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Revision 1
Re-issue

Steam Condensate/Cooling Water Waste Group Operable Units RI/FS Work Plan; Includes: 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 Operable Units

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

United States Department of Energy
P.O. Box 550
Richland, Washington 99352

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TERMS

AAMSR	aggregate area management study report
ARAR	applicable or relevant and appropriate requirement
bgs	below ground surface
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
COC	contaminant of concern
COPC	contaminant of potential concern
DOE	U.S. Department of Energy
DQA	data quality assessment
DQO	data quality objective
Ecology	Washington State Department of Ecology
EHQ	environmental hazard quotient
EMI	electromagnetic induction
EPA	U.S. Environmental Protection Agency
FFS	focused feasibility study
FS	feasibility study
GG/PN	gross gamma/passive neutron (monitoring)
GPR	ground-penetrating radar
GRA	general response action
HAB	Hanford Advisory Board
HASP	health and safety plan
HI	hazard index
HQ	hazard quotient
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
IDW	investigation-derived waste
K_d	distribution coefficient
LFI	limited field investigation
NEPA	*National Environmental Policy Act of 1969*
OU	operable unit
PCB	polychlorinated biphenyl
PFP	Plutonium Finishing Plant
PRG	preliminary remediation goal
PUREX	Plutonium-Uranium Extraction (Plant)
QRA	qualitative risk assessment
RAO	remedial action objective
RCP	reinforced concrete pipe
RCRA	*Resource Conservation and Recovery Act of 1976*
RECUPLEX	Recovery of Uranium and Plutonium by Extraction (Plant)
REDOX	Reduction-Oxidation (Facility)
RESRAD	RESidual RADioactivity dose model
RI	remedial investigation
RL	U.S. Department of Energy, Richland Operations Office
ROD	record of decision

SAP	sampling and analysis plan
SGL	spectral gamma logging
STOMP	Subsurface Transport Over Multiple Phases
TBP	tributyl phosphate
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TSD	treatment, storage, and/or disposal (unit)
UNH	uranyl nitrate hexahydrate
UPR	unplanned release
VCP	vitrified clay pipeline
WAC	*Washington Administrative Code*
WCP	waste control plan
WESF	Waste Encapsulation and Storage Facility
WIDS	*Waste Information Data System*

1.0 INTRODUCTION

This work plan supports the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) remedial investigation/feasibility study (RI/FS) activities for the 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 Operable Units (OU). The 200 Areas are collectively one of four areas on the Hanford Site that are on the U.S. Environmental Protection Agency's (EPA) National Priorities List (40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan," Appendix B, "National Priorities List,") under CERCLA. The general RI/FS process is described in EPA/540/G-89/004, *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*. The application of the process in the 200 Areas is described in DOE/RL-98-28, *200 Areas Remedial Investigation/Feasibility Study Implementation Plan - Environmental Restoration Program* (Implementation Plan); Section 1.1 of this document summarizes the Implementation Plan.

As part of the *Hanford Federal Facilities Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1989), Change Packages M-15-02-01 and M-13-02-01, approved June 2002 (Ecology et al. 2002, *Hanford Tri-Party Agreement Modifications to 200 Area Waste Sites Cleanup Milestones, Tri-Party Agreement Change Requests and Comment and Response Document, Change Number M-13-02-1, June 2002*), the 200-CW-2 OU (S Pond and Ditches Cooling Water Group), the 200-CW-4 OU (T Pond and Ditches Cooling Water Group), and the 200-SC-1 OU (Steam Condensate Group) were consolidated with the 200-CW-5 OU (U Pond/Z-Ditches Cooling Water Group) (see Section 4.1). These OUs are located near the center of the Hanford Site in south-central Washington State. The 200-CW-5 OU consists of 12 waste sites and 3 associated unplanned releases (UPR), including UPR-200-W-110, which was moved from the 200-PW-1 OU, as defined in the updated Tri-Party Agreement Appendix C package pending approval. The 200-CW-5 OU initially was assigned eight UPRs; however, six of them were found to be duplicate designations for other sites within the OU. The duplicate UPR sites subsequently were rejected from the *Waste Information Data System* (WIDS), following RL-TPA-90-0001, *Tri-Party Agreement Handbook Management Procedures*, TPA-MP-14, "Maintenance of the Waste Information Data System [WIDS]," for waste site reclassification.

Three new waste sites were added to the 200-CW-5 OU in this revision to the work plan; the 200 W-84 Process Sewer, the 200-W-102 pipeline, and the 216-W-Laundry Waste Crib (LWC). The 200-W-84 Process Sewer is a pipeline that delivered chemical sewer effluents from the 221-U Facility to the 216-U-14 Ditch. This pipeline was transferred from the 200-IS-1 OU to the 200-CW-5 OU because of its link to the 216-U-14 Ditch. The 200-W-102 pipeline is a recent WIDS discovery site that formerly routed laundry wastewater from the 2723-W and 2724-W Laundry/Mask Cleaning Facilities to the 216-U-14 Ditch. The 216-W-LWC has been reassigned to the 200-CW-5 OU from the 200-CS-1 OU following the issuance of the Tri-Party Agreement procedure for waste site reclassification (RL-TPA-90-0001). The 216-W-LWC is a *Resource Conservation and Recovery Act of 1976* (RCRA) past-practice (RPP) site that also received wastewater from the 2723-W and 2724-W Laundry/Mask Cleaning Facilities.

The 200-CW-2 OU consists of eight waste sites and one associated UPR as defined in the updated Tri-Party Agreement Appendix C package pending approval. The 200-CW-2 OU initially was assigned five UPRs; however, all five were found to be duplicate designations for other sites within the OU. The duplicate UPR sites subsequently were rejected from the WIDS, and UPR-200-W-124 was proposed for addition in accordance with the Tri-Party Agreement procedure TPA-MP-14 for waste site reclassification (RL-TPA-90-0001).

