Cs$ results are 61,900 pCi/g and represent the highest results of any of the samples taken at lower depths. The sample data show $^{137}Cs$ at 3,080 pCi/g at 12.1 m (40 ft) bgs, 21,300 pCi/g at 15.2 m (50 ft) bgs, and 0.003 pCi/g at 28.6 m (94.5 ft) bgs. Although the borehole logging results are consistently higher than the sample data, the relative levels of sample results at different depths are consistent and generally confirm the vertical distribution of the radionuclide predicted by logging.

The logging report stated that processed uranium ($^{238}U$) was detected at 35.8 m (118 ft) bgs at a concentration of 13 pCi/g. No samples were obtained at 35.8 m (118 ft) bgs. Samples were obtained at 28.6 m to 59.8 m (94.5 and 197.5 ft) bgs and $^{238}U$ results ranged from 0.69 to 1.7 pCi/g.

Europium-154 was detected during logging at 9.4 m (31 ft) bgs, with a concentration of 9 pCi/g. It was surmised in the logging report that $^{154}Eu$ also may occur in the high-rate zone, between 9.7 m and 20.9 m (32 to 69 ft) bgs, however it was not detected because of interference from the high levels of $^{137}Cs$ in that zone. Sample results from this borehole did not show any detectable $^{154}Eu$. Only one sample result was detected above the MDA for any of the europium isotopes; that was for $^{155}Eu$ (0.282 pCi/g) at 28.6 m (94.5 ft) bgs.

Other non-natural radionuclides detected at single depths in samples obtained from this borehole included $^{241}$Am (2 pCi/g) at 10.8 m (35.5 ft) bgs, $^{14}$C (3.3 pCi/g) at 18.9 m (62.5 ft) bgs, and $^{239/240}$Pu (0.2 pCi/g) at 15.2 m (50 ft) bgs. Strontium-90 was detected at depths of 10.8 m to 28.6 m (35.5 to 94.5 ft) bgs. The reported $^{90}$Sr concentrations ranged from 12.5 to 12,700 pCi/g, with the maximum concentration occurring at 10.8 m (35.5 ft) bgs. Tritium was detected at 4.4 m (14.5 ft) (8.28 pCi/g) and 10.8 m (35.5 ft) (2.62 pCi/g) bgs. Tritium also was detected at a lower depth in samples from 28.6 m to 91.5 m (94.5 to 302 ft) bgs. The reported levels in these deeper samples ranged from 4.95 to 7.59 pCi/g, with the maximum occurring at 91.5 m (302 ft) bgs.

Recognizable changes in the potassium-uranium-thorium logs occurred in this borehole. The potassium-uranium-thorium logs showed decreases in $^{40}$K and increases in $^{238}$U, which is associated with the different geometry near the base of the borehole, because it was logged in stages. However, below 56.1 m (185 ft) bgs the decrease in $^{40}$K represented a transition from fine-grained to coarser grained sediments.

Neutron moisture logs showed no major areas of wetness and were reported to be within acceptable repeatability limits. Analytical sample results at 28.6 m and 91.5 m (94.5 ft and 302 ft) bgs were 2.6 and 2.9 percent moisture, respectively.

### 3.3.5.2 216-B-12 Crib Contamination–Laboratory Data

Contamination was detected in the vadose zone beneath the 216-B-12 Crib in Borehole C3246 to a depth of 91.5 m (302 ft) bgs for radionuclides. However, many of these maximum concentrations are less than 1 or 2 pCi/g.

When actively receiving effluent, the 216-B-12 Crib was about 7.9 m (26 ft) deep on one end and 9.1 m (30 ft) deep on the downgradient end. With few exceptions, all radioisotopes with concentrations greater than 1.2 pCi/g were located at or above the 12.1 m (40 ft) bgs level of the borehole.

The following radionuclides were detected at the given maximum concentrations in this upper zone.

- $^{137}$Cs 61,900 pCi/g
- $^{155}$Eu 34.9 pCi/g
- $^{239/240}$Pu 3.9 pCi/g
- $^{40}$K 14.2 pCi/g
- $^{90}$Sr 12,700 pCi/g
- $^{228}$Th 7.5 pCi/g
- Tritium 8.3 pCi/g
- $^{233/234}$U 4.9 pCi/g
- $^{238}$U 5.1 pCi/g

The concentration of the major radioactive contaminants generally decreased with depth beneath the crib bottom. Additional radioisotopes such as $^{228}$Ac, $^{241}$Am, $^{212}$Bi, $^{214}$Bi, $^{212}$Pb, $^{214}$Pb, $^{237}$Np, $^{226}$Ra, $^{228}$Ra, $^{208}$Tl, $^{230}$Th, $^{232}$Th, $^{234}$Th, $^{113}$Sn, and $^{235}$U also were detected in this upper zone. However, concentrations were equal to or less than 2 pCi/g.

With a few exceptions, radionuclides either were not detected or were detected at concentrations of less than about 2.0 pCi/g at depths greater than 12.1 m (40 ft). Carbon-14 (maximum

3.3 pCi/g at 18.9 m [62.5 ft]), $^{137}Cs$ (maximum 31,500 pCi/g at 15.2 m [50 ft]), $^{40}K$ (maximum 15.8 pCi/g at 59.9 m [197.5 ft]), strontium-90 (maximum 97.1 pCi/g at 15.2 m [50 ft]), tritium (maximum 7.59 pCi/g at 91.5 m [302 ft]) are sporadically present in the vadose zone at depths greater than 12.2 m (40 ft) bgs.

The effluent discharged to the 216-B-12 Crib was condensate waste from the 221-U, 224-U and 221-B Buildings. The Work Plan (DOE/RL-2000-60, Rev. 1) describes it as containing "larger amounts of uranium, fission products and tributyl phosphate." The high $^{137}Cs$ and $^{90}Sr$ concentrations, and the presence of radioisotopes such as $^{14}C$, $^{154}Eu$, $^{40}K$ and tritium corroborate this history. Tributyl phosphate was found at a maximum concentration of 2,000 µg/kg at a depth of 12.2 m (40 ft) bgs; it was found at a concentration of 610 µg/kg at 29.5 m (97.5 ft) bgs.

Residual concentrations of pesticides and herbicides used to kill vegetation on the surface of the crib were tested for at 0.15 m (0.5 ft) bgs; none were detected.

Ammonium, nitrate, nitrogen in nitrate and nitrite, boron, total chromium, mercury, silver, thorium, and uranium exceeded screening levels in soil samples collected from Borehole C3246. Maximum concentrations were detected at various depths in concentrations above screening levels beneath the 216-B-12 Crib.

- Ammonia as N — 404 mg/kg at 28.6 m (94.5 ft)
- Boron — 1.3 mg/kg at 4.4 m (14.5 ft)
- Chromium (total) — 30.4 mg/kg at 91.5 m (302 ft)
- Nitrate (as N) — 165 mg/kg at 10.8 m (35.5 ft)
- Nitrogen in nitrate and nitrite — 126 mg/kg at 15.2 m (50 ft)
- Mercury — 1.3 mg/kg at 10.8 m (35.5 ft)
- Silver — 2.4 mg/kg at 15.2 m (50 ft)
- Thorium — 5.4 mg/kg at 28.6 m (94.5 ft)
- Uranium — 28 mg/kg at 10.8 m (35.5 ft).

The contaminant distribution model in the Work Plan (DOE/RL-2000-60, Rev. 1) is well correlated with the characterization results. Most of the radionuclides were found in the predicted high-contamination range (4.5 m to 19.7 m [15 to 65 ft] bgs), as were many of the metals associated with contamination. Those that were found in elevated concentrations farther down the borehole were still in the predicted medium-contamination range (to 30.3 m [100 ft] bgs) except chromium, which was high at the 91.5 m (302-ft) level.

A stratigraphy diagram for the 216-B-12 Crib is shown in Figure 3-17. Stratigraphy and data are shown in Figure 3-18. Vertical profile plots of contaminants are shown in Figure 3-19.

### 3.3.6 Nature and Extent of Contamination in the 207-A South Retention Basin

This section describes the nature and extent of contamination in the 207-A South Retention Basin, which is located in the 200 East Area, directly east of the 242-A Evaporator. It was used for the interim storage of 242-A Evaporator process condensate to allow for sampling and analysis before the condensate was discharged to the 216-A-37-1 Crib for final disposition.

The basin consists of three concrete cells, 2.1 m (7 ft) deep, with elastomeric coating to prevent constituents from penetrating the concrete. It was in service from 1977 to 1989 (DOE/RL-2000-60, Rev. 1).

### 3.3.6.1 Geophysical Logging Summary for the 207-A South Retention Basin

Logging data were not collected for the 207-A South Retention Basin. This type of logging is not effective in the 4.2 m (14-ft) shallow borehole used at this site. The conceptual contaminant distribution model for this site (DOE/RL-2000-60, Rev. 1) indicates that contamination is unlikely to be present more than about 4.5 m (15 ft) bgs because the coated concrete effectively protected the soil from contamination.

### 3.3.6.2 207-A South Retention Basin Contamination–Laboratory Data

Three types of samples were collected for this site: the concrete basin and elastomeric lining; borings of the soil beneath the lining, collected to a depth of 4.2 m (14 ft) bgs; and composite samples of the soil and the water from residual runoff in the basin.

To collect soil borings and concrete samples, three push holes were made, C4113 in the west cell, C4114 in the middle cell, and C4115 in the east cell.

Relatively little radionuclide contamination was detected in the vadose zone beneath the 207-A South Retention Basin. Maximum contaminant concentrations are nearly all present in the top 1.8 m (6 ft) of the borehole, and concentrations are relatively small. Of the contaminants with concentrations of over 1 pCi/g, maximum concentrations are present in Borehole C4115 (east cell), except for $^{90}$Sr whose maximum concentration is in Borehole C4114 (middle cell).

The only radionuclides wit measured concentrations higher than 1.5 pCi/g were $^{234}$Th (3.16 pCi/g) and tritium (16.6 pCi/g).

Additional radioisotopes such as $^{228}$Ac, $^{241}$Am, $^{212}$Bi, $^{214}$Bi, $^{137}$Cs, $^{155}$Eu, $^{212}$Pb, $^{214}$Pb, $^{94}$Nb, $^{239/240}$Pu, $^{226}$Ra, $^{228}$Ra, $^{208}$Tl, $^{228}$Th, $^{230}$Th, $^{232}$Th, $^{234}$Th, $^{233/234}$U, $^{235}$U, and $^{238}$U also were detected. However, concentrations were equal to or less than 1 pCi/g.

The effluent discharged to the 216-A-37-1 Crib was process condensate from the 242-A Evaporator containing mixed waste from spent halogenated and nonhalogenated solvents and ammonia (DOE/RL-2000-60, Rev. 1).

Residual concentrations of pesticides and herbicides were tested for at 0.3 m to 0.6 m (1 to 2 ft) bgs. 2,4-dichlorophenoxyacetic acid (7.1 µg/kg, Borehole C4115) and 2-(2,4,5-trichlorophenoxy) propionic acid (3.3 µg/kg, Borehole C4114) were found in one of six samples.

Maximum concentrations of nonradionuclides were detected at various depths, however none exceeded screening levels.

#### 3.3.6.3 Concrete Samples from the 207-A South Retention Basin

Three concrete samples were taken from boreholes in each of the east, middle, and west cells in the 207-A South Retention Basin.

Organics related to the composition of the elastomer were found in the concrete. The Material Safety Data Sheets and elastomer descriptions and engineering drawings were reviewed. The constituents such as xylenes, all benzene derivatives, cresols, naphthalene and its derivatives, isopherone and other ketones, were all constituents related to the elastomer. The diesel, gasoline, motor oil, and octadecane are fuel-related residuals. These were not detected in the soil beneath the basin. Tributyl phosphate was in the process condensates that originally were stored in the basin (DOE/RL-2000-60, Rev. 1) and is present in small amounts in the concrete. The mesityl oxide is a tentatively identified compound, is not calibrated for, and was not used in the process.

#### 3.3.6.4 Composite Soil and Water Samples from the East, Middle and West Concrete Cells

Separate composite samples of residual soil and water runoff were taken from the east, middle, and west cells in the 207-A South Retention Basin for waste-disposal purposes. The samples were analyzed for a small suite of analytes—metals, gross alpha, gross beta, pH, a limited number of radionuclides, and total organic carbon. Risk-based screening for human health and ecological and residual radioactivity was not performed on the composites.

Gross beta was found at 15 pCi/L in the water; gross alpha was found at 2 pCi/L. Total organic carbon was measured at 18.9 mg/L. None of the other measurements seemed elevated above normal levels.

### 3.3.7 Nature and Extent of Contamination in the 216-U-8 and 216-U-12 Cribs

The 216-U-8 and 216-U-12 Cribs were characterized in 1995 as part of 200-UP-2 OU characterization activities. During the DQO process, it was determined that characterization data previously obtained for these sites are sufficient to support the 200-PW-2 OU RI/FS process. Geophysical logging of nearby boreholes for each of the two sites was intended as an efficient means to provide additional data to support refinement of the conceptual contaminant distribution models.

This section summarizes the nature and extent of contamination in the 216-U-8 and 216-U-12 Cribs from earlier characterization efforts.

The 216-U-8 Crib is located in the 200 West Area, directly south of the 224-U Building, south of 16$^{th}$ Street and west of Beloit Avenue (Figure 1-2). It is directly north of the 216-U-12 Crib. It was used for acidic process condensate from U Plant, the 224-U Building, and the 291-U-1 Stack. The waste was acidic, and contained $^{235}U$, $^{238}U$, $^{90}Sr$, $^{137}Cs$, and $^{154}Eu$. When actively receiving waste, the crib was 9.8 m (32 ft) deep (DOE/RL-2000-60, Rev. 1).

The 216-U-12 Crib is located directly south of the 216-U-8 Crib. It received 291-U-1 Stack drainage, 244-WR Vault waste, and 224-U Building process condensate. The waste was acidic liquid containing thorium, uranium, $^{90}Sr$, $^{137}Cs$, nitrate, and tributyl phosphate. When actively receiving waste, the crib was 4.6 m (15 ft) deep (DOE/RL-2000-60, Rev. 1).

The Work Plan (DOE/RL-2000-60, Rev. 1) and DOE/RL-2003-23 contain detailed discussions on contaminant distribution models, prior characterization, and geophysical logging.

### 3.3.7.1 Geophysical Logging Summary for the 216-U-8 and 216-U-12 Cribs

In 2003 and 2004 two wells were logged in the 216-U-8 Crib. These wells also were logged in 1994. Four wells were logged near the 216-U-12 Crib in 2003. One of the four had been logged in 1991. New logging data are presented for these six wells in the following paragraphs. In addition, for the two wells in the 216-U-8 Crib and the well in the 216-U-12 Crib that had been logged previously, a comparison is made to recent logging.

**216-U-8 Crib, Well 299-W19-70 (A7770).** Spectral gamma logging was performed in this borehole on March 18 and March 19, 2004. The borehole is located approximately in the center of the 216-U-8 Crib. Cesium-137 was detected in this borehole between 0.9 m and 4.0 m (3 and 13 ft) and between 10.4 m and 27.5 m (34 and 90 ft). The maximum concentration was measured at approximately 71,000 pCi/g at 11.9 m (39 ft) in depth.

Uranium-238 was detected sporadically between 13.7 m and 27.5 m (45 and 90 ft). The maximum $^{238}U$ concentration is approximately 1,400 pCi/g at 13.7 m (45 ft). The relatively high $^{137}Cs$ concentrations between 10.4 m and 27.5 m (34 and 90 ft) effectively raises the MDL for $^{238}U$ and $^{235}U$, resulting in the inability to quantify these radionuclides. Uranium-238 likely is present in the depth interval between 10.4 m and 13.7 m (34 and 45 ft) at concentrations above 1,400 pCi/g. Between 15.3 and 27.5 m (50 and 90 ft) it is likely $^{238}U$ exists at each depth interval at concentrations near and below an approximate MDL of 15 pCi/g. Uranium-235 also exists where $^{238}U$ is detected. Logging experience regarding processed uranium suggests the $^{238}U/^{238}U$ ratio is approximately 20:1. It would be necessary to acquire spectra at significantly longer counting times to quantify the processed uranium at low concentrations. The repeat sections for the SGLS indicate good agreement for the naturally occurring radionuclides.

Comparing 1994 $^{137}Cs$ RLS data with the current SGLS and HRLS data shows good agreement with regard to general profile and concentrations. A 2004 logging report of another borehole (A7771) in the crib notes that the depth of the 1994 RLS data were shifted downward 8 ft for comparison with the 2004 logging. It is surmised in the 2004 report that this may have been caused by the addition of fill on the crib surface and the extension of the casing. With that adjustment, the previous 1994 RLS gamma logs reported that $^{137}Cs$ was identified in the intervals 3.2 m to 9.9 m (10.5 to 32.5 ft) (intermittently), and 10.2 m to 27.3 m (33.5 to 89.5 ft), the maximum survey depth. Activity exceeded 200 pCi/g from 11.3 m to 22.7 m (37.0 to 74.5 ft), and from 23.6 m to 23.8 m (77.5 to 78.0 ft). The maximum activity of 16,156 pCi/g was observed at 12.8 m (42.0 ft) at the base of the zone of detector saturation. It is anticipated that the actual concentration would have been significantly higher in the region between 11.6 m and 12.8 m (38 and 42 ft) if the detector could have measured it in the 1994 runs.

The most recent $^{238}U$ comparison with the 1994 data shows the same general profile and concentrations at each depth interval. In the 1994 logging data, $^{238}U$ was identified in the interval 13.6 m to 16.0 m (44.5 to 52.5 ft), intermittently from 16.8 m to 20.6 m (55.0 to 67.5 ft), again from 21.2 m to 22.9 m (69.5 to 75.0 ft), intermittently from 24.4 m to 26.1 m (80.0 to 85.5 ft), and from 26.4 m to 27.3 m (86.5 to 89.5 ft), the maximum survey depth. Activity exceeded 200 pCi/g from 13.6 m to 14.2 m (44.5 to 46.5 ft). The maximum activity of 1,806 pCi/g was observed at 13.7 (45.0 ft).

In the 1994 logging data, $^{154}Eu$ was identified at 13.0 m (42.5 ft), and from 13.6 m to 14.5 m (44.5 ft to 47.5 ft). The maximum activity detected was 12.1 pCi/g at 10.5 m (34.5 ft), immediately below the base of the saturation zone. Europium-154 was not detected in the current logging. This is likely caused in part by radioactive decay that occurred in the ensuing 10 years and in part by high levels of $^{137}Cs$ that may have masked the $^{154}Eu$ from detection.

It appears no significant movement of uranium or $^{137}Cs$ contamination has occurred in the area of the borehole since 1994.

**216-U-8 Crib, Well 299-W19-71 (A7771).** Spectral gamma logging was performed in this borehole on March 23 and March 24, 2004. The borehole is located in the southern third of the 216-U-8 Crib. Cesium-137, $^{235}U$, and $^{238}U$ were the man-made radionuclides detected in this borehole. Cesium-137 was detected in the intervals between 1.1 and 4.4 m (3.5 and 14.5 ft) and 9.6 m and 26.8 m (31.5 and 87.9 ft) at concentrations ranging from the MDL (0.2 pCi/g) to 28,500 pCi/g. The maximum concentration of $^{137}Cs$ was measured at 12.0 m (39.5 ft).

Uranium-235 and $^{238}U$ were detected in the intervals between 14.2 m and 20.9 m (46.5 and 68.5 ft), and 24.2 m and 26.8 m (79.5 and 87.9 ft). Uranium-238 concentrations, based on the 1,001-keV photopeak, ranged from 24 pCi/g to 184 pCi/g, which was measured at 46.5 ft. U-235 concentrations, based on the 186-keV photopeak, ranged between 1.7 pCi/g to 12 pCi/g, which was measured at 17.2 m (56.5 ft).

The plots of the repeat logs from the 2004 runs demonstrate reasonable repeatability of the HRLS and SGLS data. Cesium-137 (662 keV) concentrations are comparable between the repeat and original log runs for the HRLS and SGLS. The natural radionuclides at energy levels of 609, 1,461, 1,764, and 2,614 keV also are comparable between the repeat and original SGLS log runs.