The 200-CW-4 OU consists of eight waste sites. The 200-SC-1 OU consists of 13 waste sites and 3 UPRs as defined in the updated Tri-Party Agreement Appendix C package pending approval. The 200-CW-5, 200-CW-2, 200-CW-4, and 200-CS-1 OU waste sites received cooling water, steam condensate, and chemical sewer waste from several facilities in the 200 East and 200 West Areas. These effluent streams ranged from acidic to basic and carried chemicals and radionuclides that contaminated the waste sites.

Effluents were discharged to the 200-CW-5 OU waste sites from the UO_3 Plant, the U Plant, the 284-W Powerhouse, the 2723-W and 2724-W Laundry/Mask Cleaning Facilities, the 242-S Evaporator, the Z Plant complex (including the Plutonium Finishing Plant [PFP]), and other smaller facilities. The 200-CW-2 OU waste sites received effluents from the 202-S or Reduction-Oxidation (REDOX) Facility and overflow from U Pond via the 216-U-9 Ditch. The 221-T, 242-T, and 2706-T Facilities routed effluents to the 200-CW-4 OU waste sites and the 200-SC-1 OU waste sites. The 200-SC-1 OU waste sites also received waste from the Plutonium-Uranium Extraction (PUREX) Facility and the 242-A Evaporator, 221-B/Waste Encapsulation and Storage Facility (WESF), the REDOX Facility and the 241-SX Sludge Heater, the 216-U-1&2 Pump-and-Treat System, and the Z Plant complex.

The characterization and remediation of waste sites at the Hanford Site are addressed in the Tri-Party Agreement (Ecology et al. 1989). Tri-Party Agreement milestones govern the schedule of work at the Hanford Site. The controlling milestone for the 200-CW-5 OU milestone was M-13-22, "Submit U Pond/Z-Ditches Cooling Water Group Work Plan," December 31, 1999. All characterization work for non-tank-farm OUs in the 200 Areas is scheduled to be completed by December 31, 2008 (Milestone M-15-00C).

1.1 200 AREAS IMPLEMENTATION PLAN

The Implementation Plan (DOE/RL-98-28) outlines a strategy intended to streamline the characterization and remediation of waste sites in the 200 Areas, including CERCLA sites; RPP sites; and certain RCRA treatment, storage, and/or disposal (TSD) units. The Implementation Plan 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. The Implementation Plan establishes a regulatory framework to integrate the requirements of RCRA and CERCLA into one standard approach for cleanup activities in the 200 Areas. The integrated RCRA-CERCLA approach is used as illustrated in Figure 1-1.

The Implementation Plan consolidates much of the information normally found in a specific work plan to avoid duplicating this information for each of the 23 200 Areas OUs. The Implementation Plan also lists potential applicable or relevant and appropriate requirements (ARAR) and preliminary remedial action objectives (RAO), and covers potentially feasible remedial technologies that could be employed in the 200 Areas. This work plan references the Implementation Plan for further details on several topics, such as general information on the physical setting and operational history of 200 Areas facilities, ARARs, RAOs, and post-work plan activities.

The Implementation Plan addresses more than 800 waste sites assigned to 23 process-based OUs, which, in turn, were grouped into 9 major waste categories (e.g., process waste, landfills, cooling water). This categorization facilitates the use of the analogous site approach, which was a fundamental concept under the Implementation Plan. The 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 OUs fall within the Steam Condensate/Cooling Water/Chemical Sewer category. This category includes ground-level disposal structures (e.g., ponds and ditches) that received steam condensate and cooling water waste streams. Steam condensate and cooling water from closed process systems generally were not in direct contact with radioactive and chemical materials. These waste streams potentially received contamination through pinhole leaks and/or infrequent pipe ruptures and process upsets. The pipe ruptures, process upsets, and large quantities of liquids discharged resulted in detectable accumulations of contaminants at the waste sites.

1.2 SCOPE AND OBJECTIVES

This work plan documents background information, defines characterization and assessment activities and schedule based on the framework established in the Implementation Plan, and identifies the steps required to complete the RI/FS process for the OUs. The general approach to characterization and evaluation of 200 Areas OUs is outlined in the Implementation Plan. Details presented in this work plan include background information on the waste sites in these OUs, existing representative waste site characterization data, and the approach that will be used to investigate, characterize, and evaluate the sites. This work plan includes a discussion of the RI planning and execution process, along with a schedule for the characterization work. Preliminary RAOs that are likely to be considered for the OUs are identified in the work plan. These preliminary remedial alternatives will be developed further and agreed to in the FS, the proposed plan, and the eventual record of decision (ROD).

An RI data quality objectives (DQO) process was conducted for the 200-CW-5 OU to define the chemical and radiological constituents to be characterized and to specify the number, type, and location of samples to be collected at representative waste sites. The applicability of this DQO for the analogous waste sites is discussed in Section 4.1. An investigation-derived waste (IDW) DQO process was performed for the 216-Z-11 Ditch (200-CW-5) to ensure that waste designation requirements would be met during RI characterization. The results of the two DQO processes form the basis for the work plan and the associated sampling and analysis plan (SAP) (Appendix A). The SAP includes a representative site-specific quality assurance project plan and a field sampling plan for implementing the characterization activities in the field. An EPA-approved waste control plan (WCP) (WCP-2002-0001, Rev. 0, *Waste Control Plan for the 200-CW-5 Operable Unit*) details the management and ultimate disposal of waste generated by the characterization activities at the 216-Z-11 Ditch (200-CW-5 OU). A unique WCP will be developed for each OU in support of post-ROD confirmatory sampling characterization activities.