Data collected from the same borehole in 1994 by Westinghouse Hanford Company also were reviewed. In the 2004 logging report, it is noted that the depth of the 1994 RLS data were shifted downward 2.4 m (8 ft). It is surmised in the report that this shift may be caused by the addition of fill on the crib surface and the extension of the casing. The depths noted below have been revised to reflect that change in depth reference. Cesium-137 was identified in the intervals 2.4 m to 4.6 m (8.0 to 15.0 ft), 10.5 m to 11.6 m (34.5 to 38.0 ft), and 13.6 m to 26.7 m (44.5 to 87.5 ft), the maximum survey depth. Activity exceeded 200 pCi/g from 11.4 m to 11.6 m (37.5 to 38.0 ft), and from 13.6 m to 16.8 m (44.5 to 55.0 ft). The maximum activity of >10,000 pCi/g was observed at 11.6 m (38.0 ft), and from 13.6 m to 13.7 m (44.5 to 45.0 ft). The data indicated that the detector was saturated from high count rate between the two depths, thus the reported peak levels from the 2004 logging are greater than the peak levels from 1994.

In the 1994 data, $^{235}U$ was identified in the intervals 17.2 m to 18.0 m (56.5 to 59.0 ft) and 24.9 m to 26.2 m (81.5 to 86.0 ft), and at 26.5 m (87.0 ft). The maximum activity of 6.2 pCi/g was observed at 25.0 m (82.0 ft). The most prominent energy peak for $^{235}U$ at 186 KeV is unidentifiable when the $^{137}Cs$ concentration is more than 20 pCi/g.

Uranium-238 was identified throughout the intervals 13.9 m to 16.6 m (45.5 to 54.5 ft) and 16.5 m to 18.1 m (54.0 to 59.5 ft), and intermittently from 20.1 m to 21.0 m (66.0 to 69.0 ft) and 81.5 ft to 86.0 ft. Activity exceeded 200 pCi/g at 13.9 m to 14.2 m (45.5 to 46.5 ft). The maximum activity of 779 pCi/g was observed at 13.9 m (45.5 ft), the bottom of the detector saturation zone. Detector saturation prevented observation of the initial occurrence of $^{238}U$.

Comparison log plots of the data collected in 1994 by Westinghouse Hanford Company and in 2004 by Stoller were reviewed. The comparison of 1994 RLS data with the current SGLS and HRLS data shows good agreement with regard to the general $^{137}Cs$ profile and concentration. The $^{235}U$ and $^{238}U$ concentrations, as measured by the SGLS in 2004, appear to generally agree in both uranium profile and concentration with those measured in 1994 with the RLS.

It appears no significant movement of uranium or $^{137}Cs$ contamination has occurred in the area of the borehole since 1994.

**216-U-12 Crib, Well 299-W22-22 (A4967).** Spectral gamma logging was performed in this borehole on June 27 and June 30, 2003. The borehole is located about 6.1 m (20 ft) southeast of the 216-U-12 Crib.

Cesium-137 and $^{60}Co$ were the man-made radionuclides detected in this borehole. Cesium-137 was detected at a few sporadic locations in the borehole near its MDL of approximately 0.2 pCi/g. Cobalt-60 was detected between 73.8 m and 75.6 m (242 and 248 ft) near the MDL of 0.05 pCi/g. Historical gross gamma logs (ARH-ST-156, *Evaluation of Scintillation Probe Profiles From 200 Area Crib Monitoring Wells*) indicate an influx of gamma activity in the depth interval of 70 m to 89 m (230 to 292 ft) between 1965 and 1970 that had mostly decayed away by 1976. On the basis of the current SGLS log, this activity can be attributed, at least in part, to $^{60}Co$ contamination.

Notable changes are observed in the potassium-uranium-thorium and total gamma logs. An interval between 57 m and 63 m (188 and 208 ft) indicates relatively low potassium-uranium-thorium concentrations. The driller's log suggests "caliche" in this interval. The early Palouse soil (48.8 m to 57.3 m [161 to 189 ft]) is identified by a 0.3-pCi/g increase in the $^{232}Th$ concentration and a 75-c/sec increase in total gamma count rate. The naturally occurring $^{238}U$ concentrations determined from log run 2 between 0.6 m and 30.6 m (2 and 101 ft) appear slightly elevated relative to the remainder of the borehole. Enhanced radon is likely to have been present in the borehole during this log run. The repeat section indicated good agreement of the naturally occurring potassium, uranium, and thorium.

**216-U-12 Crib, Well 299-W22-23 (A7874).** Spectral gamma logging was performed in this borehole between June 30 and July 2, 2003. The borehole is located about 10.7 m (35 ft) south of the 216-U-12 Crib.

Cesium-137 and $^{60}$Co were the man-made radionuclides detected in this borehole. Cesium-137 was detected at a few sporadic locations in the borehole near its MDL of approximately 0.2 pCi/g. Cobalt-60 was detected at a depth of approximately 69.7 m (230 ft) near its MDL of 0.05 pCi/g. The comparison plot of the RLS and SGLS data shows $^{137}$Cs and $^{60}$Co contamination detected in 1995 and 2003, respectively (RLS concentrations are decayed to the date of the SGLS logging). The total depth of logging was 2.4 m (8.0 ft) greater for the RLS than the SGLS. The $^{60}$Co and $^{137}$Cs7 measured by the RLS, except for depths between 72.4 m and 73.3 m (239 and 242 ft) and at 73.9 m (244.5 ft), are below the current SGLS MDLs for $^{137}$Cs and $^{60}$Co and should be considered suspect. Cobalt-60 is detected in these depth intervals at concentrations of approximately 0.1 pCi/g.

Notable changes are evident in the potassium-uranium-thorium and total gamma logs. Relatively high concentrations of naturally occurring $^{238}$U are indicated between 15.5 m and 19.1 m (51 and 63 ft) in depth. The driller's log (WHC-SD-ER-TI-005, *Summaries of Well Construction Data and Field Observations for Existing 200-West Resource Protection Wells*) indicates a coarse sand near this interval, which may be a medium where radon is migrating and collecting in the formation. An interval between 57.6 m and 63 m (190 and 208 ft) indicates relatively low potassium-uranium-thorium concentrations. The driller's log suggests "a brown clay and some gravel and caliche" in this interval. The portion of the Cold Creek unit, formerly called early Palouse soil, (48.8 m to 63 m [161 to 190 ft]) is identified by a 0.3 pCi/g increase in the $^{232}$Th concentration and a 75-c/sec increase in total gamma count rate. The repeat section indicated good agreement of the naturally occurring potassium-uranium-thorium. Radon may affect the repeatability of the $^{238}$U results between 15.2 m and 16.7 m (50 and 55 ft) where logging runs were conducted on separate days.

**216-U-12 Crib, Well 299-W22-28 (A4969).** Spectral gamma logging was performed in this borehole on July 25 and 28, 2003. The borehole is located about 152.5 m (500 ft) west of the 216-U-12 Crib.

Cesium-137 and $^{60}$Co were the only man-made radionuclides detected in this borehole. Cesium-137 was detected at the ground surface at approximately 1.5 pCi/g. Cobalt-60 was detected at the bottom of the borehole at a concentration of approximately 0.1 pCi/g. The comparison plot of the RLS and SGLS data shows $^{137}$Cs and $^{60}$Co contamination at similar depths and concentrations (RLS concentrations are decayed to the date of the SGLS logging). The total depth of logging was 2.7 m (9 ft) greater for the RLS than the SGLS. Cobalt-60 was detected by the RLS to the total depth of 72.4 m (239 ft). It is likely the total depth of contamination has not been penetrated by the logging systems. On the basis of the RLS $^{60}$Co contamination profile between 68.2 m and 69.4 m (225 and 229 ft), where no $^{60}$Co is detected by the SGLS, downward movement of contamination may have occurred since 1995 (CP-18666, Appendix F).

Notable changes are evident in the potassium-uranium-thorium and total gamma logs. An interval between 56.1 m and 60.6 m (185 and 200 ft) indicates relatively low $^{40}$K and $^{232}$Th concentrations. The driller's log refers to this interval as a "yellow clay." The Cold Creek unit interval from 47 m to 56.7 m [155 to 187 ft]) is identified by a 0.3-pCi/g increase in the

$^{232}$Th concentration and a 75-c/sec increase in total gamma count rate. The repeat sections indicated good agreement of the naturally occurring potassium, uranium, and thorium.

**216-U-12 Crib, Well 299-W22-75 (A7879).** Spectral gamma logging was performed in this borehole on May 22 and 25, 2003. The borehole is located inside the 216-U-12 Crib.

Cesium-137, $^{235}$U (based on the 186-keV photopeak), and $^{238}$U (based on the 1001-keV photopeak) were the man-made radionuclides detected in this borehole. Cesium-137 was detected in the interval from 5.2 m to 18.5 m (17 to 61 ft) with concentrations ranging from 0.3 to 8,400 pCi/g. The maximum concentration of $^{137}$Cs was measured at 7.6 m (25 ft). Cesium-137 was detected at a depth of 3.6 m (12 ft) with a concentration near the MDL (0.2 pCi/g). Uranium-238 was detected in the intervals from 5.2 m to 6.1 m (17 to 20 ft), 8.8 m to 9.4 m (29 to 31 ft), 11.2 m to 16.1 m (37 to 53 ft), and 18.5 m to 24.5 m (61 to 81 ft) with an MDL of at least 10 pCi/g. In the interval from 5.2 m to 6.1 m (17 to 20 ft), $^{238}$U was detected at concentrations ranging from 55 to 330 pCi/g. In the interval from 8.8 m to 9.4 m (29 to 31 ft), $^{238}$U was detected at concentrations ranging from 20 to 30 pCi/g. In the interval from 11.2 m to 16.1 m (37 to 53 ft), $^{238}$U was detected with concentrations ranging from 17 to 75 pCi/g. Uranium-238 was detected in the interval from 18.5 m to 24.5 m (61 to 81 ft) at concentrations ranging from 17 to 335 pCi/g. The maximum concentration of $^{238}$U was measured at 23 m (76 ft), although the highest concentration may be in the interval of high dead time where the MDL significantly increases. Uranium-235 was detected in the intervals from 5.5 m to 5.8 m (18 to 19 ft), 20.6 m to 24.5 m (68 to 81 ft), and at 13.3 m (44 ft) with an MDL of at least 1.5 pCi/g. Uranium-235 concentrations ranged from 6 to 9 pCi/g at 5.5 m to 5.8 m (18 and 19 ft). In the interval from 20.6 m through 24.5 m (68 through 81 ft), $^{235}$U concentrations ranged from 1.8 to 22 pCi/g. Uranium-235 was detected at a depth of 13.3 m (44 ft) with a concentration of 5 pCi/g. Uranium-235 probably exists in the same intervals as the $^{238}$U (based on the 1,001-keV photopeak), but the $^{235}$U concentration falls below its MDL.

The behavior of the naturally occurring $^{238}$U log (measured by $^{214}$Bi) suggests that radon may be present inside the borehole casing. Determination of $^{238}$U is based on gamma activity measured at 609 and/or 1,764 keV associated with $^{214}$Bi, under the assumption of secular equilibrium in the decay chain. However, $^{214}$Bi is also a short-term daughter of $^{222}$Rn. When radon is present, $^{214}$Bi will tend to "plate" onto the casing wall and quickly will reach equilibrium with $^{222}$Rn. Because the additional $^{214}$Bi resulting from radon is on the inside of the casing, the effect of the casing correction is to amplify the 609 photopeak relative to the 1,764 photopeak (the magnitude of the casing correction factor decreases with increasing energy, but gamma rays originating inside the casing are not attenuated). The reason for variations in radon content between log runs on successive days is not known. However, as a gas, radon moves easily in the subsurface, and concentrations of radon and its associated progeny can change quickly. Variations in radon content in boreholes probably are related to variations in surface weather conditions. Radon daughters such as $^{214}$Bi, also may "plate" onto the sonde[1]. When this occurs, total counts increase gradually, along with the photopeak counts associated with $^{214}$Bi and $^{214}$Pb.

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[1] The sonde is an elongate cylindrical tool assembly used in a borehole to acquire a well log. It contains various energy-input devices and/or response sensors. The sonde is lowered into the borehole by a multiconductor cable or wire line.

This phenomenon appears to best explain the observed discrepancy in $^{238}U$ values based on 609 keV versus those based on 1,764 keV between 24.8 m and 13.3 m (82 and 44 ft). The presence of radon is not an indication of man-made contamination; it is derived from the decay of naturally occurring uranium.

The plots of the repeat logs demonstrate reasonable repeatability of the HRLS and SGLS data. Cesium-137 (662-keV) concentrations are comparable between the repeat and original HRLS log runs. Taking into account the effects of radon, the plots of the repeat logs demonstrate reasonable repeatability of the SGLS data for the man-made and natural radionuclides at energy levels of 186, 662, 1,001, 1,461, 1,764, and 2,614 keV.

Recognizable changes in the potassium-uranium-thorium logs occurred in this borehole. A gradual increase of approximately 8 pCi/g in apparent $^{40}K$ concentrations occurs between 9.1 m and 18.8 m (30 and 62 ft). Above 6.1 m (20 ft), $^{40}K$ concentrations are relatively low, an effect of the surface seal of grout around the borehole reported in WHC-SD-ER-TI-005. Thorium-232 concentrations increase by 0.5 pCi/g at 5.8 m (19 ft). The increase in $^{40}K$ and $^{232}Th$ concentrations at 11.2 m (37 ft) may correspond with the silt layer identified at 11.2 m (37 ft) in the geologist's log (WHC-SD-ER-TI-005).

Comparison log plots of data collected in 1991 by Westinghouse Hanford Company and in 2003 by Stoller are included in the logging report on the DOE website at http://www.gjo.doe.gov/programs/hanf/HTFVZ.html. The 1991 concentration data for $^{137}Cs$ are decayed to the date of the HRLS logging event in June 2003 and shifted from a ground-level reference to a top-of-active-core reference. The RLS tool saturated in the interval from 6.4 m to 8.2 m (21 to 27 ft). On the 2003 logs, the apparent $^{137}Cs$ concentrations are as predicted by decay alone when compared to the 1991 log except at the depths of 41.8 m, 44.8 m, 49.7 m, and 50.3 m (138, 148, 164, and 166 ft). The report written at the time of the 1991 RLS logging event reported that no man-made radionuclides were detected below 24.2 m (80 ft). Comparing the two logging events, the $^{235/238}U$ concentrations based on the 1991 RLS are higher than the 2003 SGLS in the 6.1 m to 21.4 m (20 to 70 ft) depth. The 1991 uranium results likely were influenced by the high levels of $^{137}Cs$ present in that general range. No significant movement of uranium or $^{137}Cs$ contamination appears to have occurred in the area of the borehole since 1991.

#### 3.3.7.2 216-U-8 and 218-U-12 Cribs Contamination – Summary of Prior Characterization

Laboratory data for the 216-U-8 and 218-U-12 Cribs were not collected during the FY 2003 and 2004 RI/FS characterization effort. The Work Plan (DOE/RL-2000-60, Rev. 1) indicates that existing data are sufficient to develop an understanding of radiological and chemical contaminant distribution for the 216-U-8 and 218-U-12 Cribs. The COCs were identified for these sites based on previously collected data.

**216-U-8 Crib**. Various contaminants of potential concern (primarily $^{137}Cs$, $^{90}Sr$, and uranium isotopes) were detected throughout the vadose zone beneath the 216-U-8 Crib with the more mobile contaminants detected to the maximum depth of the investigation. The highest levels of contamination, except for $^{90}Sr$, which was present throughout the soil column, were detected at the bottom of the crib at a depth of approximately 9 m (31 ft). Elevated levels of contamination extend to a depth of approximately 13 m (42 ft) and generally decrease with depth to the bottom

of the borehole. For example, $^{137}Cs$ activities ranged from 91,190 to 1,700 pCi/g between the crib-soil interface (at 8 m [32 ft]) and 13 m (42 ft). From this point to approximately 30 m (100 ft), $^{137}Cs$ activities ranged between 3.4 and 56 pCi/g. Cesium-137 was not detected below 30 m (100 ft). Contaminants with large contaminant distribution coefficients, such as plutonium and americium, were distributed similarly to $^{137}Cs$. However, the vertical extent of contamination was less than 15 m (50 ft), and concentrations were typically less than 1 pCi/g. The RLS data from other boreholes (299-W19-70 and 299-W19-71) correlate well with soil data collected from Borehole 299-W19-94. The log data indicate that the highest contaminant concentrations were associated with the bottom of the crib at about 9 m (30 ft) bgs. Concentrations decreased with depth to the bottom of each borehole at about 25 m (80 ft) bgs. Less than 10 pCi/g of $^{137}Cs$ were detected above the bottom of the crib. A detailed discussion of the distribution of contamination based on RLS data is presented in BHI-00034, *Borehole Summary Report for the 200-UP-2 Operable Unit, 200 West Area.*

The distribution of uranium isotopes in the subsurface beneath the crib indicates that this contaminant can be both mobile and immobile in the subsurface. The highest concentrations of uranium were detected at the bottom of the crib and at approximately 57 m (188 ft) bgs, associated with a caliche layer within the Cold Creek unit. Near the base of the crib, $^{238}U$ concentrations ranged between 29 and 94 pCi/g. Beneath this zone of higher contamination and to a depth of approximately 50 m (165 ft), $^{238}U$ concentrations ranged between 4.3 and 19 pCi/g. The maximum concentration of $^{238}U$ (150 pCi/g) was detected at the caliche layer at 57 m (188 ft) bgs. At the maximum extent, 61 m (199 ft) of the investigation, the $^{238}U$ concentration was less than 1 pCi/g. Uranium-233/234 and $^{235}U$ were distributed similarly to $^{238}U$. However, contaminant concentrations were not as high. Near the bottom of the crib, concentrations ranged between 1.1 and 28 pCi/g. Beneath this upper zone of contamination to a depth of approximately 50 m (165 ft), concentrations ranged between the detection limit and 20 pCi/g. Similar to $^{238}U$, elevated levels of $^{233/234}U$ and $^{235}U$ were detected associated with the caliche layer. Concentrations of these isotopes at the caliche layer were 140 and 6.7 pCi/g. At the maximum extent of the investigation, concentrations were less than 1 pCi/g.

These data indicate that the wetting front and mobile contaminants have migrated deep within the vadose zone and uranium mobility varies greatly. Strontium-90, a moderately mobile contaminant, was present throughout the soil column beneath the 216-U-8 Crib. Concentrations ranged between 36 and 130 pCi/g from the bottom of the crib to about 27 m (90 ft). Below 27 m (90 ft) bgs, concentrations generally increased with depth to 50 m (165 ft) and ranged between 370 and 520 pCi/g. A maximum concentration of 520 pCi/g was detected at 35 m (115 ft) and 50 m (165 ft) bgs in the sand-dominated sequence of the Hanford formation. Concentrations decreased to 270 pCi/g at a depth of 60 m (197 ft) bgs (DOE/RL-2003-23).

In addition to the contaminants described in the previous paragraph, arsenic, chromium, $^{241}Am$, $^{154}Eu$, $^{237}Np$, $^{238}Pu$, $^{239/240}Pu$, $^{226}Ra$, $^{228}Ra$, and $^{234}Th$ were detected during the limited field investigation (LFI). The distribution and presence of these potential contaminants of concern in the soil column are slightly above background, single detects, and sporadic detection. A summary of all contaminants detected during the LFI is presented in BHI-00034.

**216-U-12 Crib.** DOE/RL-2003-23, Draft B, indicates that the nature and extent of contamination at the 216-U-12 Crib was evaluated using the RLS and soil data. The RLS data from borehole 299-W22-75 provide the only data available to evaluate contamination directly through the 216-U-12 Crib. Data were obtained from this borehole over a log interval of 57 m (175 ft) in 1991. The RLS and analytical chemistry data from Borehole 299-W22-78 provide information to assess contamination immediately adjacent to the crib. Data were collected from this borehole to a depth of 71 m (233 ft) in 1994 to support the 200-UP-2 LFI (DOE/RL 95-13). Although soil chemistry data are not available to evaluate contamination directly beneath the 216-U-12 Crib, DOE/RL-95-13 and DOE/RL-95-106 suggest that the site is highly analogous to the 216-U-8 Crib. These sites received the same type of waste and are located relatively close together (DOE/RL-2003-23).

Three man-made radionuclides ($^{137}$Cs, $^{235}$U, and $^{238}$U) were identified beneath the 216-U-12 Crib with the RLS (DOE/RL-2003-23). Cesium-137 was detected to a maximum depth of 8 m (59 ft). Concentrations greater than 5,000 pCi/g were detected at 6 to 8 m (20 to 25 ft) bgs. The maximum activity was estimated at 16,100 pCi/g at 7 m (23 ft) bgs. Cesium-137 detected with the RLS adjacent to the crib in Borehole 299-W22-78 was less than 1 pCi/g at less than 0.3 m (1 ft) bgs. Cesium-137 was not detected in soil samples collected in the adjacent borehole. Cesium-137 concentrations generally decreased with depth at the crib and were not detected at depths greater than 8 m (59 ft) bgs. The RLS detected $^{235}$U in a 2 m (7-ft) zone beneath the crib at a depth between 22 m and 24 m (73 and 80 ft). The maximum activity of $^{235}$U in this zone is approximately 20 pCi/g and corresponds to maximum $^{238}$U concentrations detected with the RLS. The maximum concentration (500 pCi/g) of $^{238}$U was detected 23 m (77 ft) bgs and indicates that higher concentrations were detected with depth. Uranium-238 initially was detected at a depth of 5 m (17 ft) (the approximate depth of the inlet pipe) to a maximum depth of 24 m (80 ft). Its distribution above the hot spot is sporadic. Uranium was detected in soil samples throughout the vadose zone adjacent to the crib to a depth of 70 m (230 ft). Activities typically were less than 1 pCi/g, except as noted (DOE/RL-2003-23).

Uranium isotopes were detected 4 m to 7 m (13 to 23 ft) bgs, adjacent to the 216-U-12 Crib in borehole 299-W22-78. A maximum of 66 pCi/g was detected with the RLS at the bottom of the crib 6 m (19 ft) bgs. Isotopic uranium detected in soil chemistry samples adjacent to the crib was less than 1.1 pCi/g. Soil sampling efforts from borehole 299-W22-78 near the 216-U-12 Crib indicate that the constituents were not detected above background levels (DOE/RL-95-13). Higher levels of contaminants likely were not detected because the soil samples were collected outside of the crib. These data suggest that the lateral spread of contaminants at the crib may be limited to the immediate area of the crib (DOE/RL-2003-23).

DOE/RL-95-106, Draft A, Appendix C, of presents the 216-U-12 Crib Closure and Post-Closure Plan. The following paragraphs briefly summarize the findings and screening process because the screening process for these sites does not appear in Chapter 5 of this report. DOE/RL-95-106 contains detailed information about the site characterization in the mid 1990s.

Because the 216-U-12 Crib is considered analogous to the 216-U-8 Crib, the contamination for the two sites was assessed using the analogous approach. Laboratory data collected from the 216-U-8 Crib were used to assess the 216-U-12 Crib.

The following contaminants were below either background or WAC 173-340-745 screening levels.

- **Arsenic, Barium, Cadmium, Copper, Chromium, Mercury, Nickel, Selenium, Silver and Zinc**. The maximum value is below the groundwater protection value and WAC 173-340-745 value for direct soil exposure.

- **Beryllium**. The maximum value is below Hanford Site natural background at this crib. Background is the default cleanup level when it is above groundwater protection and/or direct soil exposure values (WAC 173-340-745).

- **Manganese**. The maximum manganese value is below background.

- **Iron, Lead, and Magnesium**. No screening levels were available (in 1995) under WAC 173-340-745 or groundwater protection (WAC 173-340-720).

Table 3-1 lists the constituents for the 216-U-12 Crib. These values represent maximum concentrations of constituents found in the 216-U-8 Crib and, because it is analogous to the 216-U-12 Crib, it represents that crib as well.

### 3.3.8 Impacts to Groundwater

#### 3.3.8.1 Current Impact to Groundwater at the 216-A-10, 216-A-36B, 207-A South Retention Basin, and 216-A-37-1 Cribs

The 216-A-10, 216-A-36B, and 216-A-37-1 Cribs are documented to be at least partially responsible for the contamination in the groundwater and continue to be monitored under a RCRA groundwater assessment program (DOE/RL-2000-60, Rev. 1). Because the effluent from the 207-A South Retention Basin fed the 216-A-37-1 Crib, the basin is included in this discussion. The sites are monitored as one waste management unit with respect to groundwater because they have similar hydrology and waste constituents. All of the sites are part of the 200-PO-1 Groundwater OU. Monitoring of the groundwater indicates that impact to groundwater also occurs from other facilities. Based on the information in the Work Plan, Table 3-1 (DOE/RL-2000-60, Rev. 1), the effluent volume discharged to each crib is greater than the soil column pore volume.

Table 3-2 lists the wells being monitored for each crib based on the Work Plan (DOE/RL-2000-60, Rev. 1) and PNNL-14187. The HEIS database was queried for the constituents that exceeded the groundwater screening values, as discussed in Chapter 4 of this document, from 2001 and 2002. These years were selected because results from years before 2001 were reported in the Work Plan (DOE/RL-2000-60, Rev. 1). PNNL-14187 indicates that the most extensive contaminants are tritium, $^{129}I$, and nitrate. PNNL-14187 indicates that chromium and manganese exceed drinking water criteria in groundwater; however, these constituents may be present because of the corrosion of well casings or screens.
The groundwater screening and fate and transport analyses performed for the vadose zone indicate that nitrate exceeded the groundwater screening criteria in the 216-A-36B and

216-A-37-1 Cribs. Manganese also exceeded screening criteria in the 216-A-37-1 Crib in the vadose zone. Pentachlorophenol, B-BHC and total petroleum hydrocarbons (TPH)-diesel produced single positive detections in the vadose zone that were above the groundwater screening levels. The pentachlorophenol was not detected in the groundwater.

Figures 3-20, through 3-23 show the major groundwater plumes in the vicinity of the 200-PW-2 and 200-PW-4 OU waste sites.

### 3.3.8.2 Current Impact to Groundwater at the 216-U-12 Crib

The Work Plan (DOE/RL-2000-60, Rev. 1) and DOE/RL-2003-23 present the most recent information related to groundwater. The effluent volume discharged at this site is greater than the soil pore volume, as indicated in Table 2-3. These data indicate that an impact has been made to groundwater at this site. The status of groundwater contamination in the vicinity of the 216-U-12 Crib is described in PNNL-14187 and indicates that, in the past, the site was one of several contributing sources.

PNNL-14187 indicates that the 216-U-12 Crib is the source of elevated nitrate and $^{99}$Tc that have been detected in downgradient wells. The regional nitrate and $^{99}$Tc plumes are a comingled series of smaller plumes with sources from the 216-U-1, 216-U-2, 216-U-8, and 216-U-12 Cribs in the U Plant area. Iodine-129 and tritium were detected repeatedly in several monitoring wells downgradient from the 216-U-12 Crib, but the sources appear to be the REDOX Plant effluent disposal cribs that are upgradient of the 216-U-12 Crib. Technetium-99 concentrations ranged from 12 to 76 pCi/L in the two downgradient wells during FY 2002, which is well below the 900 pCi/L drinking water standard. Technetium-99 concentration trends in both wells have remained relatively stable over the past 2 years. Carbon tetrachloride also has been detected in wells in the vicinity of the 216-U-12 Crib. PNNL-14187 indicates that carbon tetrachloride contamination is present in the unconfined aquifer system beneath most of the 200 West Area. The carbon tetrachloride contamination is believed to be from pre-1973 waste from the Plutonium Finishing Plant. Maximum concentrations of carbon tetrachloride within the plume are well above the maximum contaminant level, 5 µg/L, for carbon tetrachloride that is allowed in drinking water(DOE/RL-2003-23).

According to the Work Plan (DOE/RL-2000-60, Rev. 1), $^{129}$I and tritium were detected repeatedly in several 216-U-12 Crib downgradient monitoring wells, but the source appears to be REDOX Plant effluent disposal cribs upgradient of the 216-U-12 Crib. Iodine-129 is elevated above the 1-pCi/L drinking water standard in wells 299-W22-79 and 699-36-70A. Iodine-129 in these wells measured 1.9 and 7.37 pCi/L, respectively, in FY 2001 and 1.65 pCi/L in FY 2002 in well 299-W22-79. Iodine-129 was measured at 12 pCi/L in 2003 in well 699-36-70A. During FY 2001, the center of the tritium plume appears to have moved farther east of the crib. Tritium concentrations remained above the 20,000-pCi/L drinking water standard in downgradient well 699-36-70A. The 2002 data reported concentrations are 5,200 and 69,000 pCi/L in wells 299-W22-79 and 699-36-70A, respectively. The 2003 data for well 699-36-70A reported 65,000 pCi/L. No results were available for well 299-W22-79 for 2003.

### 3.3.8.3 Current Impact to Groundwater at the 216-U-8 Crib

The Work Plan (DOE/RL-2000-60, Rev. 1) and DOE/RL-2003-23 present the most recent information related to groundwater. The Work Plan indicates that uranium is the major groundwater contaminant and has been decreasing over time. No data beyond RLS logging were required as part of the RI characterization. Section 3.4 of the Work Plan discusses groundwater in additional detail.

The status of groundwater contamination in the vicinity of the 216-U-8 Crib is described in PNNL-13116, *Hanford Site Groundwater Monitoring for Fiscal Year 1999*, which indicates that this site was one of several sources contributing to the impact. The report indicates that nitrate, carbon tetrachloride, $^{129}I$, tritium, and uranium exceed groundwater protection standards and/or guidelines in the vicinity of the crib. Uranium is a major groundwater contaminant at the 216-U-8 Crib and was monitored in groundwater at Borehole 299-W19-2. The 216-U-8 Crib is the only representative site in the 200-PW-2 OU that has been confirmed to have contributed uranium to the groundwater. No groundwater data are available to evaluate the impact on the aquifer at the crib during the periods of effluent discharge (1952 to 1960). Monitoring at the crib began in 1974, was stopped in the spring of 1990, was resumed in the summer of 1994, and was discontinued in 1995 because well 299-W19-2 did not produce enough water for sampling as the water table elevation declined across the 200 West Area. The well was decommissioned in March 1998. Trend analysis indicates that uranium has been detected in the aquifer since monitoring began. Between 1974 and 1984, uranium concentrations decreased over time and ranged between 1 μg/L and 71 μg/L (DOE/RL-2003-23).

After 1986, concentrations increased sharply to approximately 150 μg/L, exceeding the proposed maximum contaminant level of 20 μg/L. A general decrease in the level of contamination was observed after 1989; however, sampling was halted. Samples collected in 1994 and 1995 typically ranged between 14.5 and 79 pCi/L (DOE/RL-2003-23).

Figures 3-22 and 3-23 show the major groundwater plumes near the U Plant Closure Area. PNNL-14187 reports that the groundwater contaminant plume underlying the U Plant disposal facilities consists of $^{129}I$, nitrate, trichloroethylene, $^{99}Tc$, and uranium. These constituents originated from the U Plant disposal facilities and extend beyond the 200 West Area fence line to the east. Carbon tetrachloride contamination also is present in groundwater beneath the U Plant, but its sources include disposal facilities in the 200-ZP-1 OU. More detail is available in DOE/RL-2003-23.

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Figure 3-1. Topographic Map of the Hanford Site.

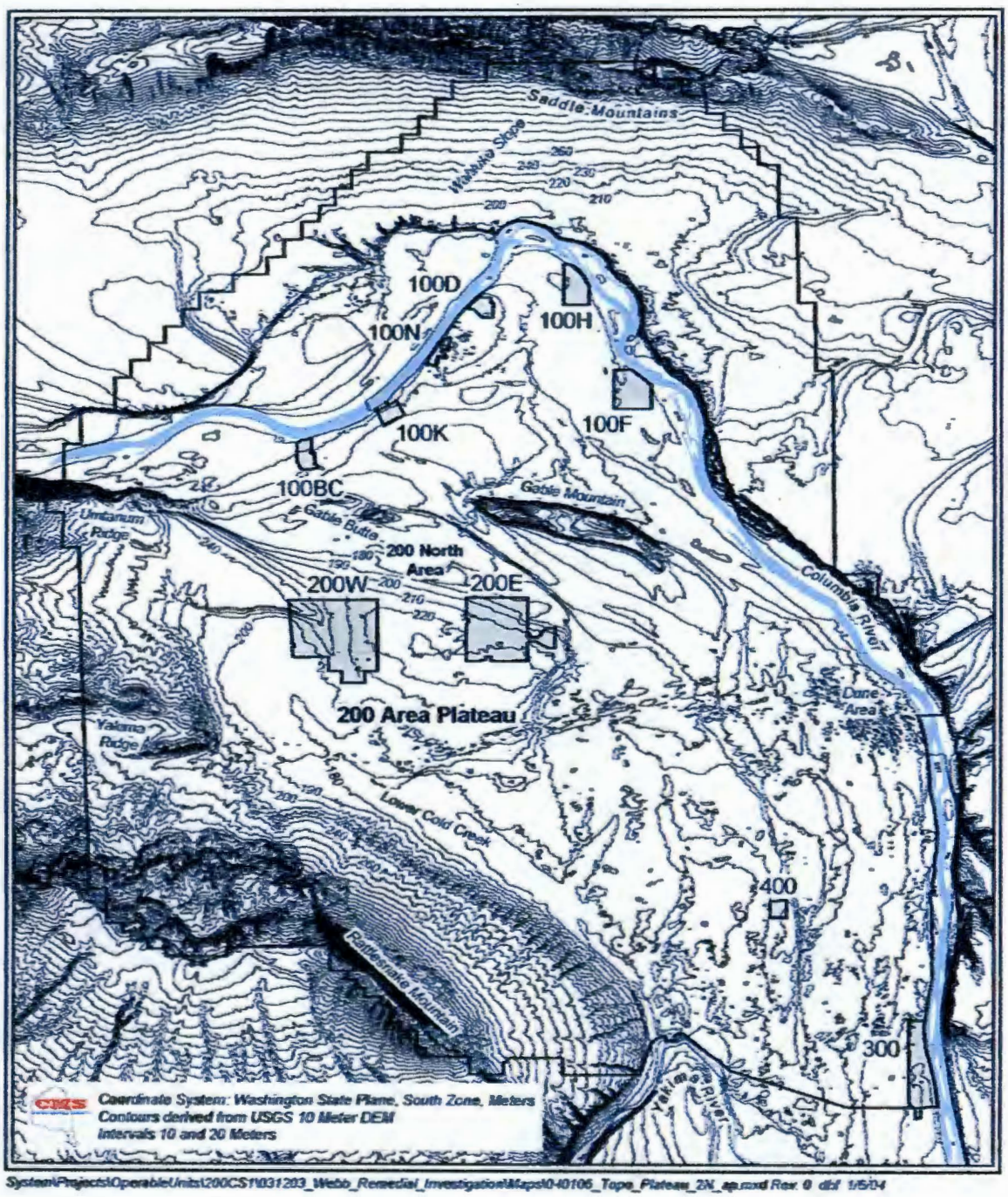


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Figure 3-2. Stratigraphic Column for the 200 Areas.

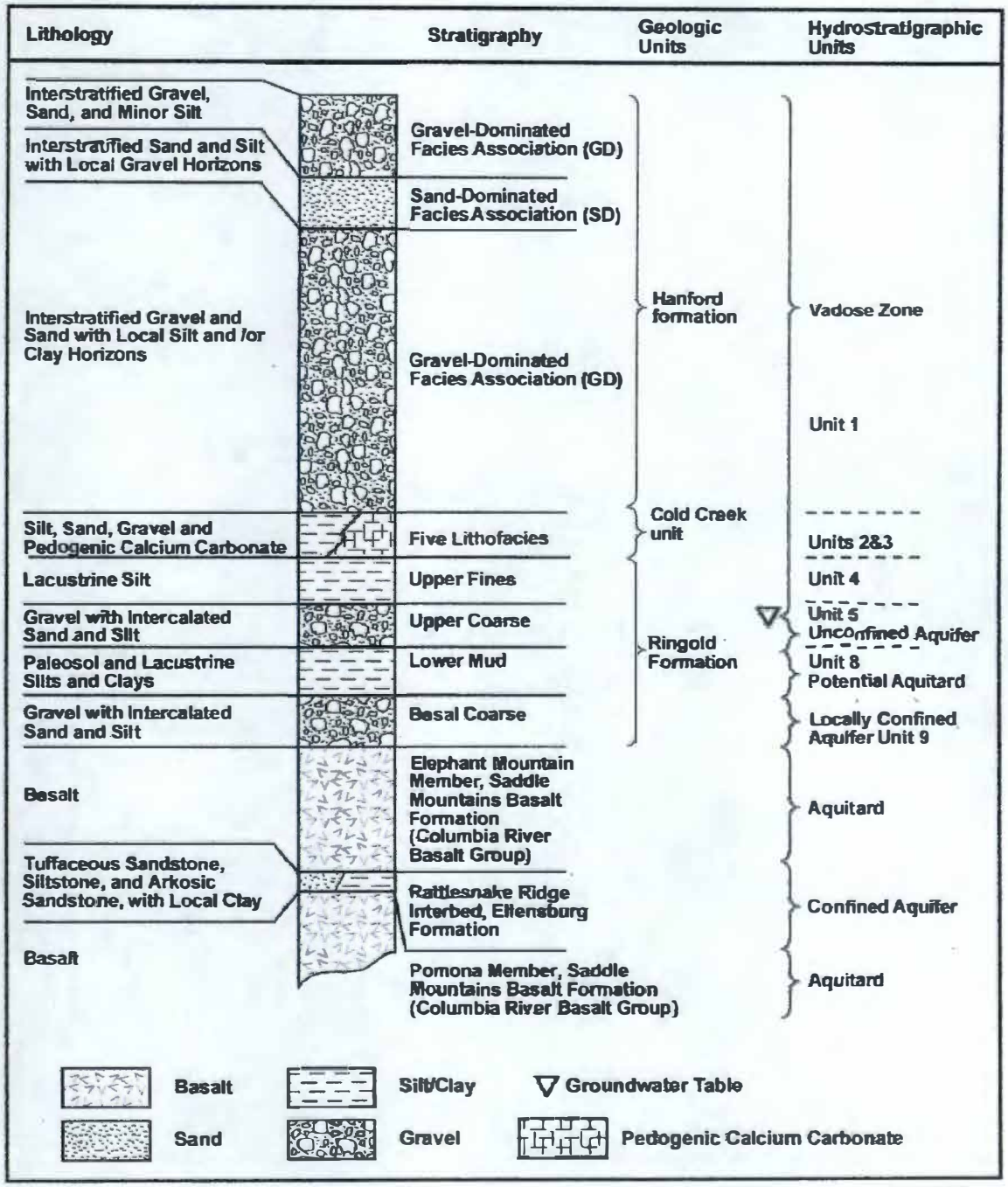


Figure 3-3. Water-Table Map of the 200 East Area, March 2002 (from PNNL-14187).