After characterization data have been collected, results will be presented in an RI report. The RI report will include an evaluation of the characterization data for the representative sites, including an assessment of the accuracy of the conceptual model and development of a contaminant distribution model. The RI report will support the evaluation of remedial alternatives that will be included in the FS. The FS will use the existing and newly collected data to evaluate a range of remedial actions for the representative sites and for the remaining sites within the OUs that fall within the contaminant distribution models. Remedial alternatives may be applied at any or all of the waste sites in the OUs, and different alternatives may be applied to different waste sites depending on site characteristics. The FS ultimately will support a proposed plan leading to an ROD for all of the waste sites in the OUs. The schedule for assessment activities at the 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 OUs is presented in Chapter 6.0.

Figure 1-1. Regulatory Process for the 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 Operable Units (modified from DOE/RL-98-28).

200-CW-5 200-CW-2 200-CW-4 200-SC-1 RI/FS Work Plan →	200-CW-5 200-CW-2 200-CW-4 200-SC-1 Remedial Investigation Report →	200-CW-5 200-CW-2 200-CW-4 200-SC-1 Feasibility Report →	200-CW-5 200-CW-2 200-CW-4 200-SC-1 Proposed Plan →	Record of Decision (ROD) →	Remedial Design/Remedial Action Work Plan
Provides group & site-specific background information on waste sites in 200-CW-5, 200-CW-2, 200-CW-4, 200-SC-1 Defines site characterization needs based on DQO's to assess nature & vertical extent of contamination within the representative waste sites Includes sampling & analysis plan Provides pre-ROD project schedule	Field investigation report -Representative waste sites Risk Assessment performed at this stage	Evaluates remedial alternatives -Representative and analogous waste sites	Propose selected remedy for waste sites based on FS Public review required -Supporting FS will be available through Administrative Record for public review **Public input (45 days)**	Decision document authorizing selected remedy	Designs and implements chosen remedy Includes sampling and analysis plan for confirmatory and verification sampling Provides post-ROD schedule following CERCLA schedule

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2.0 BACKGROUND AND SETTING

This section describes the 200-CW-5 U Pond/Z-Ditches Cooling Water Group, the 200-CW-2 S Pond and Ditches Cooling Water Group, the 200-CW-4 T Pond and Ditches Cooling Water Group, and the 200-SC-1 Steam Condensate Group OUs, associated waste sites, and the physical setting of the 200 Areas and vicinity. Information in this section is summarized mainly from the following resources:

- DOE/RL-98-28, *200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program*
- DOE/RL-91-60, *U Plant Source Aggregate Area Management Study Report*
- DOE/RL-91-61, *Z Plant Source Aggregate Area Management Study Report*
- DOE/RL-95-13, *Limited Field Investigation for the 200-UP-2 Operable Unit*
- DOE/RL-95-106, *Focused Feasibility Study for the 200-UP-2 Operable Unit*
- DOE/RL-96-81, *Waste Site Grouping for 200 Areas Soil Investigation*
- WIDS (WIDS data sheets and historical files).

The waste sites in the 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 OUs are located on the Hanford Site in south-central Washington State (Figure 2-1). These OUs consist of waste sites that received mostly cooling water and steam condensate from a variety of 200 Areas operations.

Inside the Central Plateau Core Zone boundary, potential human receptors include current and future site workers and inadvertent intruders; potential ecological receptors include terrestrial plants and animals. Outside the Core Zone boundary, the preferred land use is conservation (mining) (DOE/EIS-0222F, *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement*). Figures 2-2 and 2-3 show the locations of the 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 OU waste sites relative to the 200 West and East Areas, respectively. Figure 2-4 shows that all of the 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 OU waste sites are contained within the 200 Areas Central Plateau Core Zone Boundary.

2.1 PHYSICAL SETTING

Sections 2.1.1 through 2.1.5 summarize the geology and hydrology associated with the 200 Areas, including the 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 OUs. More detail on the physical setting of the 200 Areas and vicinity is provided in Appendix F of the Implementation Plan (DOE/RL-98-28).

2.1.1 Topography

The OUs include waste sites located in both the 200 East and 200 West Areas on the Central Plateau. The Central Plateau is the common term used to describe the broad, flat area that constitutes a local topographic high around the 200 Areas at the Hanford Site. The plateau was formed approximately 13,000 years ago during the cataclysmic Missoula floods. The northern boundary of the Central Plateau is defined by an erosional channel that runs east-southeast before turning south just east of the 200 East Area. This erosional channel formed during the waning stages of flooding as floodwaters drained from the basin. The northern half of the 200 East Area lies within this ancient flood channel. A secondary flood channel running southward off the main channel bisects the 200 West Area. The former river and flood channels (now buried) may provide preferential pathways for groundwater and contaminant movement.

Waste sites in the 200 West Area are situated in a relatively flat area in a secondary flood channel. Surface elevations range from approximately 205 m (673 ft) to 217 m (712 ft) (datum from NAVD88, *North American Vertical Datum of 1988*), and the surface slopes gently to the west. Waste site surface elevations in the 200 East Area and vicinity range from approximately 189 m (620 ft) (NAVD88) in the northern portion of the 200 Areas to 230 m (755 ft) at waste sites just south of the 200 East Area. The ground surface within the 200 East Area slopes gently to the northeast.