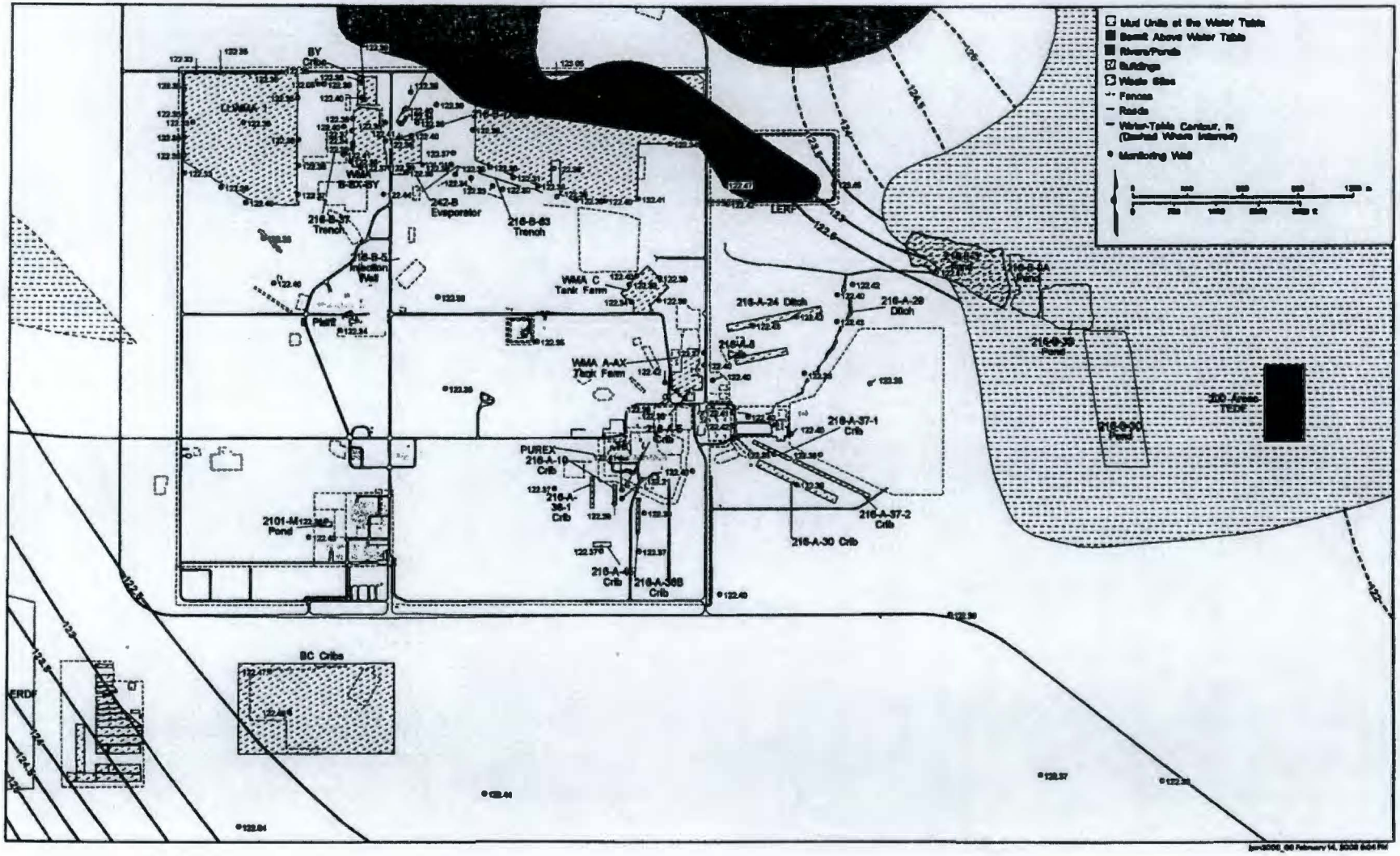


Figure 3-4. Water-Table Contours in the 200 West Area, March 2002 (from PNNL-14187).

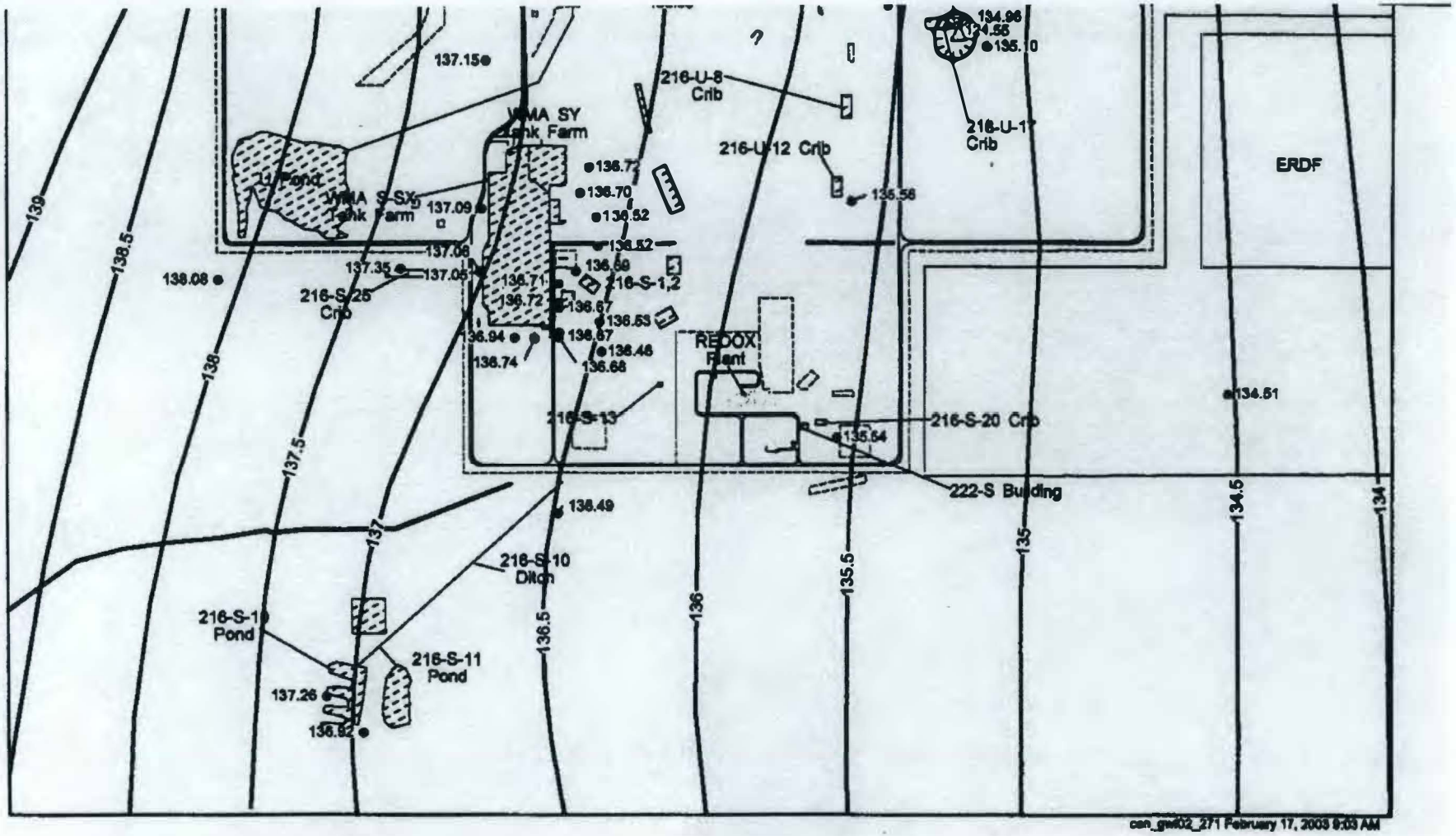


Figure 3-5. Stratigraphy Diagram for the 216-A-19 Trench.

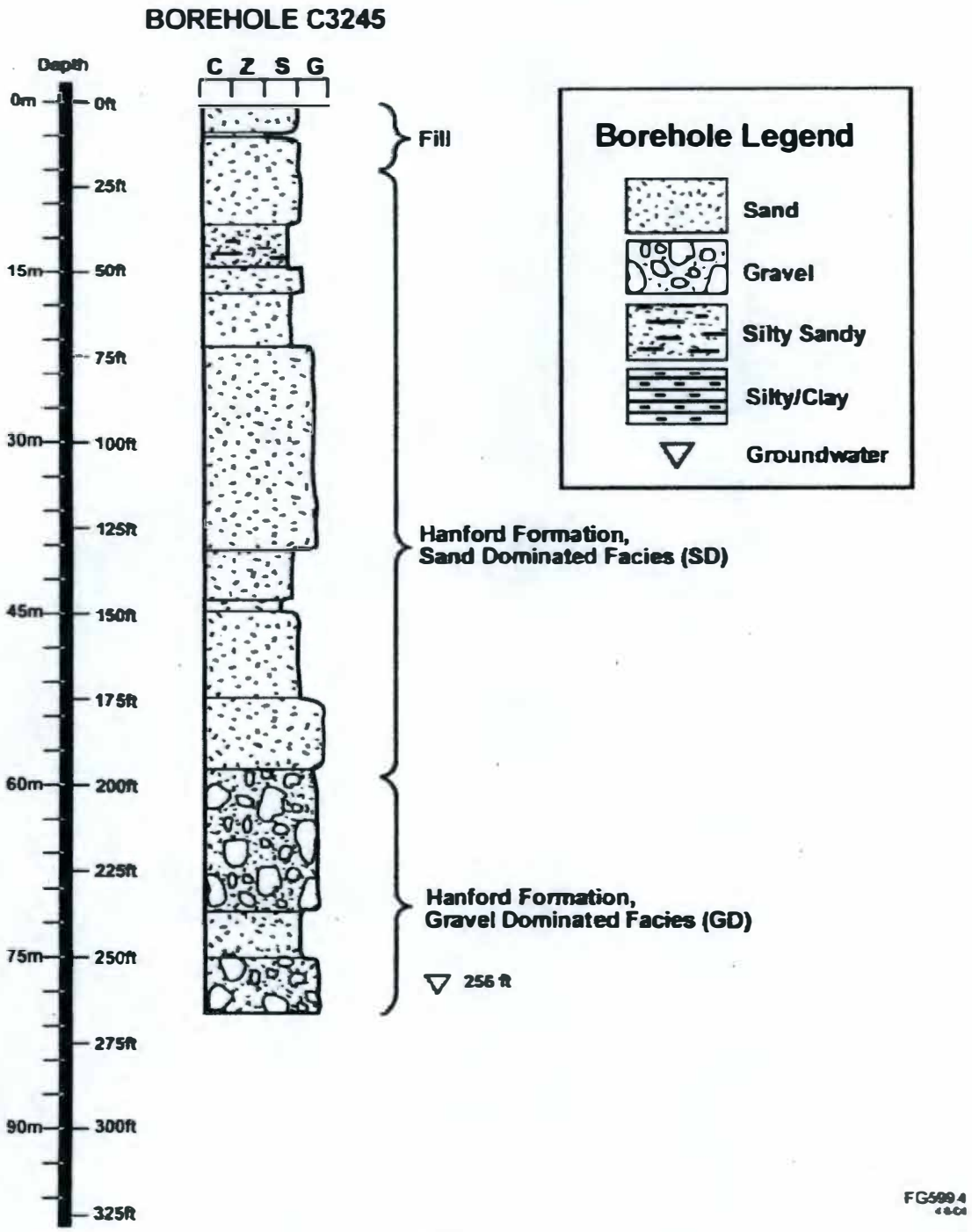
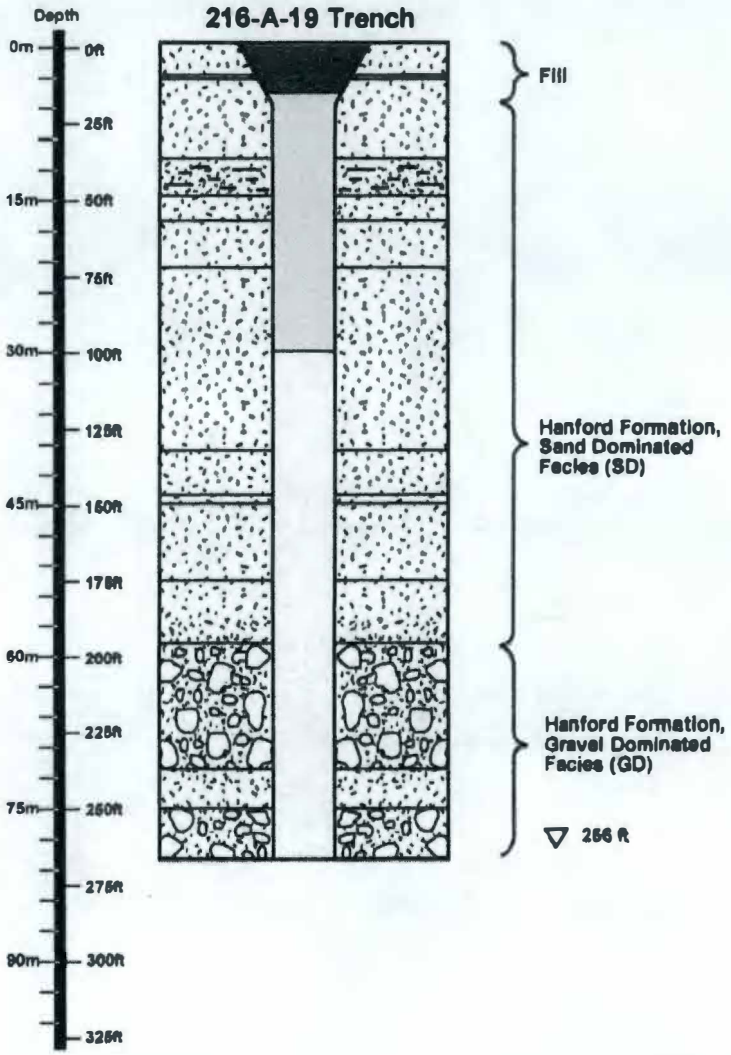


Figure 3-6. Stratigraphy and Contaminant Data for the 216-A-19 Trench.




**C3245**
**Select Radionuclides and Non-Radionuclides Concentrations at the 216- A-19 Trench**

| Analyte | Units | Depth | | |
|---|---|---|---|---|
| | | 0- 5.33 m (0-17.5 ft) | >5.33 – 30.5 m (>17.5 - 100 ft) | >30.5 – 83.1 m (>100-272.5 ft) |
| Bismuth[b] | ug/kg | All ND | 8,140 – 36,400,000 | All ND |
| Boron | ug/kg | 31,210 – 38,930 | ND – 34,330 | All ND |
| Nitrate as N | ug/kg | 414,000 – 546,000 | 3,230 – 9,860,000 | 2,540 – 7,030 |
| Nitrate/Nitrite as N | ug/kg | 476,000 – 544,000 | 3,100 – 1,120,000 | 2,000 – 7,800 |
| Vanadium | ug/kg | 96,100 – 99,600 | 35,900 – 108,000 | 48,500 – 62,000 |
| Thorium | ug/kg | 2,220 – 3,490 | 1,950 – 2,730 | 2,050 – 3,510 |
| Manganese | ug/kg | 430,000 – 538,000 | 237,000 – 456,000 | 271,000 – 310,000 |
| Total Uranium | ug/kg | 39,600 – 129,000 | ND – 130,000 | All ND |
| Tributyl phosphate[b] | ug/kg | 130,000 – 280,000 | ND – 29,000 | All ND |
| Bis-2-ethylhexyl phthalate[a] | ug/kg | 650 - 680 | ND - 620 | ND – 1,100 |
| Americium-241 | pCi/g | ND – 0.081 | ND – 0.006 | All ND |
| Cesium-137 | pCi/g | All ND | ND – 0.072 | ND – 0.033 |
| Nickel-63 | pCi/g | ND – 17.6 | ND – 10.1 | All ND |
| Plutonium 239/240 | pCi/g | 0.035 – 0.18 | ND – 0.03 | All ND |
| Strontium-90 | pCi/g | 16.1 - 20 | ND – 7.73 | All ND |
| Tritium | pCi/g | All ND | All ND | ND – 0.424 |

ND = non-detects, detection limits vary with the sample and are presented in the complete data tables in the appendix of this report.
a. Bis-(2-ethylhexyl) phthalate is a common laboratory contaminant and may be an artifact of the analytical system.
b. No RBCs exist for these analytes.

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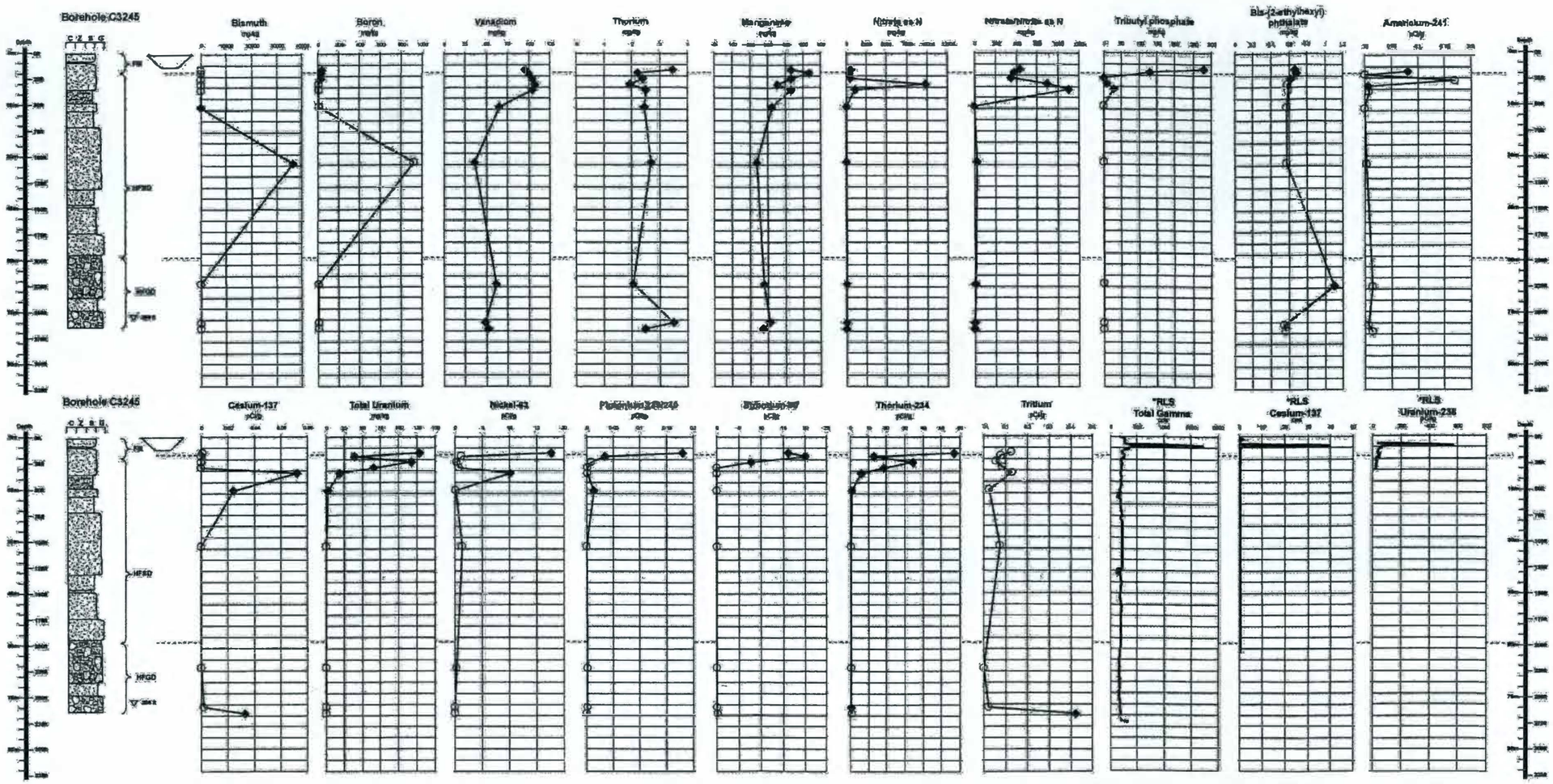
4/7/04

Figure 3-7. Vertical Profile Plots of Contaminants for the 216-A-19 Trench.




| 216-A-19 – Borehole C3245 |
|---|
| F - Fill |
| HFSD - Hanford Formation Sand Dominated |
| HFGD - Ringold Formation Gravel Dominated |

**Background Values**

| Analyte | Background | Analyte | Background | Analyte | Background |
|---|---|---|---|---|---|
| Cs-137<br>Sr-90<br>Pu-239/240 | 1.05 pCi/g<br>0.178 pCi/g<br>0.0248 pCi/g | Uranium<br>Barium<br>Vanadium<br>Manganese | 3.21 ug/g<br>32 mg/kg<br>85.1 mg/kg<br>512 mg/kg | Nitrate as N | 12 mg/kg |

**Concentration & Borehole Legend**

Sand; Silty Sandy; Gravel; Silty/Clay

Water Table; Positive Detect; Non-detect

FG608.2
4/04

Figure 3-8. Stratigraphy Diagram for the 216-A-10 Crib.