2.1.2 Geology

The OUs are located in the Pasco Basin on the Columbia Plateau. They are underlain by basalt of the Columbia River Basalt Group and a sequence of suprabasalt sediments. From oldest to youngest, major geologic units of interest are the Elephant Mountain Basalt Member, the Ringold Formation, the Plio-Pleistocene unit, the Hanford formation/Plio-Pleistocene unit, and the Hanford formation. The fluvial-lacustrine Ringold Formation is informally divided into several informal units (from oldest to youngest): unit A, lower mud, unit E, and upper unit. They are overlain by a Plio-Pleistocene-aged unit in the 200 West Area consisting of a locally derived subunit that is interpreted to be a weathered surface that developed on the top of the Ringold Formation (WHC-MR-0418, *Historical Records of Radioactive Contamination in Biota at the 200 Areas of the Hanford Site*; PNL-7336, *Geohydrology of the 218-W-5 Burial Ground, 200 West Area, Hanford Site*) and an eolian facies (Slate 1996, "Buried Carbonate Paleosols Developed in Pliocene-Pleistocene Deposits of the Pasco Basin, South-Central Washington, U.S.A."). The eolian facies originally was described as a separate unit called the "early Palouse soil." A recently identified unit of uncertain origin, referred to as the Hanford formation/Plio-Pleistocene unit, is reported in the northwest corner of the 200 East Area. This unit may be equivalent or partially equivalent to the Plio-Pleistocene or it may represent the earliest ice age flood deposits overlain by a locally thick sequence of fine-grained nonflood deposits (HNF-5507, *Subsurface Conditions Description for the B-BX-BY Waste Management Area*). Glaciofluvial cataclysmic flood deposits of the Hanford formation are present in both the 200 East and 200 West Areas. The Hanford formation deposits consist of gravel-dominated and sand-dominated sequences. A generalized stratigraphic column for the 200 Areas is shown in Figure 2-5.

The Elephant Mountain Basalt Member is a medium- to fine-grained tholeiitic basalt with abundant microphenocrysts of plagioclase (DOE/RW-0164-F, *Consultation Draft, Site Characterization Plan, Reference Repository Location, Hanford Site, Washington*). The basalt is overlain by the Ringold Formation over most of the 200 East Area and all of the 200 West Area. This formation consists of an interstratified sequence of unconsolidated clay, silt, sand, and granule-to-cobble gravel deposited by the ancestral Columbia River. These alluvial sediments consist of four major units; from oldest to youngest these are the fluvial gravel and sand of unit A, the buried soil horizons and lake deposits of the lower mud sequence, the fluvial sand and gravel of unit E, and the lacustrine mud of the upper Ringold.

Overlying the Ringold Formation in the 200 West Area is the locally derived subunit of the Plio-Pleistocene unit, which consists of poorly sorted, locally derived, interbedded reworked loess, silt, sand, and basaltic gravel (WHC-SD-EN-TI-290, *Geologic Setting of the Low-Level Burial Grounds*). The subunit consists of a lower carbonate-rich paleosol (caliche) and an upper eolian facies. The carbonate-rich section consists of interbedded carbonate-poor and carbonate-rich strata. The upper silty eolian facies was previously interpreted to be early Pleistocene loess and is referred to as the early Palouse soil (PNL-7336). Generally, it is well-sorted quartz-rich/basalt-poor silty sand to sandy silt (BHI-00270, *Preoperational Baseline and Site Characterization Report for the Environmental Restoration Disposal Facility*).

Where the Ringold Formation and Plio-Pleistocene unit are not present, the Hanford formation/Plio-Pleistocene unit and Hanford formation sediments overlie the basalt. The Hanford formation/Plio-Pleistocene unit is made up of two facies and has been identified in the 200 East Area only near the B, BX, and BY Tank Farms. The lower facies overlies basalt and is described in HNF-5507 as loose, unconsolidated sandy gravel to gravelly sand. These gravels contain 50 percent to 70 percent basalt and are similar to and often indistinguishable from Hanford formation flood gravels in the absence of the second facies. The second facies consists of an olive-brown to olive-gray, well-sorted calcareous eolian/overbank silt with laminations and pedogenic structures. However, the second facies also has been observed to be massive and void of sedimentary or pedogenic structures. The Hanford formation consists of unconsolidated gravel, sand, and silts deposited by cataclysmic floodwaters. These deposits consist of gravel-dominated and sand-dominated facies. The gravel-dominated facies consist of cross-stratified, coarse-grained sands and granule-to-boulder gravel. The gravel is uncemented and matrix poor. The sand facies consists of 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. An upper and lower gravel unit and a middle sand facies are present in the study area.

The cataclysmic floodwaters that deposited the sediments of the Hanford formation also locally reshaped the topography of the Pasco Basin. The floodwaters deposited a thick sand and gravel bar that constitutes the higher southern portion of the 200 Areas, informally known as the Central Plateau. In the waning stages of the ice age, these floodwaters also eroded a channel north of the 200 Areas in the area currently occupied by Gable Mountain Pond. These floodwaters removed all of the Ringold Formation from this area and deposited Hanford formation sediments directly over basalt.

Holocene-age deposits overlie the Hanford formation and are dominated by eolian sheets of sand that form a thin veneer 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 windblown material has settled out through standing water over many years.

2.1.3 Vadose Zone

The vadose zone is approximately 104 m (340 ft) thick in the southern section of the 200 East Area and thins to the north to as little as 0.3 m (1 ft) near West Lake. The Ringold and Hanford Formations dominate the sediments in the vadose zone. The Hanford formation/Plio-Pleistocene unit may be present in a small area immediately above the basalt beneath the B, BX, and BY Tank Farms. Because erosion during cataclysmic flooding removed much of the Ringold Formation north of the central part of the 200 East Area, the vadose zone is composed predominantly of Hanford formation sediments between the northern part of the 200 Areas and Gable Mountain. Areas of basalt project above the water table north of the 200 East Area.

In the 200 West Area, the vadose zone thickness ranges from 40.2 m (132 ft) to 102 m (337 ft). Sediments in the vadose zone are the Ringold Formation, the Plio-Pleistocene unit, and the Hanford formation. Erosion during cataclysmic flooding removed some of the Ringold Formation and Plio-Pleistocene unit.

Perched water has been documented above the Plio-Pleistocene unit at locations in the 200 West Area. While liquid waste disposal facilities were operating, localized areas of saturation or near saturation were created in the soil column. With the reduction of artificial recharge in the 200 Areas, downward flux of liquid in the vadose zone beneath these waste sites has been decreasing. However, moisture content in the vadose zone is expected to remain elevated above preoperational levels for some time. As unsaturated conditions are reached, liquid flux at these disposal sites becomes increasingly less significant as a source of recharge and contaminant movement to groundwater. In the absence of artificial recharge, recharge from natural precipitation becomes the more dominant driving force for moving contamination remaining in the vadose zone to groundwater.