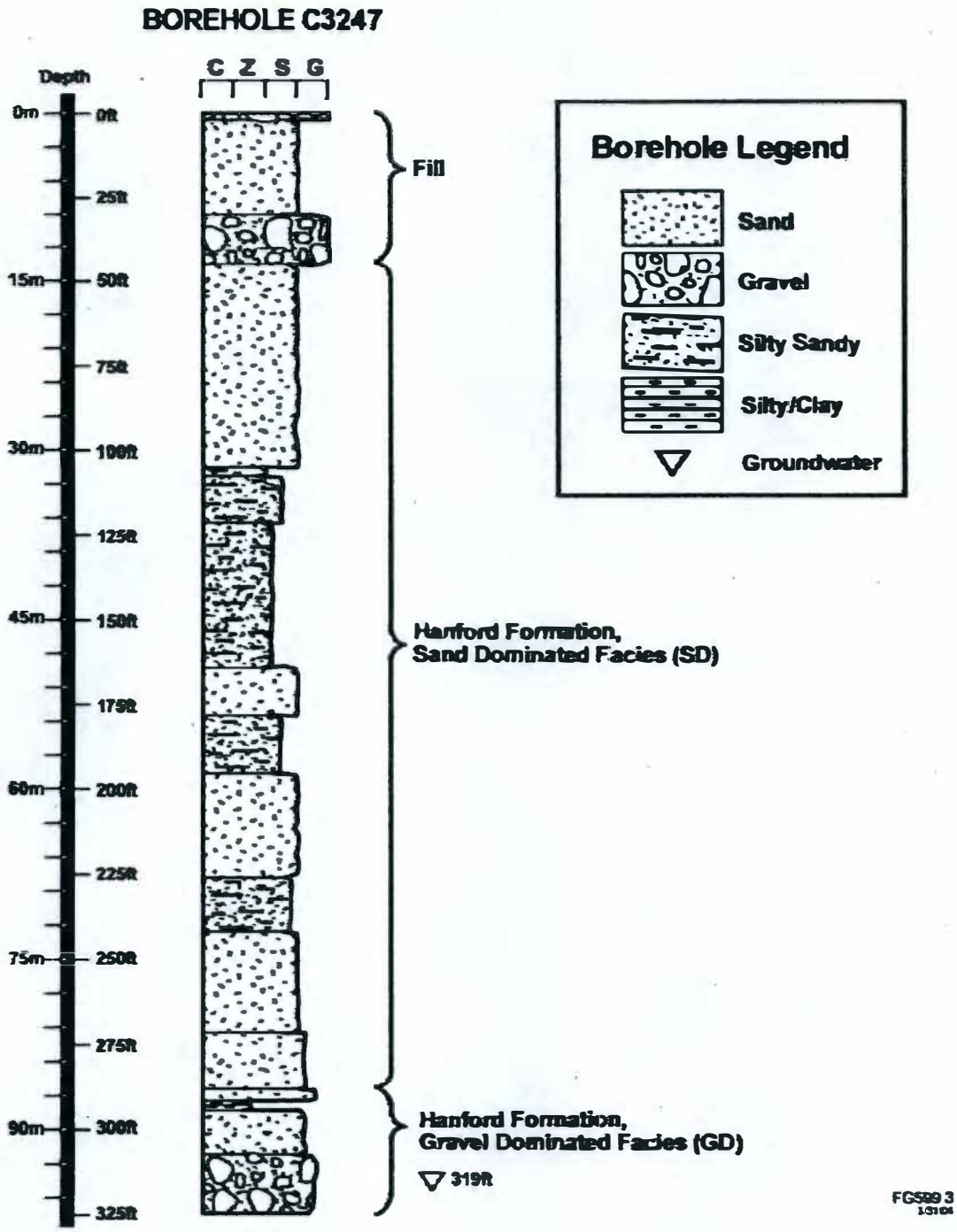
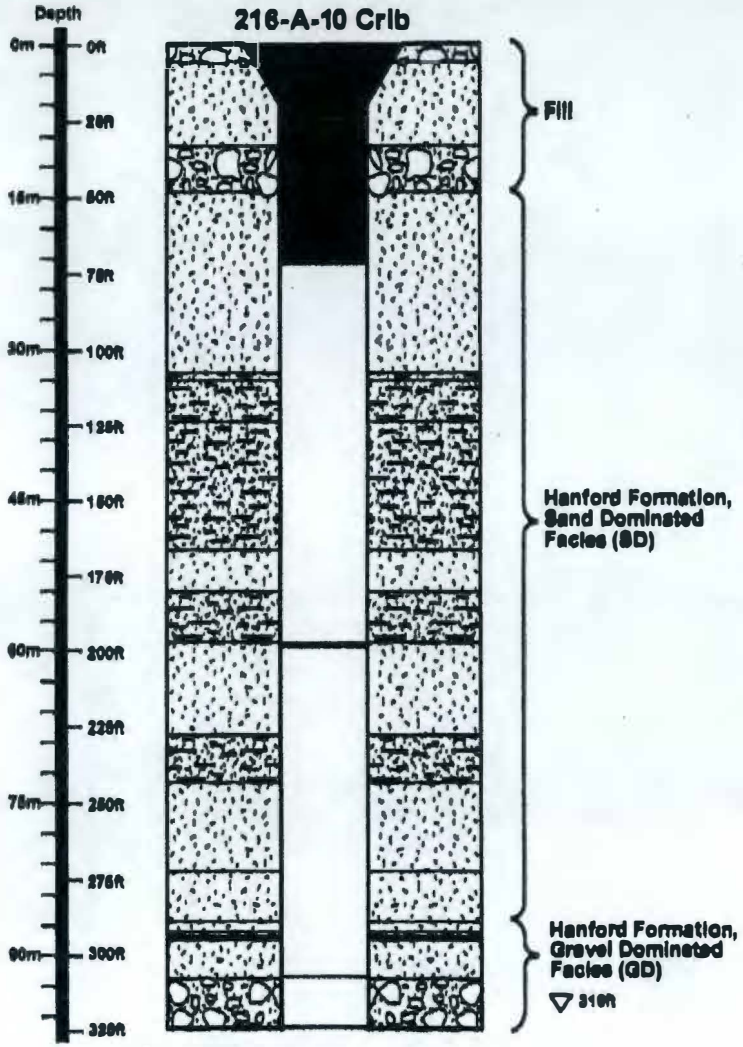


Figure 3-9. Stratigraphy and Contaminant Data for the 216-A-10 Crib.



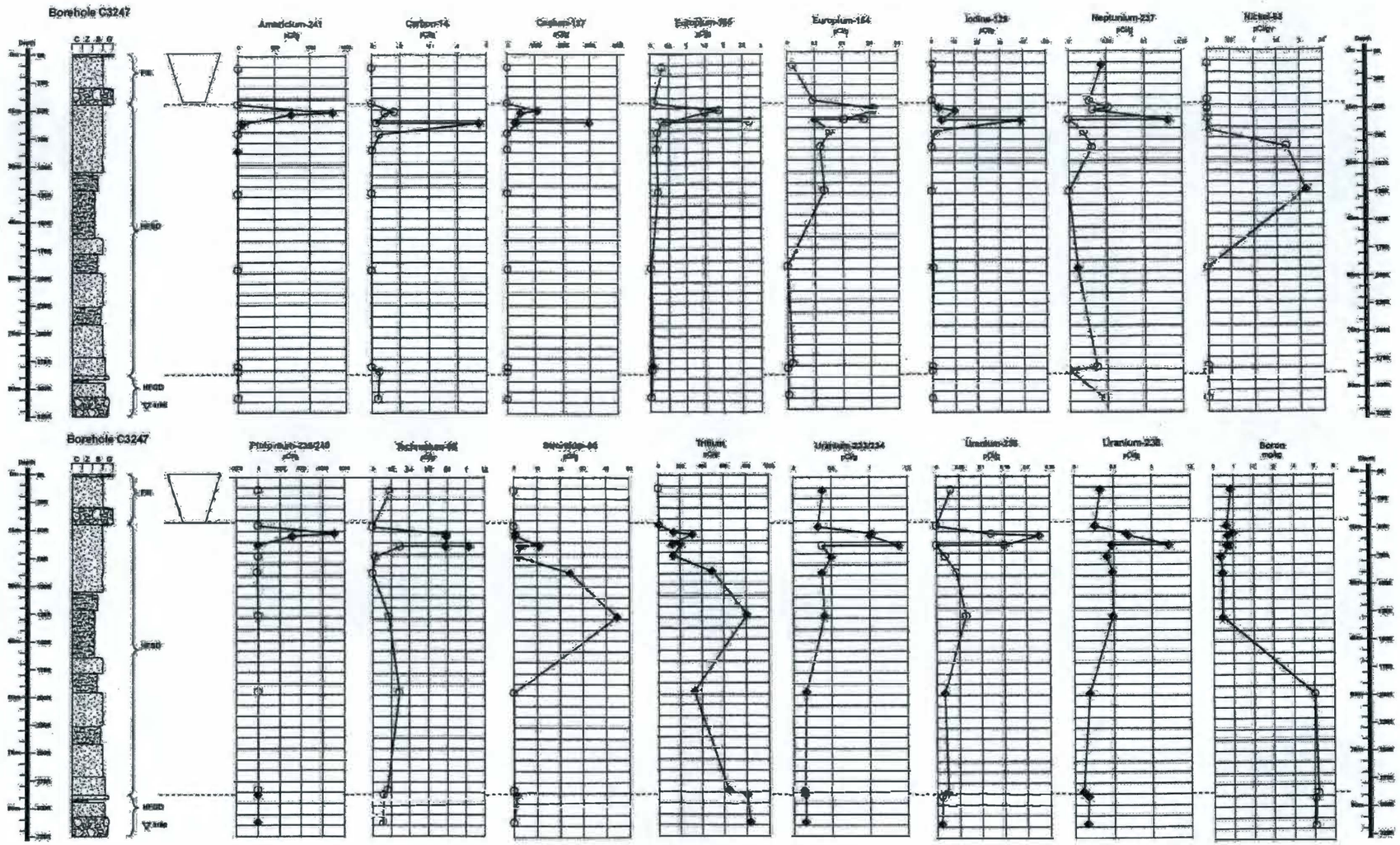

**C3247**
**Crib Select Radionuclides and Non-Radionuclides Concentrations at the 216-A-10 Crib**

| Analyte | Units | Depth | | |
|---|---|---|---|---|
| | | [redacted] | | |
| | | 0 - 22m (0-72.6 ft) | >22 - 60m (>72.6 – 197.6 ft) | >60 - 96m (>197.6-317 ft) |
| Boron | ug/kg | 690 - 1000 | 400 - 490 | All ND |
| Methylene chloride [a] | ug/kg | ND - 29 | 7 - 19 | ND - 6 |
| TPH-diesel | ug/kg | ND - 1.0E+07 | All ND | All ND |
| Pentachlorophenol | ug/kg | ND - 20 | All ND | All ND |
| B-BHC | ug/kg | 7 | NA | NA |
| 1-chloropropane [b] | ug/kg | ND - 380 | All ND | All ND |
| 2-butoxyethanol [b] | ug/kg | ND - 380 | All ND | All ND |
| Tributyl phosphate [b] | ug/kg | ND - 2.0E+06 | ND - 382 | All ND |
| Americium-241 | pCi/g | ND - 1320 | ND - 4.12 | All ND |
| Carbon-14 | pCi/g | ND - 7.5 | All ND | All ND |
| Cesium-137 | pCi/g | ND - 2950 | All ND | All ND |
| Europium-154 | pCi/g | ND - 0.2 | All ND | All ND |
| Europium-155 | pCi/g | All ND | All ND | ND - 0.054 |
| Iodine-129 | pCi/g | ND - 38.8 | All ND | All ND |
| Neptunium-237 | pCi/g | ND - 0.132 | ND - 0.012 | All ND |
| Nickel-63 | pCi/g | All ND | ND - 2.13 | All ND |
| Plutonium-238 | pCi/g | ND - 318 | All ND | All ND |
| Plutonium-239/240 | pCi/g | ND - 7110 | All ND | ND - 0.008 |
| Technetium-99 | pCi/g | ND - 1.03 | All ND | All ND |
| Strontium-90 | pCi/g | ND - 11.1 | ND - 44.7 | ND - 1.47 |
| Tritium | pCi/g | ND - 319 | 330 - 805 | 841 - 835 |
| Uranium-233/234 | pCi/g | ND - 1.39 | 0.17 - 0.407 | 0.15 - 0.16 |
| Uranium-235 | pCi/g | ND - 0.227 | ND - 0.016 | ND - 0.024 |
| Uranium-238 | pCi/g | 0.265 - 1.22 | 0.2 - 0.496 | 0.11 - 0.17 |

NA = not analyzed
ND = non-detects, detection limits vary with the sample and are presented in the complete data tables in the appendix of this report.
a. Methylene chloride is a common laboratory contaminants and may be artifacts of the analytical system.
b. No RBCs exist for these analytes.

F3600.5
4/04

Figure 3-10. Vertical Profile Plots of Contaminants for the 216-A-10 Crib. (2 Sheets)




**216-A-10 Crib - Borehole C3247**

F - Fill

HFSD - Hanford Formation Sand Dominated

CCU - Cold Creek Unit

RF - Ringold Formation

**Background Values**

| Analyte | Background | Analyte | Background | Analyte | Background |
|---|---|---|---|---|---|
| Cs-137 | 1.05 pCi/g | Eu-154 | 0.0334 pCi/g | U-235 | 0.109 pCi/g |
| Pu-239/240 | 0.0248 pCi/g | Eu-155 | 0.0539 pCi/g | U-236 | 1.06 pCi/g |
| Sr-90 | 0.178 pCi/g | U-234 | 1.10 pCi/g | Pu-238 | 0.00378 pCi/g |

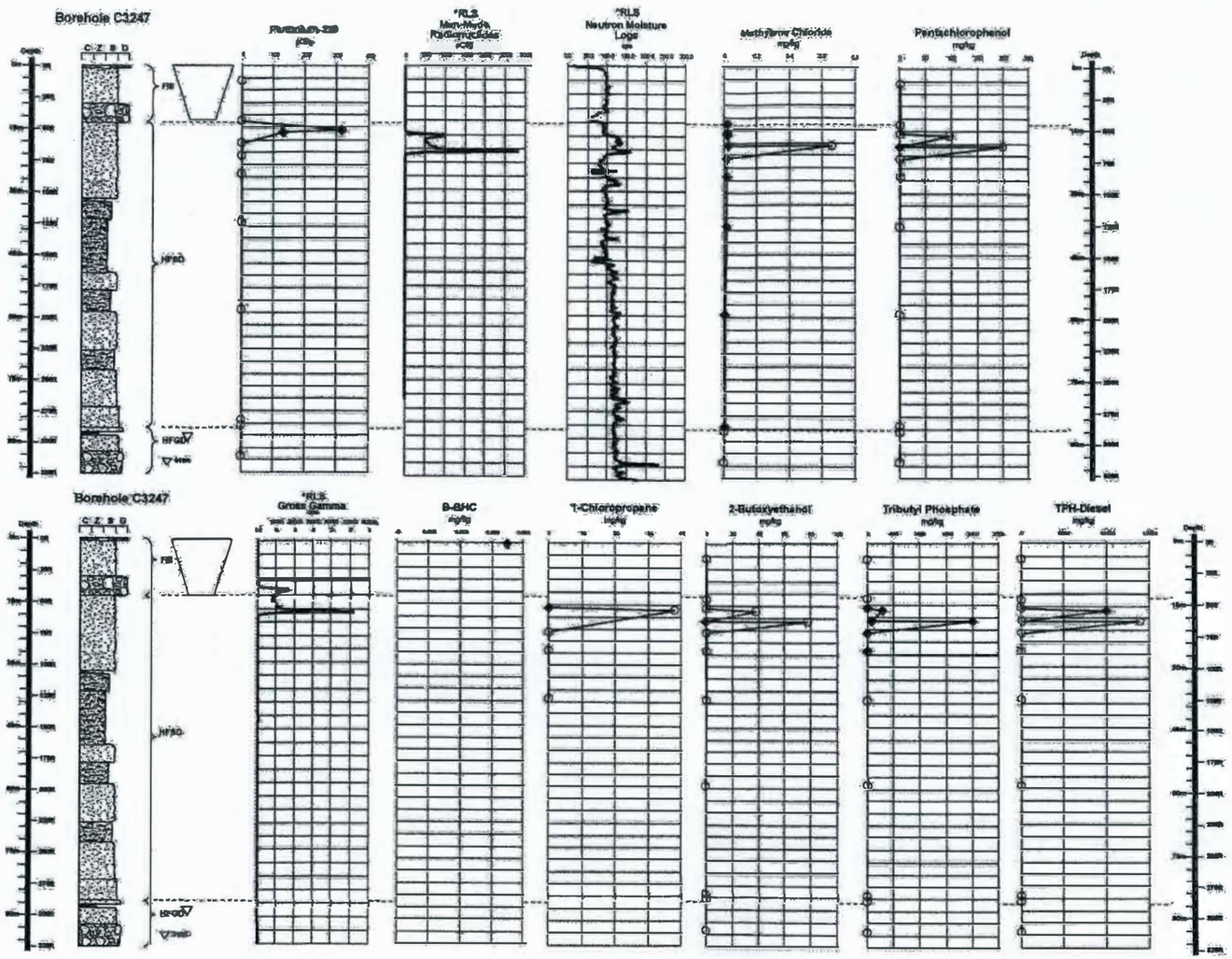
**Concentration & Borehole Legend**

Sand, Silty Sandy, Gravel, Silty/Clay

Water Table, Positive Detect, Non-detect

FG608.3

Figure 3-10. Vertical Profile Plots of Contaminants for the 216-A-10 Crib. (2 Sheets)




**216-A-10 Crib - Borehole C3247**

F - Fill

HFSD - Hanford Formation Sand Dominated

CCU - Cold Creek Unit

RF - Ringold Formation

**Background Values**

| Analyte | Background | Analyte | Background | Analyte | Background |
|---|---|---|---|---|---|
| Cs-137 | 1.05 pCi/g | Eu-154 | 0.0334 pCi/g | U-235 | 0.109 pCi/g |
| Pu-239/240 | 0.0248 pCi/g | Eu-155 | 0.0539 pCi/g | U-238 | 1.06 pCi/g |
| Sr-90 | 0.178 pCi/g | U-234 | 1.10 pCi/g | Pu-238 | 0.00378 pCi/g |

**Concentration & Borehole Legend**

Sand, Silty Sandy, Gravel, Silty/Clay

Water Table, Positive Detect, Non-detect

FG608.3a

Figure 3-11. Stratigraphy Diagram for the 216-A-36B Crib.