2.1.4 Groundwater

The unconfined aquifer in the 200 Areas occurs within the Hanford formation/Plio-Pleistocene unit, the Hanford formation, or the Ringold Formation, depending on location. Groundwater in the unconfined aquifer flows from recharge areas where the water table is higher (west of the Hanford Site) to areas where it is lower, near the Columbia River (PNNL-13116, *Hanford Site Groundwater Monitoring for Fiscal Year 1999*). In the northern half of the 200 East Area, the water table is present within the Hanford formation, except in areas where basalt extends above the water table. Near the B-BX-BY waste management area, the water table occurs within the Hanford formation/Plio-Pleistocene unit. In the central and southern sections of the 200 East Area, the water table is located near the contact between the Ringold and Hanford Formations.

Depth to groundwater in the 200 East Area and vicinity ranges from about 54 m (177 ft) near B Pond to about 104 m (340 ft) near the southern section. The water table across the 200 East Area is very flat. Consequently, it is difficult to determine groundwater flow direction based on water level measurements from monitoring wells. The configuration of contaminant plumes, however, indicates that groundwater flows to the northwest in the northern half of the 200 East Area, and to the east/southeast in the southern half of the 200 East Area. Identifying the specific location of the groundwater divide between the northern and southern sections is hampered by the flat water table. Highly transmissive Hanford formation sediments are the cause of the flat water table in the 200 East Area (PNNL-13116). Because surface liquid discharges were terminated in the 200 East Area, the water table has been declining at a rate of about 0.13 m/yr (0.4 ft/yr) based on water-level measurements collected between March 1999 and April 2001 (PNNL-13404, *Hanford Site Groundwater Monitoring for Fiscal Year 2000*).

Groundwater beneath the 200 West Area occurs in the Ringold Formation. Depth to water varies from about 40.2 m (132 ft) to greater than 102 m (337 ft). Groundwater flow is predominately to the east. The surface elevation of the water table beneath the 200 West Area currently is dropping at a rate of 0.41 m/yr (1.3 ft/yr) (PNNL-13404).

Recharge to the unconfined aquifer within the 200 Areas is from artificial sources and less significant natural precipitation. Estimates of recharge from precipitation range from 0 cm/yr to 10 cm/yr (0 to 4 in./yr) and depend largely on soil texture and the type and density of vegetation. PNL-5506, *Hanford Site Water Changes 1950 through 1980, Data Observation and Evaluation*, reported that between 1943 and 1980, 6.33×10^{11} L (1.67×10^{11} gal) of liquid waste were discharged to the soil column. Most sources of artificial recharge were terminated in 1995. The artificial recharge that does continue is largely limited to liquid discharges from sanitary sewers, 2 state-approved land disposal structures, and 140 small-volume, uncontaminated miscellaneous liquid discharge streams. One of the approved land disposal structures, the Treated Effluent Disposal Facility (a liquid waste disposal facility), is located 600 m (2,000 ft) east of the 216-B-3C lobe of B Pond and receives treated liquid waste from the 200 East and 200 West Area facilities.

2.1.5 Summary of Hydrogeologic Conditions at Representative Sites

216-U-10 Pond. The 216-U-10 Pond is located in the south half of the 200 West Area. Ground surface elevation is approximately 202.2 m (663.4 ft) (NAVD88). Stratigraphic units of interest beneath the site in the vadose zone consist of (in ascending order) the Ringold Formation unit E, the Plio-Pleistocene Unit, and the Hanford formation sand- and gravel-dominated sequences. The stratigraphy beneath the 216-U-10 Pond is shown in Figure 2-6 and is based on the geology in boreholes 299-W23-231 and 299-W18-15. Groundwater beneath the ditch occurs within the Ringold Formation unit E about 64 m (210 ft) below ground surface (bgs). Groundwater flows to the east beneath this site.

216-U-14 Ditch. The 216-U-14 Ditch is located in the south half of the 200 West Area. Ground surface elevation is approximately 207.9 m (682.1 ft) (NAVD88). Stratigraphic units of interest beneath the site in the vadose zone consist of (in ascending order) the Ringold Formation unit E, the Plio-Pleistocene Unit, and the Hanford formation sand- and gravel-dominated sequences. The stratigraphy beneath the 216-U-14 Ditch is shown in Figure 2-7 and is based on the geology in borehole 299-W19-21. Groundwater beneath the ditch occurs within the Ringold Formation unit E about 69.9 m (229.3 ft) bgs. Groundwater flows to the east beneath this site.

216-Z-11 Ditch. The 216-Z-11 Ditch is located in the south half of the 200 West Area. Ground surface elevation is approximately 204.4 m (670.6 ft) (NAVD88). Stratigraphic units of interest beneath the site in the vadose zone consist of (in ascending order) the Ringold Formation unit E, the Plio-Pleistocene Unit, and the Hanford formation sand- and gravel-dominated sequences. The stratigraphy beneath the 216-Z-11 Ditch is shown in Figure 2-8 and is based on the geology in borehole B3808. Groundwater beneath the ditch occurs within the Ringold Formation unit E about 68.5 m (225 ft) bgs. Groundwater flows to the east beneath this site.

2.2 WASTE SITE DESCRIPTION AND HISTORY

The OUs addressed in this work plan are located near the center of the Hanford Site in south-central Washington State. The 200-CW-5 OU consists of 10 waste sites and 3 associated UPRs (including UPR-200-W-110, which was moved from the 200-PW-1 OU to the 200-CW-5) as defined in the pending Tri-Party Agreement Appendix C Package. The 200-CW-5 OU initially was assigned eight UPRs; however, six of them were found to be duplicate designations for other sites within the OU. The duplicate UPR sites subsequently were rejected from the WIDS, following the Tri-Party Agreement procedure TPA-MP-14 for waste site reclassification (RL-TPA-90-0001).

One new pipeline (200-W-102) is identified in this work plan. The 200-W-102 pipeline is a recent WIDS discovery site. The 200-W-102 pipeline routed laundry wastewater from the 2723-W and 2724-W Laundry/Mask Cleaning Facilities to the 216-U-14 Disposal Ditch (also in the 200-CW-5 OU). The 216-W-LWC has been reassigned to the 200-CW-5 OU from the 200-CS-1 OU following the Tri-Party Agreement procedure for waste site reclassification (RL-TPA-90-0001). The 216-W-LWC is an RPP site that also received wastewater from the 2723-W and 2724-W Laundry/Mask Cleaning Facilities.

The 200-CW-2 OU consists of eight waste sites and one associated UPR as defined in the pending Tri-Party Agreement Appendix C Package. The 200-CW-2 OU initially was assigned five UPRs; however, they were found to be duplicate designations for other sites within the OU. The duplicate UPR sites subsequently were rejected from the WIDS, and UPR-200-W-124 was added following the Tri-Party Agreement procedure TPA-MP-14 for waste site reclassification (RL-TPA-90-0001).

The 200-CW-4 OU consists of eight waste sites and the 200-SC-1 OU consists of 13 waste sites and 3 UPRs as defined in the pending Tri-Party Agreement Appendix C Package. The 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 OU waste sites received cooling water, steam condensate, and chemical sewer waste from several facilities in the 200 East and West Areas. These effluent streams ranged from acidic to basic and carried chemicals and radionuclides that contaminated the waste sites.

Effluents were discharged to the 200-CW-5 OU waste sites from the UO_3 Plant, the U Plant, the 284-W Powerhouse, the 2723-W and 2724-W Laundry/Mask Cleaning Facilities, the 242-S Evaporator, the Z Plant complex (including the PFP), and other smaller facilities. All effluent from these sources ultimately was distributed to the U Pond system by means of ditches and/or a retention basin. Unplanned releases in this OU included sludge trenches created to bury sludge scraped from the 207-U Retention Basin during maintenance activities and a narrow trench east of and adjacent to the 216-Z-11 Ditch that received contaminated backfill during the creation of the 216-Z-19 Ditch. Table 2-1 provides summary information on the 200-CW-5 OU waste sites.

The 200-CW-2 OU waste sites received effluents from the 202-S Facility (REDOX Facility) and overflow from U Pond via the 216-U-9 Ditch. The 221-T, 242-T, and 2706-T facilities routed effluents to the 200-CW-4 OU waste sites and the 200-SC-1 OU waste sites. The 200-SC-1 OU waste sites also received waste from the PUREX Facility and the 242-A Evaporator, 221-B/WESF, REDOX and the 241-SX Sludge Heater, the 216-U-1&2 Pump-and-Treat system, and the Z Plant complex. Tables 2-2 through 2-4 provide summary information on the 200-CW-2, 200-CW-4, and 200-SC-1 OU waste sites.

2.2.1 Facilities and Waste Processes

The waste sites in the 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 OUs received predominantly cooling water and steam condensate, but also received effluent containing very low concentrations of radionuclides and/or chemicals. The cooling water was separated from contaminated process liquids by physical barriers, which typically were the walls of a heating or cooling pipe coil.

Steam and cooling water were circulated through coils inside process vessels to adjust the temperature in the vessels. Regulating the rate of steam entering the coils increased the temperature; the spent steam was condensed with cooling water after exiting the process vessel. The condensed steam and cooling water were released to plant sewers or piping systems that discharged to ditches and ponds. The use of very large volumes of cooling water for steam condensation and process vessel cooling resulted in the generation of very large volumes of effluent; more than 90 percent of all liquids discharged to the soil column in the 200 Areas were from cooling water (DOE/RL-98-28).

Over time, the coils that circulated steam and cooling water inside chemical process tanks were known to develop pinholes and hairline cracks because of the corrosive chemicals and high thermal gradients in the tanks. These minor defects usually did not lead to contamination of the steam and cooling water, because the pressure in the pipe coils was greater than the pressure in the process or condenser vessels. However, during instances when the pressure in the coils was reduced or suspended, minor leakage through the flaws contaminated the steam/cooling water waste streams. Other accidental releases from other causes such as operator error have led to the contamination of the effluent discharged to the waste facilities in these OUs.

Sections 2.2.1.1. through 2.1.2.4 identify the buildings and processes involved in discharging effluent to the 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 OU waste sites.

2.2.1.1 200-CW-5 Operable Unit

The waste sites in this OU received primarily cooling water from the 234-5Z PFP and supporting facilities and from the 221-U Plant and its supporting facilities. The 216-U-10 Pond was the final disposal site for most of these waste streams. The pond received 165 billion L of water between 1944 and 1985 from a number of facilities by way of the 216-U-14 Ditch and the Z Ditches. A number of trenches were dug within the pond boundaries to improve percolation and were given UPR identifiers (UPR-200-W-104, 105, 106, 107). Because no spills or releases are associated with these sites, and because they were confined within the boundaries of the pond, they were rejected from WIDS, as discussed in Section 2.2. Another structure associated with this collection system is the 207-U Retention Basin.

Several ditches and ponds received overflow water from the 216-U-10 Pond and lay outside the fenced portion of 200 West Area. The 216-U-9 Ditch was excavated in 1952 and extended over 1000 m to the south to the 216-S-17 Pond. This ditch was contaminated in 1953 and later backfilled. The first 500 m of the ditch were exhumed, constructing a leg to the 216-S-16 Pond and Ditch system. This system was used sporadically, mostly in the early 1950s and again in the early 1970s. The 216-U-11 Ditch (active between 1944 and 1957) was extended west of the 216-U-10 Pond and received significant quantities of water. The ditch was constructed in a U shape and was known to form a pond at the center of the U during high overflow conditions.