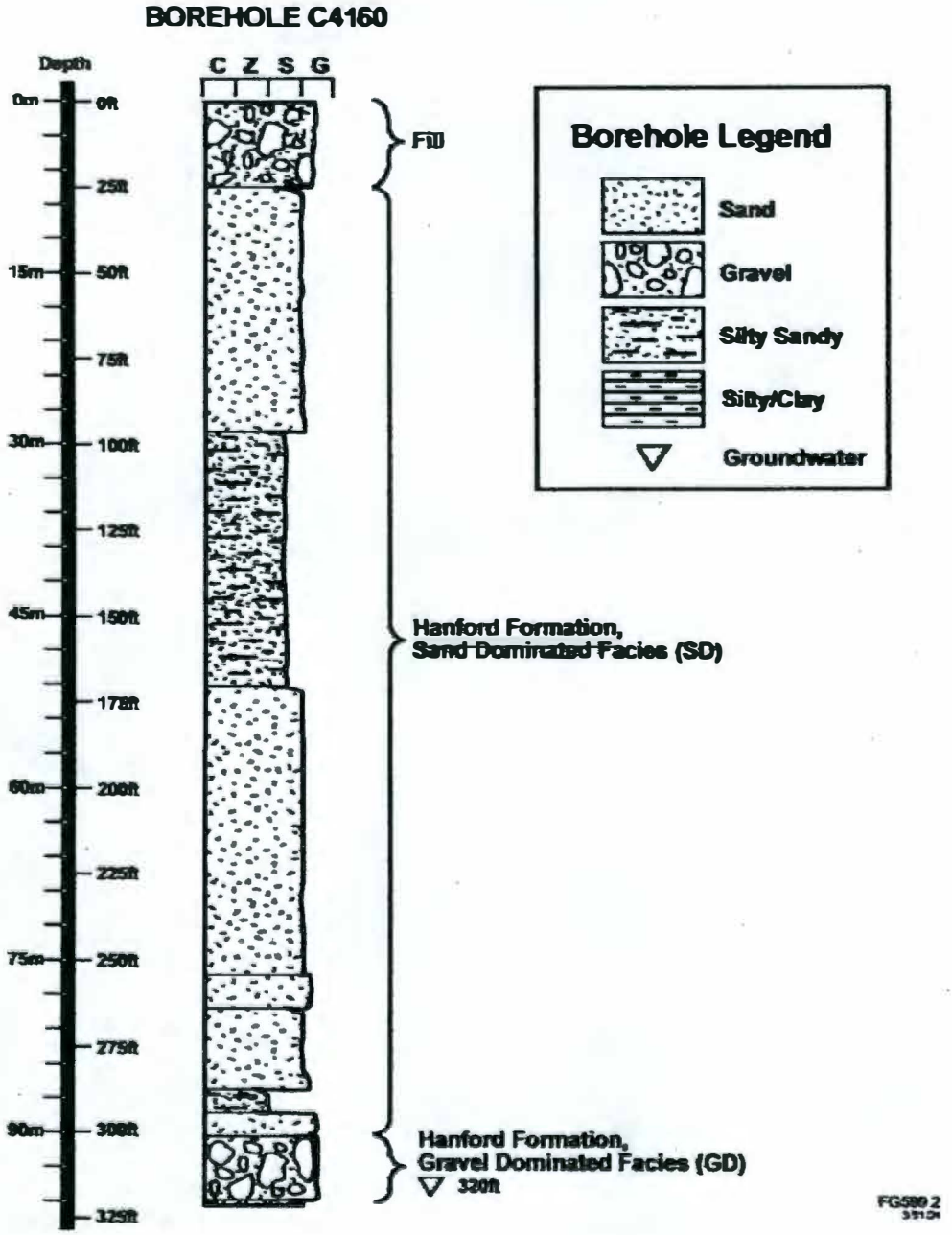
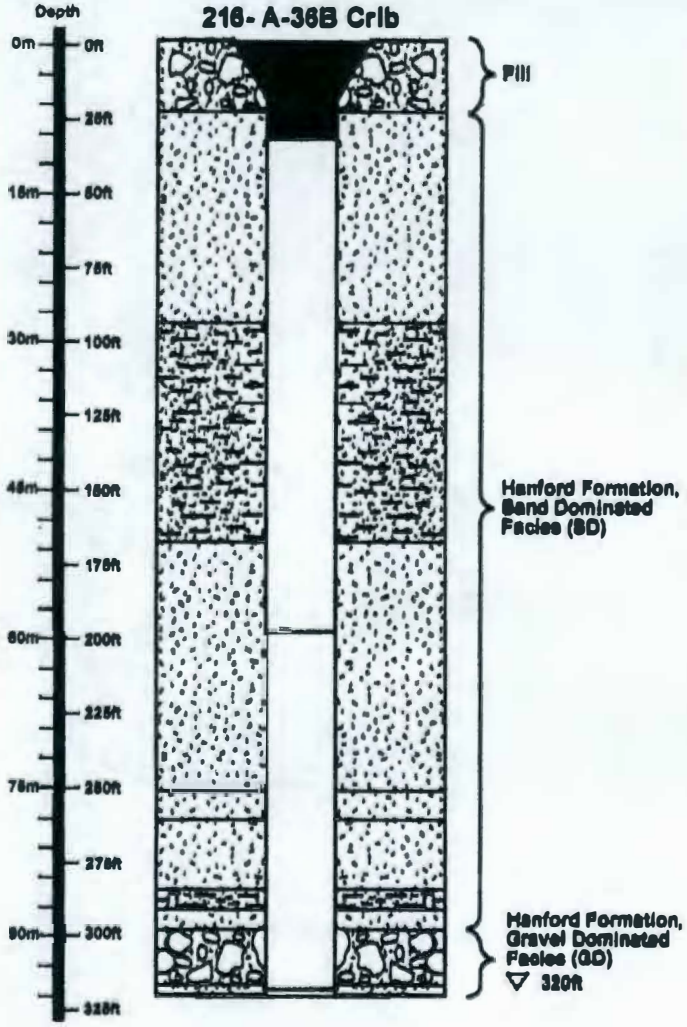


Figure 3-12. Stratigraphy and Contaminant Data for the 216-A-36B Crib.




**C4160**
**Select Radionuclides and Non-Radionuclides Concentrations at the 216- A-36B Crib**

| Analyte | Units | Depth | | |
|---|---|---|---|---|
| | | [redacted] | [redacted] | |
| | | 0- 9.1 m (0-30 ft) | >9.1 – 60.2 m (>30 – 197.5 ft) | >60.2 – 97 m (>197.5-318.5 ft) |
| Nitrite as N | ug/kg | ND-18,600 | All ND | All ND |
| Nitrate as N | ug/kg | 497 – 29,700 | 15,200 – 289,000 | 20,400 – 49,200 |
| Nitrate/Nitrite as N | ug/kg | 2,700 – 10,100 | 13,400 – 287,000 | 14,500 – 54,600 |
| Silver | ug/kg | ND-3540 [c] | All ND [c] | ND [c] – 2590 |
| Total Uranium | ug/kg | ND – 36,800 | ND – 19,200 | ND – 4,750 |
| Thorium | | 2850-3770 | Not reported radioactive thorium analyzed instead | Not reported radioactive thorium analyzed instead |
| Isophorone [a] | ug/kg | All ND | ND-500 [c] | ND-180 [c] |
| Americium-241 | pCi/g | ND – 40,000 | ND – 0.184 | ND – 0.088 |
| Antimony-125 | pCi/g | All ND | ND – 0.308 | All ND |
| Carbon-14 | pCi/g | ND - 116 | All ND | All ND |
| Cesium-134 | pCi/g | All ND | ND – 0.04 | All ND |
| Cesium-137 | pCi/g | ND – 2,650,000 | ND – 5.06 | All ND |
| Cobalt-60 | pCi/g | ND - 623 | ND – 1.36 | ND – 0.068 |
| Europium-154 | pCi/g | ND - 1800 | All ND | All ND |
| Nickel-63 | pCi/g | ND – 161,000 | All ND | All ND |
| Plutonium-239/240 | pCi/g | ND – 96,000 | ND – 0.42 | All ND |
| Ra-226 | pCi/g | ND – 0.416 | ND – 1.27 | 0.378 – 0.808 |
| Strontium-90 | pCi/g | ND – 208,000 | ND – 27,800 | All ND |
| Technetium-99 | pCi/g | ND – 41.9 | All ND | All ND |
| Thorium-232 | pCi/g | ND – 4.84 | 0.361 – 0.853 | 0.442 – 0.692 |
| Tritium | pCi/g | All ND | 3.61 – 31.8 | 21.6 – 121 |
| Uranium-233/234 | pCi/g | 0.13 – 61.2 | 0.15 - 18 | 0.12 – 0.537 |
| Uranium-235 | pCi/g | ND – 3.286 | ND – 2.6 | All ND |
| Uranium-236 | pCi/g | 4.84 | NA | NA |
| Uranium-238 | pCi/g | 0.1 – 70.9 | 0.14 – 4.4 | 0.14 – 0.523 |

ND = non-detects, detection limits vary with the sample and are presented in the complete data tables in the appendix of this report.
a. No RBCs exist for this analyte.
b. Data reported were estimated due to potential interferences.
c. Values are estimated as positive results are below the normal detection levels.

FG600.4

Figure 3-13. Vertical Profile Plots of Contaminants for the 216-A-36B Crib.

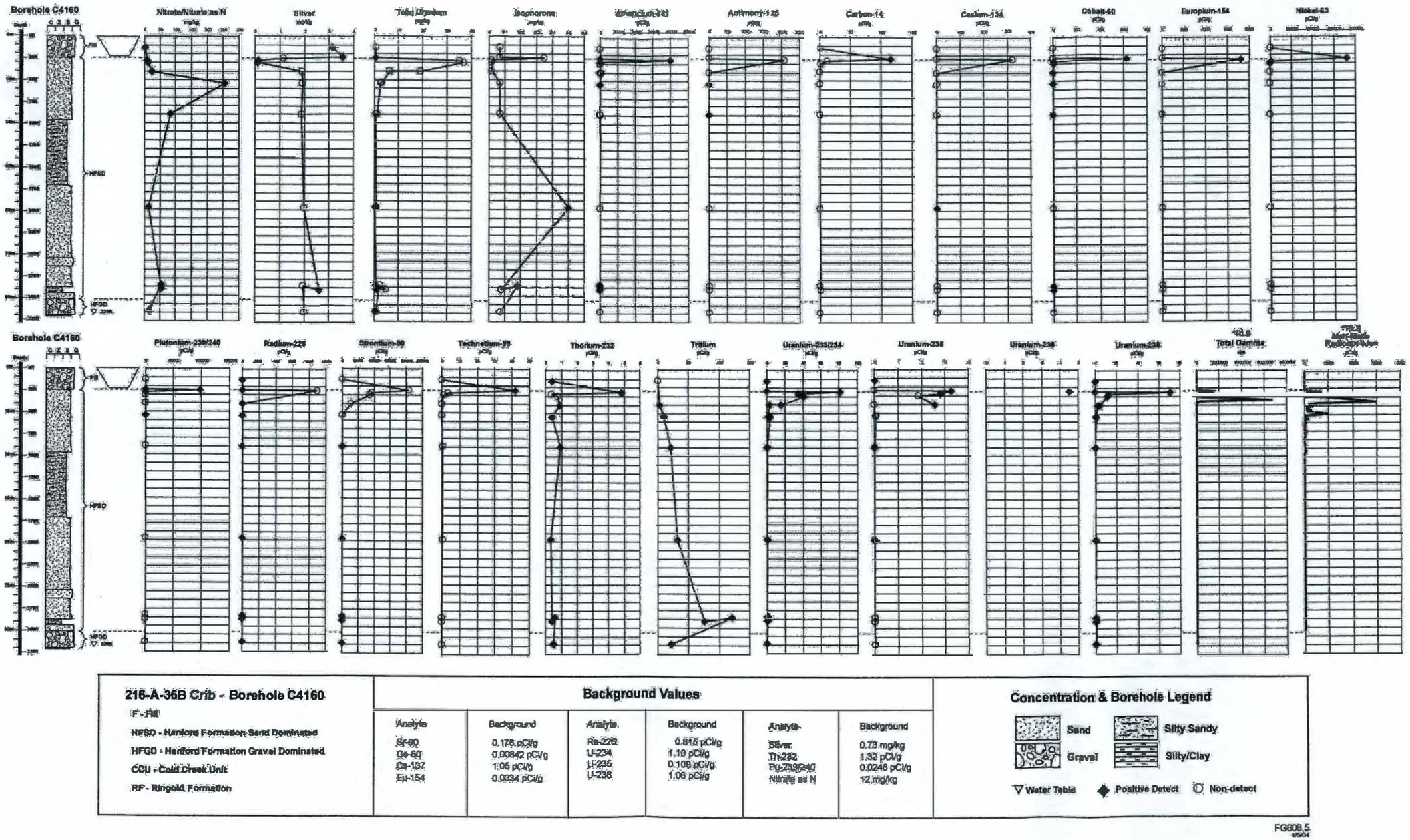


Figure 3-14. Stratigraphy Diagram for the 216-A-37-1 Crib.

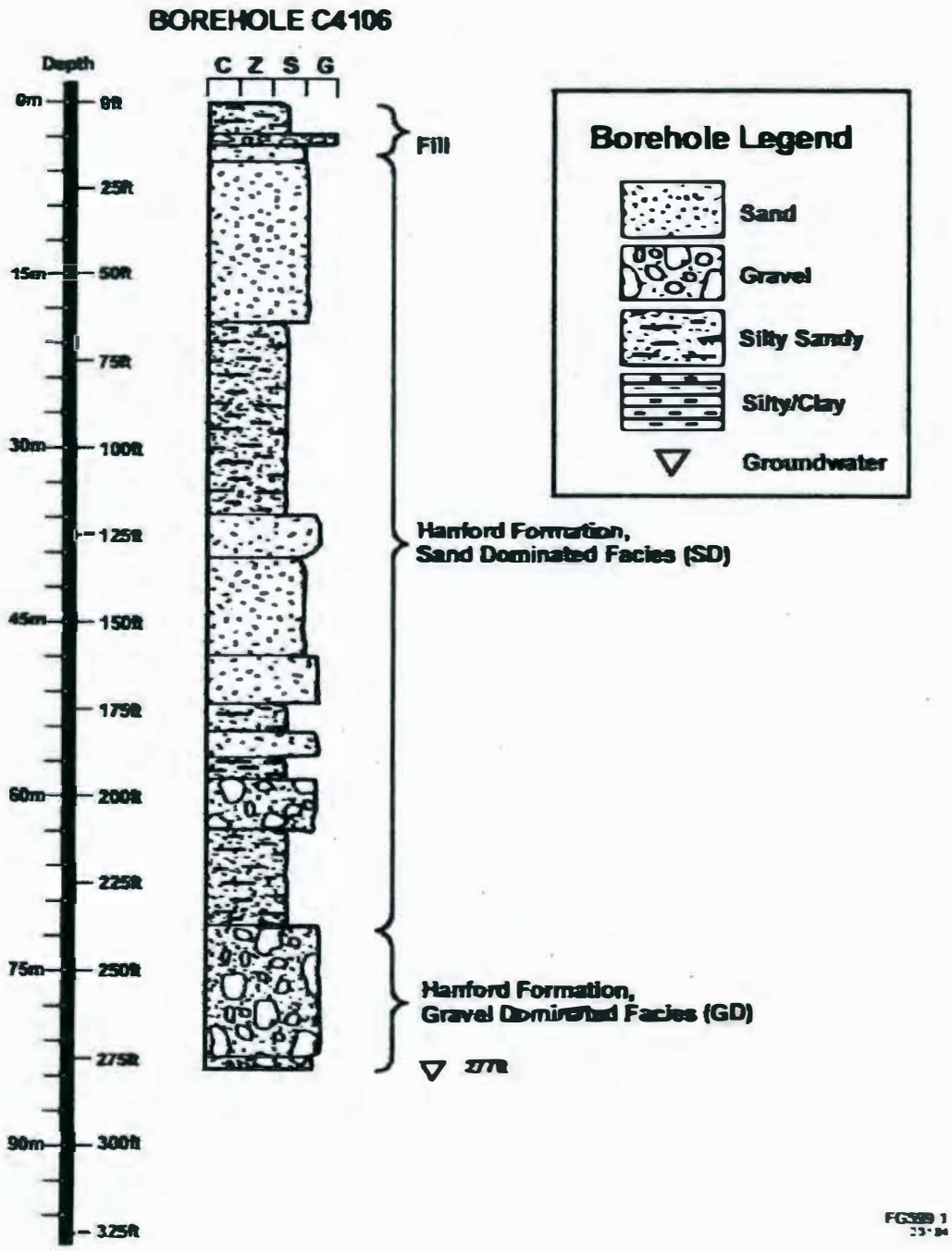
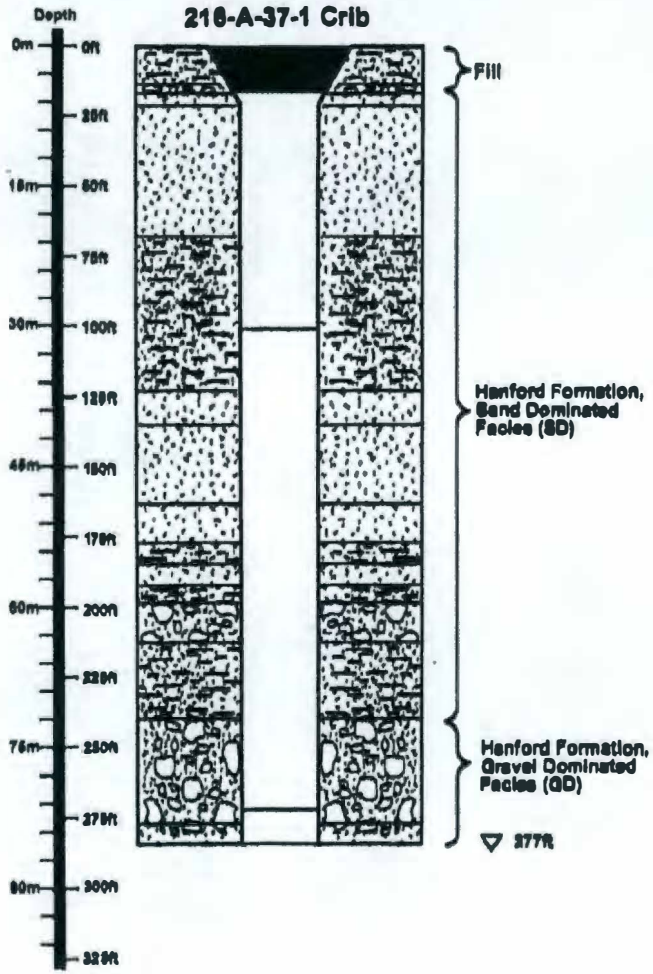


Figure 3-15. Stratigraphy and Contaminant Data for the 216-A-37-1 Crib.



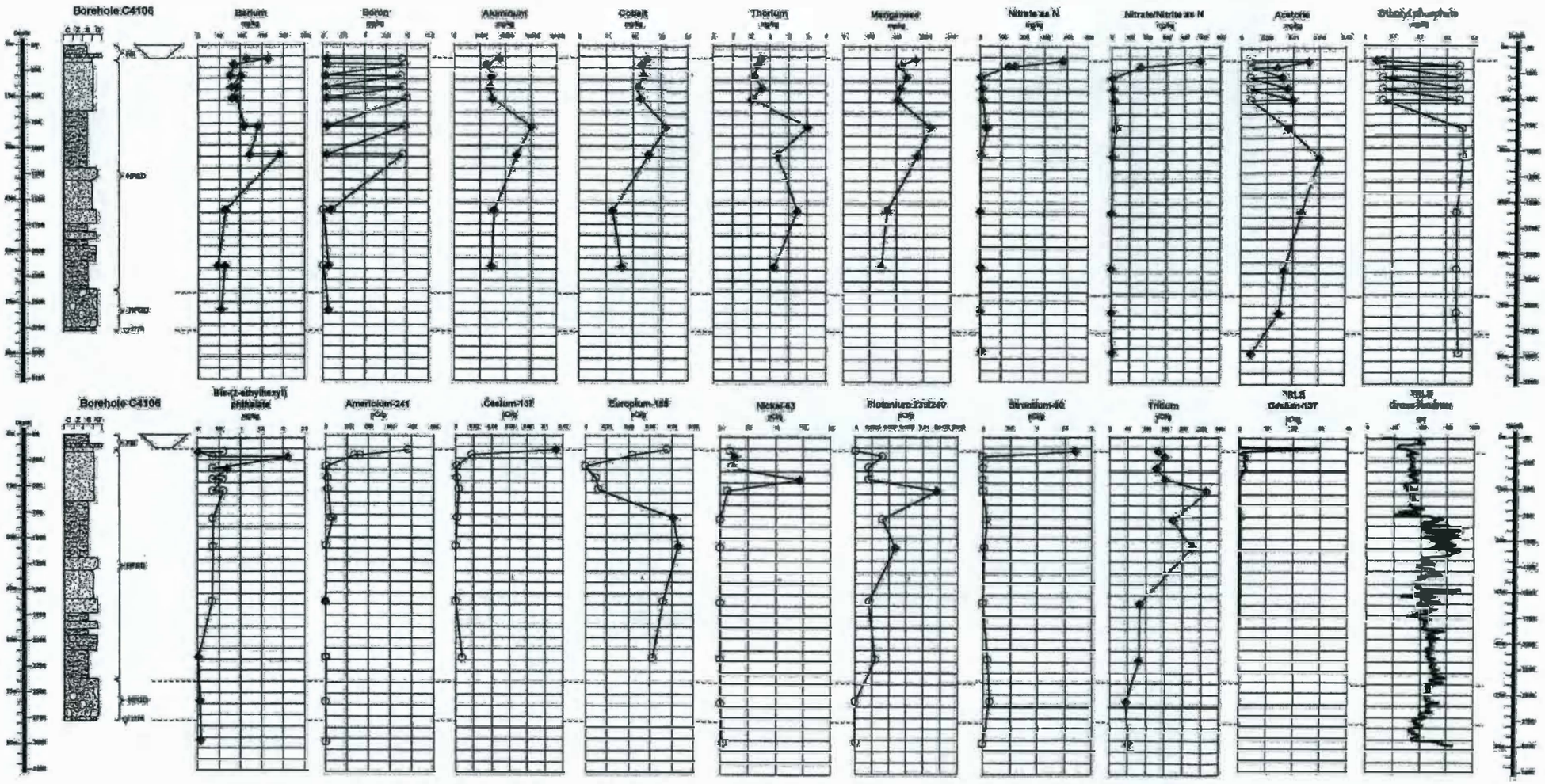

**C4106**
**Select Radionuclides and Non-Radionuclides Concentrations at the 216-A-37-1 Crib**

| Analyte | Units | Depth | | |
|---|---|---|---|---|
| | | | | |
| | | 0- 5.33 m (0-17.5 ft) | >5.33 – 30.5 m (>17.5 - 100 ft) | >30.5 – 83.1 m (>100-272.5 ft) |
| Barium | ug/kg | 83,800 – 165,000 | 78,200 – 193,000 | 44,900 – 65,500 |
| Boron | ug/kg | ND - 580 | ND - 870 | ND – 940 |
| Aluminum | ug/kg | 6,390,000 – 8,660,000 | 6,930,000 – 15,000,000 | 7,370,000 – 7,780,000 |
| Nitrate as N | ug/kg | 2,650 – 365,000 | 4,140 – 33,000 | 1,020 – 2,020 |
| Nitrate/Nitrite as N | ug/kg | 163,000 – 482,000 | 5,100 – 24,100 | 1,200 – 2,800 |
| Cobalt [b] | ug/kg | 11,000 – 13,100 | 10,600 – 15,900 | 6,330 – 7,660 |
| Thorium | ug/kg | 2,310 – 2,890 | 2,060 – 6,060 | 3,200 – 4,460 |
| Manganese | ug/kg | 436,000 – 648,000 | 416,000 – 652,000 | 297,000 – 928,000 |
| Acetone [a] | ug/kg | ND - 13 | ND – 14.9 | 2 – 11.6 |
| Tributyl phosphate [b] | ug/kg | ND - 46 | All ND | All ND |
| Bis-2-ethylhexyl phthalate [a] | ug/kg | 21 – 2,100 | ND - 660 | ND – 78 |
| Americium-241 | pCi/g | All ND | All ND | ND – 0.02 |
| Cesium-137 | pCi/g | ND – 0.113 | All ND | All ND |
| Europium-155 | pCi/g | ND – 0.012 | ND – 0.043 | All ND |
| Nickel-63 | pCi/g | ND – 2.64 | ND – 14.4 | All ND |
| Plutonium-239/240 | pCi/g | All ND | ND – 0.012 | All ND |
| Strontium-90 | pCi/g | ND – 1.7 | All ND | All ND |
| Tritium | pCi/g | 134 - 152 | 130 - 267 | 44 – 63.2 |

ND = non-detects, detection limits vary with the sample and are presented in the complete data tables in the appendix of this report.
a. Acetone and Bis-(2-ethylhexyl) phthalate are common laboratory contaminants and may be artifacts of the analytical system.
b. No RBCs exist for these analytes.

FG000.3

Figure 3-16. Vertical Profile Plots of Contaminants for the 216-A-37-1 Crib.




| 216-A-37-1 Crib - Borehole C4106 | Background Values | | | | | | Concentration & Borehole Legend |
|---|---|---|---|---|---|---|---|
| H - Fill<br>HFSD - Hanford Formation/Sand Dominated<br>RFGD - Ringold Formation/Gravel Dominated | Analyte | Background | Analyte | Background | Analyte | Background | Sand, Silty Sandy, Gravel, Silty/Clay<br>Water Table, Positive Detect, Non-detect |
| | Cs-137<br>Eu-155<br>Pu-239/240<br>Sr-90 | 1.05 pCi/g<br>0.0539 pCi/g<br>0.0248 pCi/g<br>0.178 pCi/g | Manganese<br>Nitrate as N | 512 mg/kg<br>12 mg/kg | Barium<br>Aluminum<br>Cobalt | 132 mg/kg<br>11800 mg/kg<br>15.7 mg/kg | |

FG508.1

Figure 3-17. Stratigraphy Diagram for the 216-B-12 Crib.

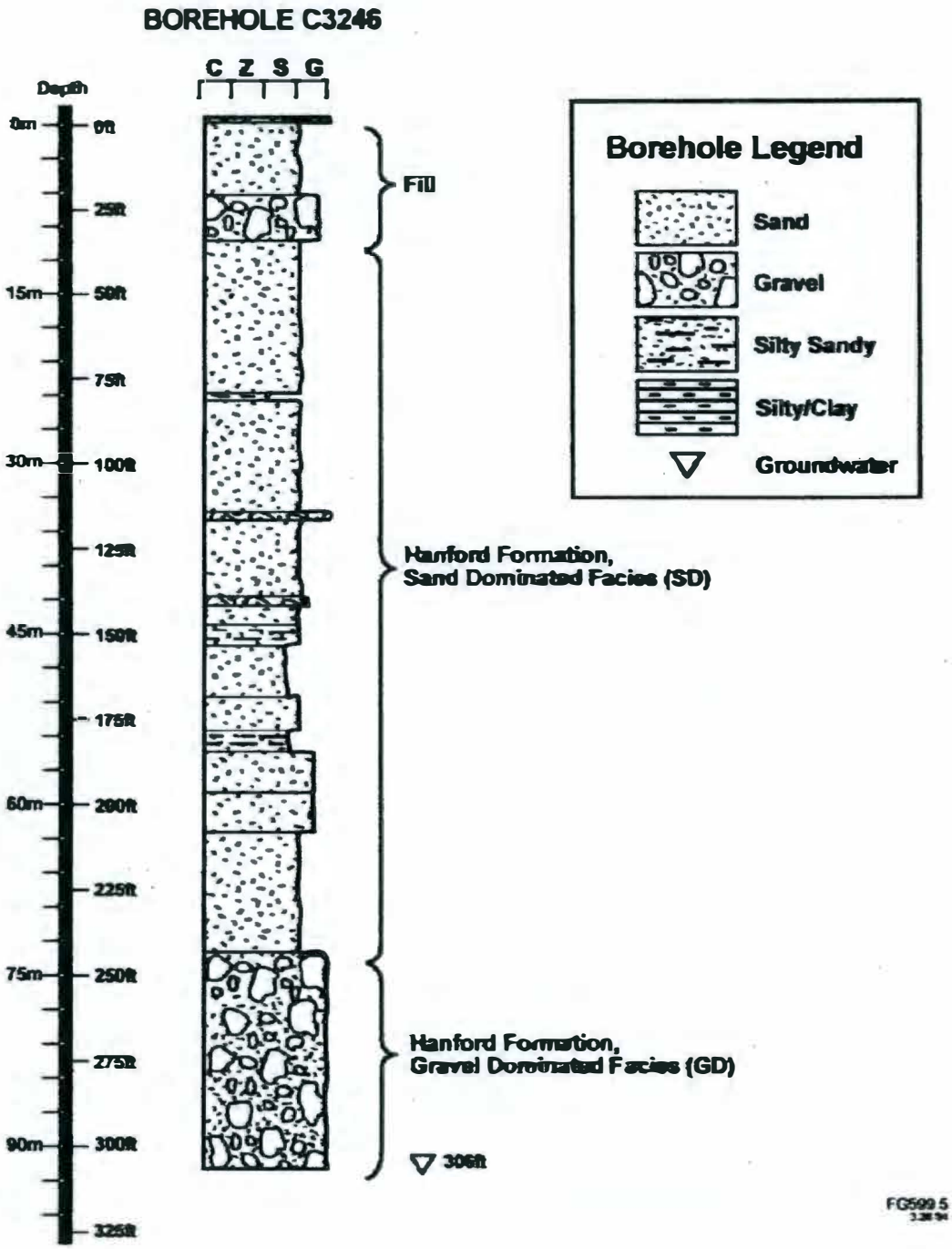
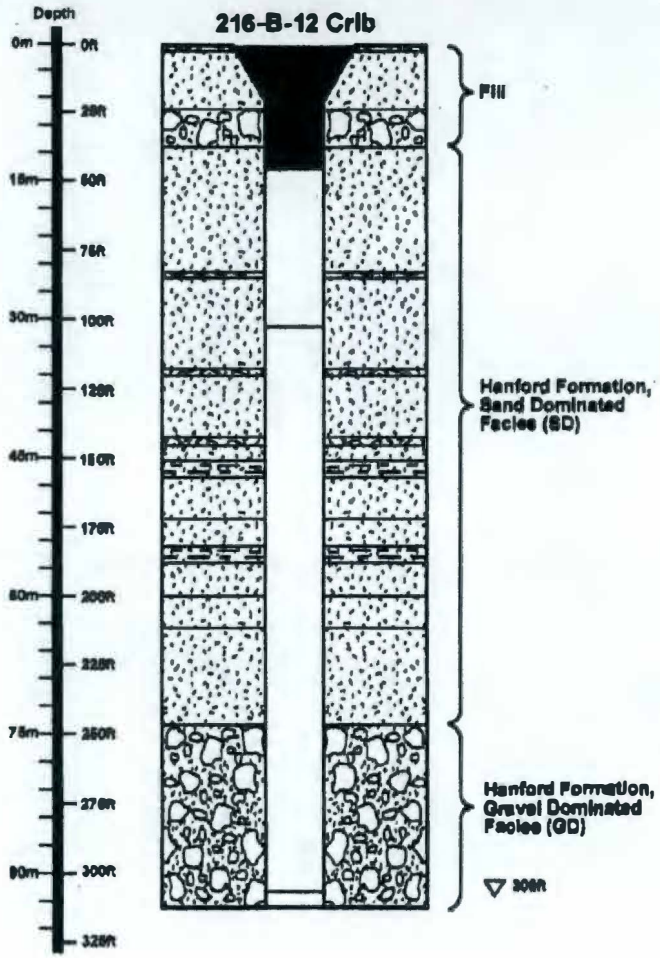


Figure 3-18. Stratigraphy and Contaminant Data for the 216-B-12 Crib.




**C3246**
**Select Radionuclides and Non-Radionuclides Concentrations at the 216- B-12 Crib**

| Analyte | Units | Depth | | |
|---|---|---|---|---|
| | | | | |
| | | 0- 12.2 m (0-40 ft) | >12.2 – 30.6 m (>40 - 100 ft) | >30.6 – 92 m (>100-302 ft) |
| Boron | ug/kg | ND – 1,300 | All ND | 750 – 1,000 |
| Nitrate as N | ug/kg | ND – 165,000 | 12,000 – 136,000 | 6,050 – 14,000 |
| Nitrate/Nitrite as N | ug/kg | 1,000 – 115,000 | 15,500 – 128,000 | 9,000 – 16,400 |
| Total Uranium | ug/kg | 445 – 28,000 | 2,770 – 8,060 | 334 – 2,890 |
| Tributyl phosphate [b] | ug/kg | ND – 2,000 | ND - 610 | All ND |
| Bis-2-ethylhexyl phthalate [a] | ug/kg | ND - 18 | All ND | ND – 20 |
| Americium-241 | pCi/g | ND - 2 | ND – 0.14 | ND – 0.47 |
| Carbon-14 | pCi/g | All ND | ND – 3.3 | All ND |
| Cesium-137 | pCi/g | ND – 61,900 | ND – 31,500 | All ND |
| Europium-155 | pCi/g | ND – 34.9 | ND – 0.282 | All ND |
| Neptunium-237 | pCi/g | ND – 0.048 | All ND | All ND |
| Plutonium-239/240 | pCi/g | ND – 3.9 | ND – 0.2 | All ND |
| Strontium-90 | pCi/g | ND – 12,700 | 12.5 – 97.1 | All ND |
| Tin-126 | pCi/g | ND – 0.742 | All ND | All ND |
| Tritium | pCi/g | ND – 6.28 | ND – 5.31 | 5.2 – 7.59 |
| Uranium-233/234 | pCi/g | 0.605 – 4.9 | 0.74 - 2 | 0.308 – 1.1 |
| Uranium-235 | pCi/g | ND – 0.32 | 0.041 – 0.16 | All ND |
| Uranium-238 | pCi/g | 0.628 – 6.1 | 0.69 - 2 | 0.43 – 0.998 |

ND = non-detects, detection limits vary with the sample and are presented in the complete data tables in the appendix of this report.
a. Bis-(2-ethylhexyl) phthalate are common laboratory contaminants and may be artifacts of the analytical system.
b. No RBCs exist for these analytes.

FG600.1

Figure 3-19. Vertical Profile Plots of Contaminants for the 216-B-12 Crib.

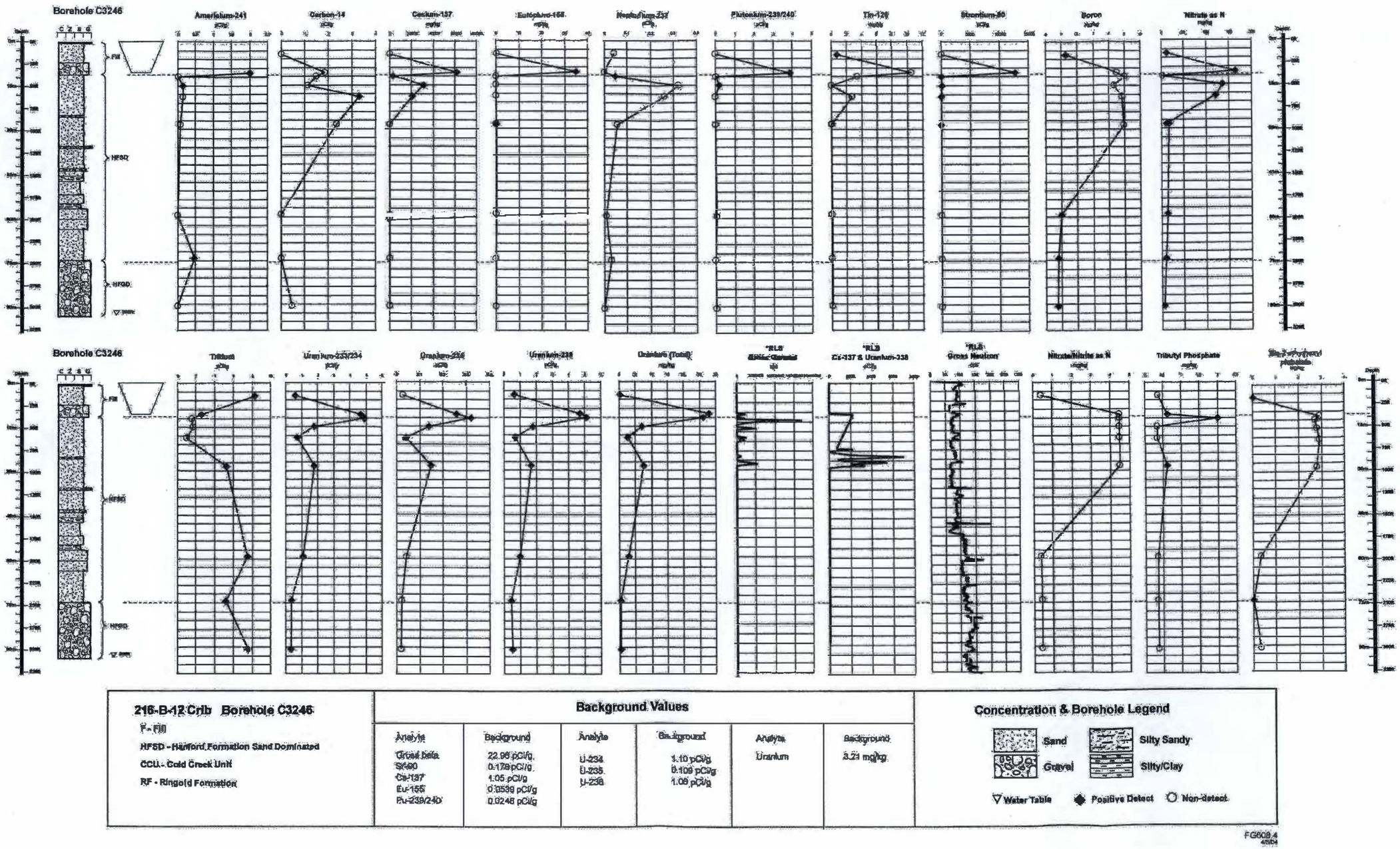


Figure 3-20. Nonradiological Contamination in Groundwater in the 200 East Area (2001 Data, from DOE/RL-2000-60, Rev. 1).

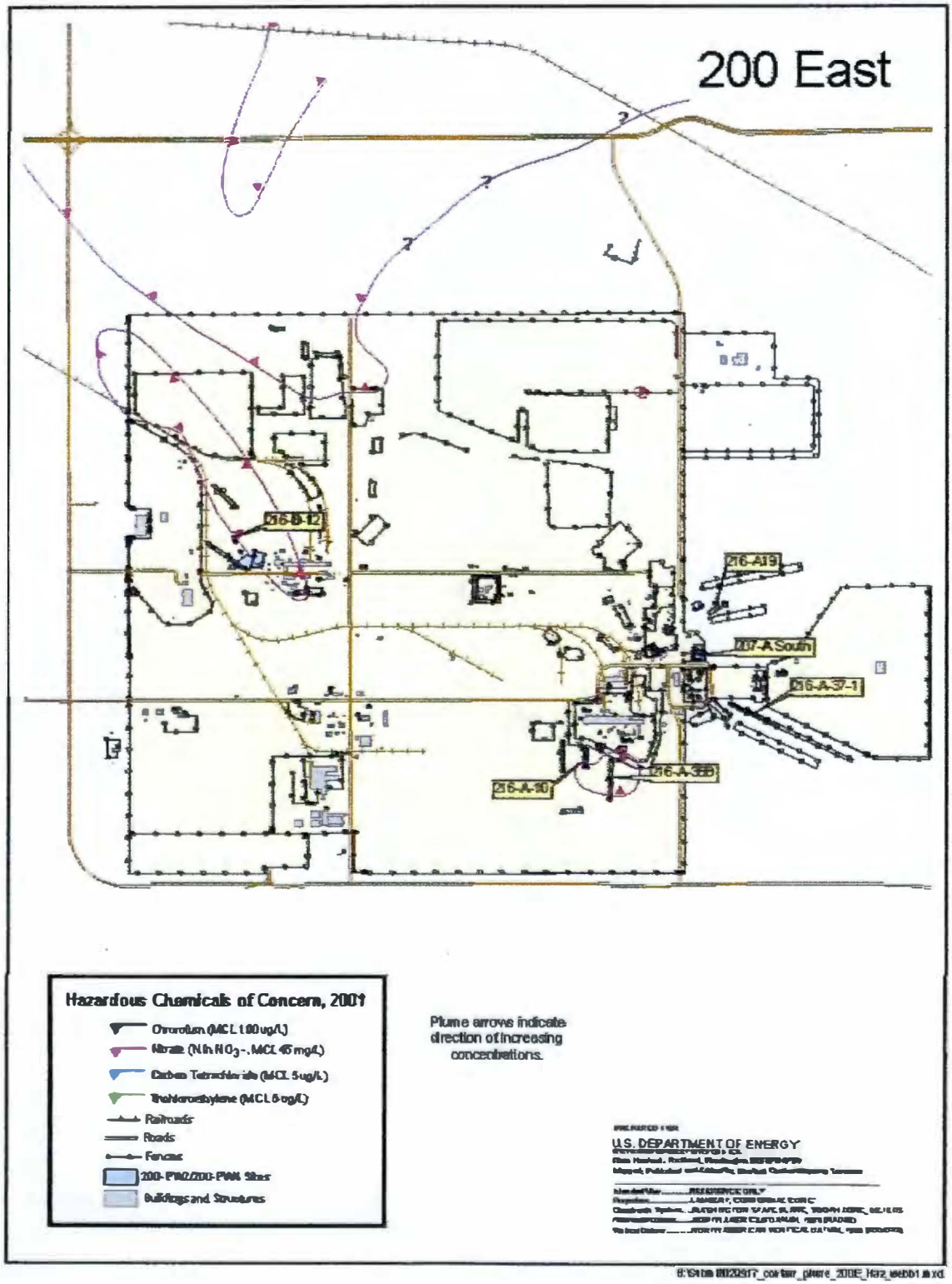


Figure 3-21. Radiological Contamination in Groundwater in the 200 East Area (2001 Data, from DOE/RL-2000-60, Rev. 1).