Waste Generation Processes at 200-CW-5

The waste-generation processes providing effluent to this waste site grouping are among the most varied in the 200 Areas. The Laundry/Mask Cleaning Facility (2723-W and 2724-W buildings) and mask cleaning station discharged wastewater generated during the cleaning and drying of both radiologically contaminated and soiled work clothes. Between 1944 and 1981, laundry effluents were carried to the 216-U-14 Ditch by the 200-W-102 Pipeline and discharged to the head end of the 216-U-14 Ditch. The effluents contained low levels of radionuclides and a variety of detergents and phosphates. Steam condensate from the dryers also was released to the ditch. Beginning in 1981, laundry waste and mask station waste from the MO-412 Building were directed to the 216-W-LWC.

The 282-W Reservoir, the 283-W Water Treatment Plant, and the 284-W Powerhouse actively discharged to the 216-U-14 Ditch through 1984. The uppermost 183 m of the 216-U-14 Ditch were converted to the 200-W Powerhouse Pond in 1984 when the ditch was taken out of service; the 200-W Powerhouse Pond remained active until 1995.

Wastewater was discharged from the 284-W Powerhouse in three modes: equipment blow-down for scale removal, batch runs for water softener regeneration, and cooling water for routine boiler operations. The water softening process released a brine solution into the effluent stream. The blow-down process produced an effluent with boiler scale and low levels of residual oxygen-scavenging chemicals such as ethylenediamine tetraacetic acid (EDTA). Other minor waste streams were associated with filter backwashes at the 282 and 283 Facilities.

Whether wastewater from the laundry, powerhouse, and water treatment system reached the 216-U-10 Pond is unknown. The portion of 216-U-14 Ditch between the 200 W Powerhouse Pond and the 207-U Retention Basin was backfilled and stabilized after 1984.

U Plant Processes. The U Plant facilities were a major source of cooling water and steam condensate effluents. The 221-U Chemical Separations (canyon) Building, 222-U Laboratory, and 224-U Concentration Building, constructed between 1943 and 1945, were the third plutonium separations facility at the Hanford Site. However, the U Plant was used as a training facility for the 221-B and 221-T Plants. Because the training operations did not involve radioactive materials, all waste streams were considered to be uncontaminated.

This status changed in 1952 when the plant was restarted following conversion for the Uranium Recovery Program. Under this program, uranium was removed from the active single-shell tank farms that had received first cycle decontamination waste generated in the $BiPO_4$ process waste. The plant used a tributyl phosphate (TBP) organic separations process, similar to one then under development for the 202-A PUREX Facility.

Cooling water and steam condensate generated by the uranium recovery process were collected in waste headers and transported to the two-basin 207-U Retention Basin via pipelines. During operations, effluents sent to one retention basin were sampled and analyzed before being released to the 216-U-14 Ditch.

After 1984, the 216-U-14 Ditch segment between the 207-U Retention Basin and the 216-U-10 Pond was kept open. Low volumes of cooling water and steam condensate were sent to the ditch until 1994, when the section between 207-U Retention Basin and Cooper Avenue was stabilized. The remaining fragment of the 216-U-14 Ditch between Cooper Avenue and the U Pond was active until 1995, receiving 242-S Evaporator cooling water. This section of the ditch had received operational quantities of 242-S Evaporator cooling water between 1973 and 1980, and again in 1985 for treatment of uranium-bearing groundwater. Additional cooling water was flushed through the 242-S Evaporator until this ditch segment was finally removed from service in 1995.

Z Plant Processes. The Z-Ditches are a series of parallel ditches that were used to route cooling and other wastewaters to the 216-U-10 Pond. The 216-Z-1D Ditch was constructed in 1944 to carry cooling water effluents from the 231-Z Plutonium Isolation Plant, the last step in the bismuth phosphate-based plutonium refining process. This facility converted the plutonium into a wet nitrate form for shipping off Site. When the bismuth phosphate process at the 221-T Plant shut down in 1956, the 231-Z Plant was converted for use on other projects, addressing metallurgical studies, weapons component fabrications, and reactor fuel development. These processes yielded low-level, low-volume waste.

The start-up of the 234-5Z PFP in 1949 provided for additional processing steps to convert plutonium nitrate from the 231-Z Plutonium Isolation Plant into more stable and safer forms, including oxalate, oxide, and pure metal. Several remote mechanical process lines were operated that permitted safer, continuous handling of the plutonium. Additional process modifications were required to adapt the plant to handle inputs from a larger number of reactors and from new chemical separations (REDOX and PUREX) plants. Machining of plutonium into weapons configurations produced large quantities of scrap. The Recovery of Uranium and Plutonium by Extraction (RECUPLEX) process in the 234-5Z PFP was used initially for scrap reclamation. Later, adjacent recovery facilities such as the 236-Z Plutonium Reclamation Facility, the 232-Z Incinerator, and the 242-Z Waste Treatment Facility were added. Operations in the Z Plant complex continued until 1989, and waste discharges to the ground ceased in 1995.

2.2.1.2 200-CW-2 Operable Unit

The 200-CW-2 OU includes the cooling water disposal sites used primarily by the REDOX process at the 202-S Canyon Building. Included in the list of facilities are the 216-U-16 and 216-U-17 Ponds, the 216-U-16 Ditch, the 207-S Retention Basin, and a series of diversion boxes, weirs, and control structures spread along the pipeline between the 200 West Area fence line and the 216-U-16 Ditch. In addition, five UPRs are considered part of this group and relate primarily to a number of coil failures inside REDOX process vessels. The failures were responsible for the closing of both the 207-S Retention Basin and the 216-S-17 Pond in 1954.

The 216-S-16 Pond/Ditch system was constructed in 1953-1954 near the REDOX Plant, by building a dike over a low spot in the topography. Several dike failures in 1958 and 1959 (UPR-200-W-47) caused a spread of contamination to the north, west, and south of the original pond. In 1965, the 216-S-16 Pond and Ditch also received contaminated water from a failed cooling coil at a feed tank inside REDOX, which contaminated much of the pond and ditch. Between 1973 and 1975, the 216-S-16 Pond and a downstream segment of the 216-S-16 Ditch received overflow from the 216-U-10 Pond by way of the 216-U-9 Ditch.