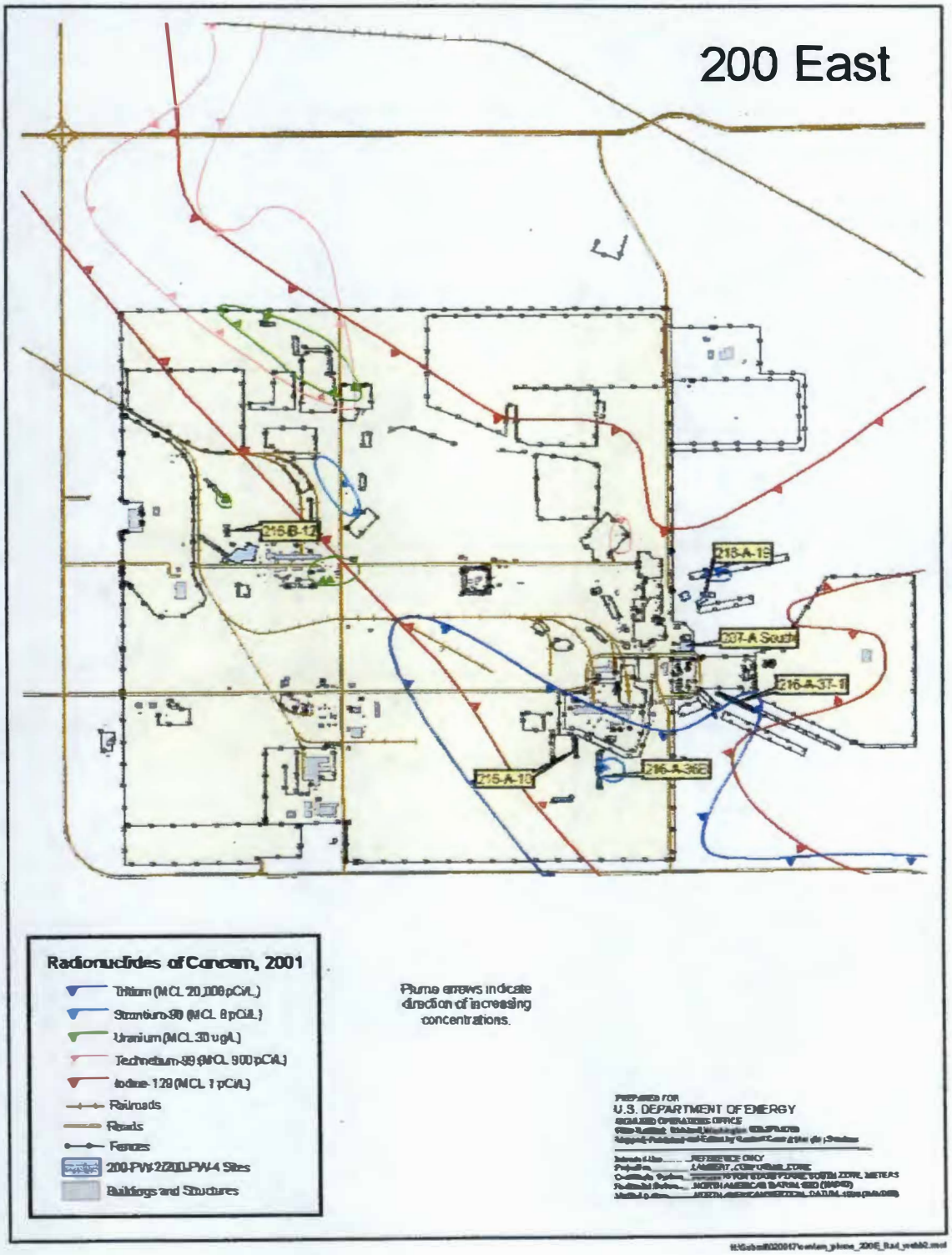


Figure 3-22. Nonradiological Contamination in Groundwater in the 200 West Area (2001 Data, from DOE/RL-2000-60, Rev. 1).

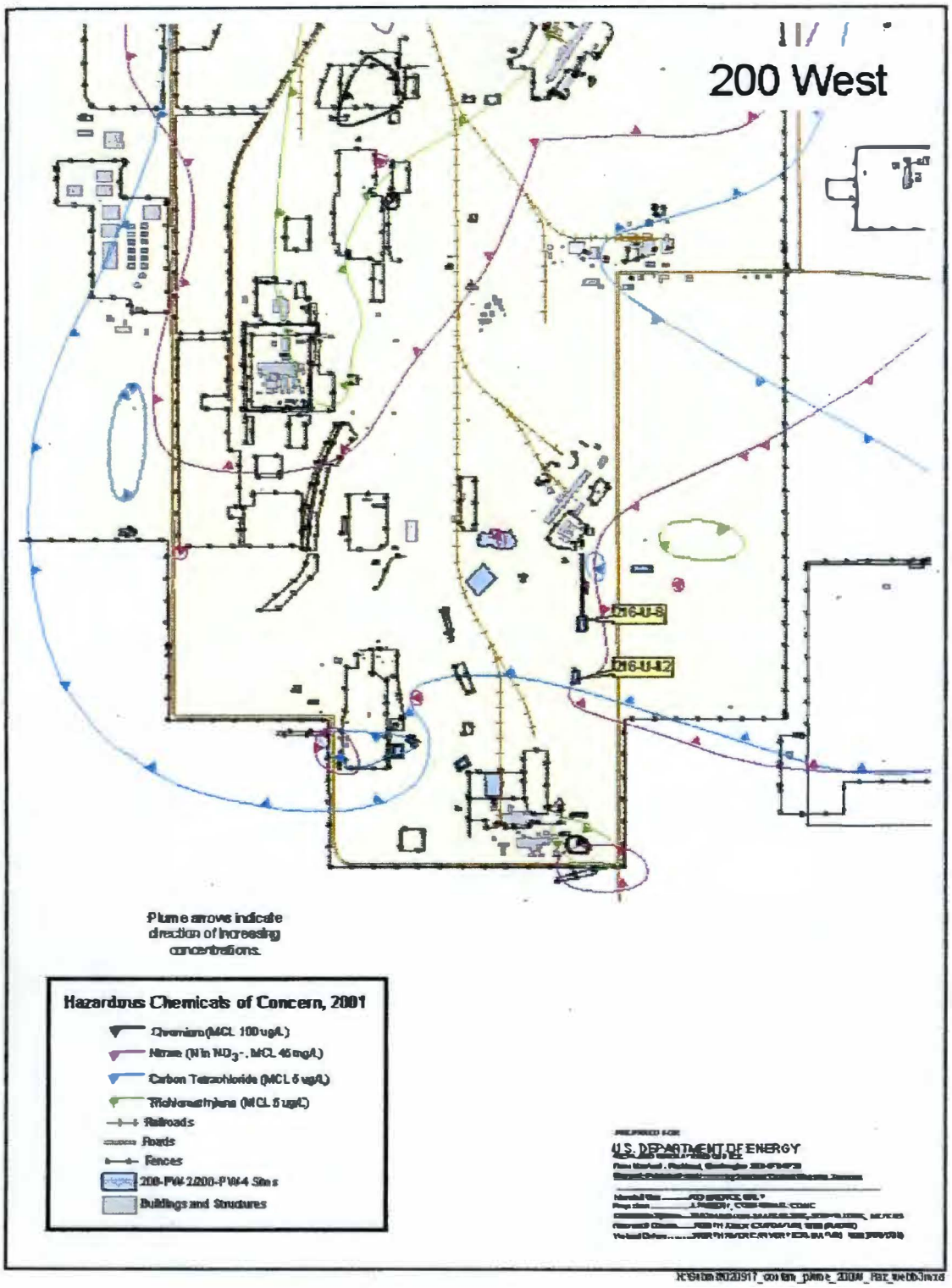


Figure 3-23. Radiological Contamination in Groundwater in the 200 West Area (2001 Data, from DOE/RL-2000-60, Rev. 1).

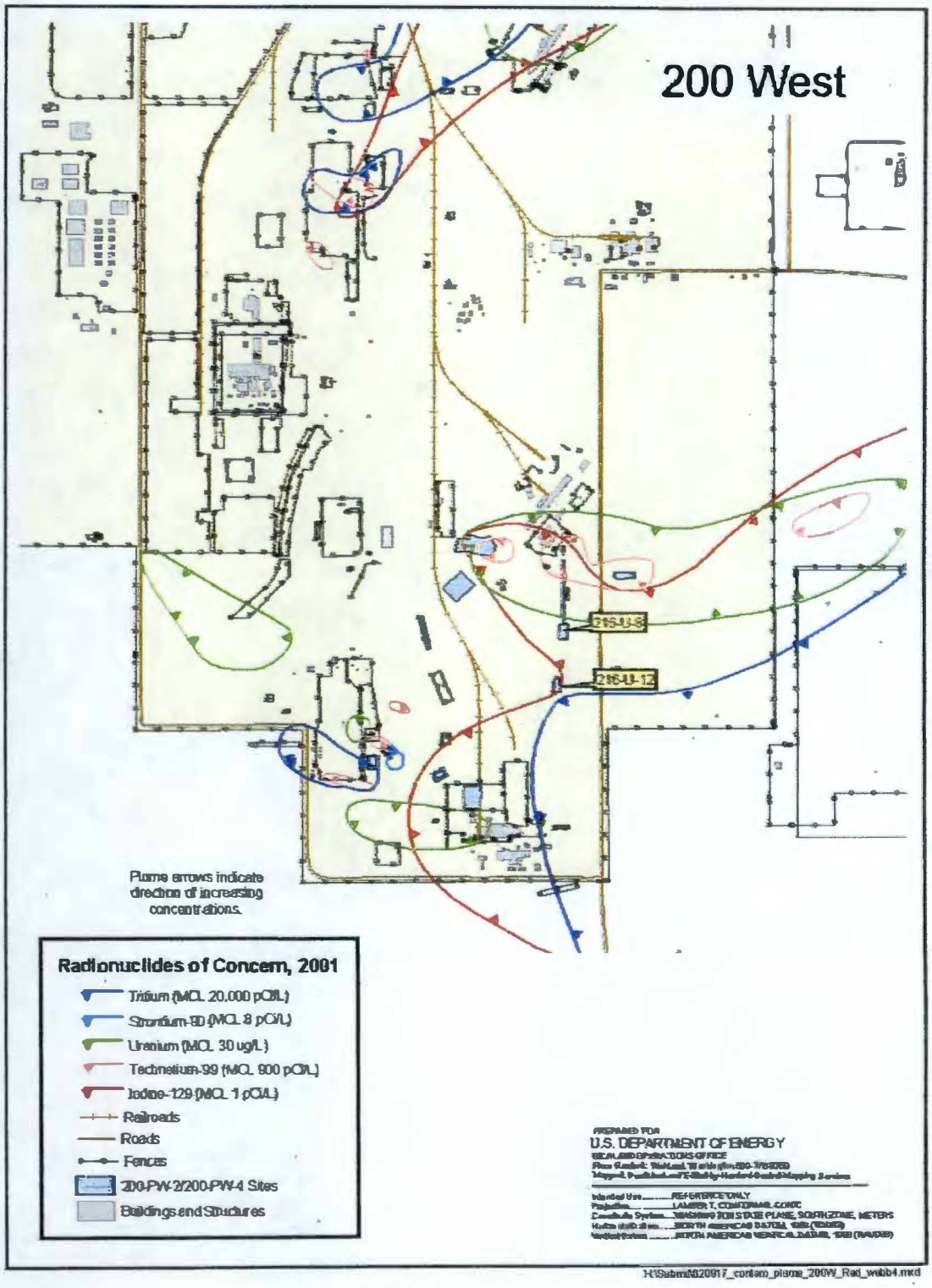


Table 3-1. Soil Physical Property Results.

| Sample Number | Sample Depth (ft bgs) | Formation* | Particle Size Distribution (Units) | | | | Moisture Content (%) | Bulk Density ($g/cm^3$) |
|---|---|---|---|---|---|---|---|---|
| | | | Gravel (%) | Sand (%) | Silt (%) | Clay (%) | | |
| **216-A-19 Trench (C3245)** | | | | | | | | |
| B16RY8 | 27.5 – 30.0 | Hanford, sand dominant | 0.0 | 97.1 | 2.6 | | 4.0 | 1.62 |
| B16RY9 | 97.5 – 100.0 | Hanford, sand dominant | 0.0 | 96.3 | 3.1 | | 1.7 | 1.66 |
| B16T00 | 242.5 – 245.0 | Hanford, sand dominant | 0.0 | 90.4 | 9.5 | | 2.8 | 1.62 |
| B16T01 | 248.0 – 250.5 | Hanford, sand dominant | 0.0 | 84.0 | 13.5 | 1.5 | 2.5 | 1.86 |
| **216-A-37-1 Crib (C4106)** | | | | | | | | |
| B16WB5 | 147.5 – 150.0 | Hanford, sand dominant | 0.0 | 88.4 | 10.5 | | 3.5 | 1.75 |
| B16WB6 | 197.5 – 200.0 | Hanford, gravel dominant | 40.5 | 46.4 | 2.5 | | 3.2 | 2.03 |
| B16WB7 | 272.5 – 275.0 | Hanford, gravel dominant | 10.9 | 72.2 | 8.1 | | 4.1 | N/A |
| **216-B-12 Crib (C3246)** | | | | | | | | |
| B171M8 | 94.5 – 97.0 | Hanford, sand dominant | 0.0 | 92.6 | 7.4 | | 2.6 | 1.60 |
| B171M9 | 302.0 – 304.5 | Hanford, gravel dominant | 47.6 | 37.9 | 14.5 | | 2.9 | 1.49 |
| **216-A-36B Crib (C4160)** | | | | | | | | |
| B174B1 | 89.5 – 92.0 | Hanford, sand dominant | 4.1 | 86.6 | 9.3 | | 3.0 | 1.71 |
| B174B2 | 287.5 – 290.0 | Hanford, sand dominant | 4.3 | 24.2 | 71.5 | | 17.2 | 1.69 |
| B174B3 | 318.5 – 321.0 | Hanford, gravel dominant | 41.8 | 49.5 | 8.7 | | 3.9 | 1.86 |
| **216-A-10 Crib (C3247)** | | | | | | | | |
| B17125 | 72.5 – 75.0 | Hanford, sand dominant | 0.0 | 82.4 | 17.6 | | 4.0 | 1.75 |
| B17127 | 317.0 – 319.5 | Hanford, gravel dominant | 60.5 | 30.7 | 8.9 | | 3.3 | 1.68 |
| **207-A South Retention Basin (C4113)** | | | | | | | | |
| B17J01 | 1.0 – 2.0 | Hanford, sand dominant | N/A | N/A | N/A | N/A | 9.8 | N/A |
| B17J07 | 7.0 – 8.0 | Hanford, sand dominant | N/A | N/A | N/A | N/A | 14.2 | N/A |
| B17JM0 | 12.5 – 13.5 | Hanford, sand dominant | N/A | N/A | N/A | N/A | 3.3 | N/A |

*Descriptions are based on DOE/RL-2002-39, *Standardized Stratigraphic Nomenclature for Post-Ringold-Formation Sediments Within the Central Pasco Basin*, Rev. 0.

N/A = not analyzed.

Table 3-2. List of Constituents Exceeding Background or Screening Levels for the 216-U-8 and 216-U-12 Cribs.

| Constituent | Maximum Concentration[1] (mg/kg) | Background[2] (mg/kg) | 100x Groundwater Protection[3] (mg/L) | WAC 173-340-745 Direct Soil Exposure (mg/kg) |
|---|---|---|---|---|
| Arsenic | 9.1 | 6.47 | 0.005 | 57.1 |
| Barium | 1070 | 132 | 112 | 22,400 |
| Beryllium | 1.00 | 1.51 | 0.002 | 9.3 |
| Cadmium | 0.81 | Not available | 0.001 | 6.56 |
| Chromium | 28.4 | 18.5 | 10.0 | 320,000 |
| Copper | 29.4 | 22.0 | 59.2 | 11,800 |
| Iron | 40,400 | 32,600 | Not available | Not available |
| Lead | 8.2 | 10.2 | Not available | Not available |
| Magnesium | 9,320 | 7,060 | Not available | Not available |
| Manganese | 505 | 512 | 224 | 44,800 |
| Mercury | 2.1 | 0.33 | 0.20 | 96.0 |
| Nickel | 22.5 | 19.1 | 10.0 | 6,400 |
| Nitrate as $NO_3$ | 197 | 52.0 | 4,400 | 2,252,800 |
| Selenium | 0.66 | Not available | 8.0 | 1,600 |
| Silver | 1.8 | 0.73 | 5.0 | 1,600 |
| Zinc | 84 | 67.8 | 480 | 96,000 |

[1] These values represent maximum concentrations of constituents found in the 216-U-8 Crib (From DOE/RL-95-106, *Focused Feasibility Study for the 200-UP-2 Operable Unit*, Appendix C, "216-U-12 Crib Closure/Post Closure Plan," Draft A).

[2] Background values were obtained from DOE/RL-92-24, *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes*

[3] These values represent 100 times the most stringent groundwater protection value between maximum contaminant levels or WAC 173-340-720, "Groundwater Protection Standards."

Note these are the standards in use at the time of publication of the Focused Feasibility Study for 200-UP-2 OU (DOE/RL-95-106).

OU = Operable unit.

WAC = *Washington Administrative Code.*

Table 3-3. 200-PW-2 and 200-PW-4 Operable Unit, Selected Sites and Corresponding Wells Up- and Downgradient

| Site | Upgradient Well | Downgradient Wells | Result Summary, 2001 to 2002 | Result Summary Pre-2001 Based on Work Plan and PNL-13788 |
|---|---|---|---|---|
| 216-A-10 | 299-E24-18 | 299-E17-1<br>299-E-24-16<br>299-E17-19 | Non detects for all pentachlorophenol; $^{129}$I ranged from below MDA to 10.7 pCi/L; no results for methylene chloride, TPH–diesel, or B-BHC | I-129 reported at 9.8 pCi/L in 299-E-24-16 which exceeds the MCL of 1 pCi/L. |
| 216-A-36B | None listed in Work Plan | 29-E17-14<br>299-E17-18<br>299-E17-9 | Nitrate as nitrogen ranged from 3.3 mg/L to 52.6 mg/L; no results for $^{99}$Tc or uranium isotopes | Nitrate as nitrogen was at a high of 184 mg/L in well 299-E17-9 with an MCL of 45 mg/L. Tritium at a high of 4.3 million pCi/L in 299-E17-9 with an MCL of 20,000 pCi/L. |
| 216-A-37-1 | 299-E-25-31 | 299-E25-9<br>299-E25-17<br>699-37-47A | Aluminum results were non-detects with three values just below detection. No difference between up and down gradient.<br>Manganese results were non-detects or estimated results below the detection limits in the upgradient wells ranging from 1.2 mg/L to 2.3 mg/L. Well 699-37-47A was similar to the upgradient well. Well 299-E25-17 was consistently higher than the upgradient at 26 mg/L to 35 µg/L.<br>Nitrate as nitrogen was less than 0.5 mg/L in the upgradient well and 0.95 mg/L to 3.8 mg/L in the downgradient wells.<br>Tritium was up to 2,190 pCi/L in the upgradient well, and twice the upgradient concentration in 299-E25-17 and 15 times the upgradient in well 699-37-47A ( high of 32,900 pCi/L). No results were reported for thallium or aluminum. | This site is within the estimated range of the tritium plume. |

DOE/RL-2000-60, *Uranium Rich/General Process Condensate and Process Waste Group Operable Unit RI/FS Work Plan and RCRA TSD Unit Sampling Plan,* Rev. 1

B-BHC = beta-1,2,3,4,5,6-Hexachlorocyclohexane
MCL = Maximum contaminant level.
MDA = Minimum detection level.
TPH = Total petroleum hydrocarbons.

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