A number of underground control and diversion (weir) structures, or vaults, were constructed along the pipeline system leading out to the 216-S-16 Ditch. These structures, bearing 2904-prefixes, consisted of the 2904-S-170 Sampling Vault (associated with the 2904-SA building) and, in order moving downstream, the 2904-S-160, 2904-S-172, and 2904-S-171 Control Structures. The 2904-S-160 structure controlled flow to either the 216-S-17 or 216-S-16 Pond. The 2904-S-172 structure appears to have controlled flow to the 216-S-5 Crib. The 216-S-171 structure was used to direct flow to either the 216-S-16 Pond/Ditch or the 216-S-6 Crib.

Waste Generation Processes for the 200-CW-2 Operable Unit

The waste sources for the S Ponds and Ditches include the steam condensate and cooling water streams from the 202-S REDOX Chemical Separations Plant. A number of steps in this process were performed at elevated temperatures within caustic environments, so coil failures (UPR-200-W-13 and W-15) were more common than at the $BiPO_4$ Plants. Plant operations were halted in 1967.

2.2.1.3 200-CW-4 Operable Unit

This OU addresses the cooling water waste disposal sites used for the various activities and processes conducted at the 221-T Bismuth Phosphate Plant complex. The largest volume waste streams at this plant were the combined cooling water and steam condensate streams used during the bismuth phosphate process and the cooling water from the 242-T Evaporator. The waste streams were collected in the 207-T Retention Basin and discharged to the 216-T-4A and 216-T-4B Ponds by way of the 216-T-4-1 and 216-T-4-2 Ditches. Over 42 billion L of liquids went to the ground at the 216-T-4A Pond/216-T-4-1 Ditch between 1944 and 1972 while unknown, but much smaller, quantities of effluents were discharged to the 216-T-4B Pond/ T-4-2 Ditch.

In 1954, the 216-T-12 Trench was excavated near the northeast corner of the 207-T Retention Basin and received slightly contaminated sludge that had accumulated in the basins. This OU also includes the 216-T-1 Ditch, which received a variety of waste from the head-end section of the 221-T Building. The two ponds were located in an area 1600 m northwest of the 221-T Building that has since become the 218-W-2A and 218-W-3AE Burial Grounds.

Waste Generation Processes at the 200-CW-4 Operable Unit

The T Plant Bismuth Phosphate complex was the first operational chemical separations plant at the Hanford Site. The complex consisted of three major buildings, three tank farms, an evaporator, and a variety of smaller facilities. The bismuth phosphate process was used to process irradiated fuel rods in a batch mode. Production rates were lower than those at the REDOX or PUREX Facility, and waste generation also was lower. Nevertheless, leaks in the process vessels resulted in contamination releases to the ponds and ditches.

High-activity waste was sent to the T, TX, and TY Tank Farms for storage. With the processing rate exceeding the capacity of existing tank farms, the 242-T Evaporator was constructed to reduce the volume of waste going to the tanks. The system operated in batch mode from 1950 to 1955 and was converted to continuous operation in 1965. The facility shut down in 1986. This system required a large quantity of cooling water to chill the concentrated waste before it was returned to the tanks.

The bismuth phosphate process ran at 221-T/224-T Plant until 1956, after which the plant was used for a number of minor programs. The plant was used to decontaminate easily moved equipment, relying on acid, caustic, or complexant solutions; detergents; and rinse water to remove the radiological contaminants. Waste solutions were disposed of to the T Pond system. The 2706-T Building was constructed in 1964 and used to decontaminate the railway equipment and vehicles. Waste from this facility went to a number of waste sites, including the 216-T-4A Pond and Ditch between July 1964 and December 1965.

Another source of effluents from the 221-T Plant was work performed at the 221-T Head-End Facility. In the mid-1940s, this facility was used to conduct scale-up tests on radioactive materials for the bismuth phosphate process. Thereafter, the Pacific National Laboratory used the facility for a variety of purposes. Waste generated in this part of the building was sent to the 216-T-1 Ditch, which received 178 million L of water between 1944 and 1995.

2.2.1.4 200-SC-1 Operable Unit

This OU consists of nine cribs, four retention basins, three UPRs, and two pipelines that received or transported steam condensate from a number of the large processing facilities in the 200 Areas. Separate steam condensate streams evolved after the bismuth phosphate chemical separations batch-mode processes. At separations plants such as REDOX and PUREX, the Uranium Recovery Process (at U Plant), and the isotope recovery programs at B Plant, large volumes of steam were required to heat or boil process chemistry for effective chemical reactions. Steam at these plants also was used for emergency power generation in case of electrical power failures and for plant heating and ventilation.

The 242 Evaporators also released large quantities of steam condensate, only some of which was discharged to these waste sites. The steam was condensed either in use or in off-line condensing units. Like cooling water systems, steam condensate waste generally was not contaminated. However, coil failures and/or operational errors resulted in significant releases.

Cribs were the preferred type of waste disposal site for these streams, because the potential for heating coil failures was significantly higher than for cooling coil failures. Contamination releases at ponds were more expansive, more expensive to clean up, and posed greater radiological exposures to personnel and the environment than releases to cribs.

Waste Generation Processes for the 200-SC-1 Operable Unit

A wide variety of processes in both the 200 East and 200 West Areas generated steam condensate waste. Volumes varied considerably based on the process and longevity of the process. Generation of steam condensate waste has been discussed in part for the 221-S REDOX Plant and the 216-S-5 and 216-S-6 Cribs. This waste stream was routinely discharged to the 216-S-16 Pond and Ditch system, but releases that contained minor waste concentrations were diverted to the 216-S-5 Crib. The 216-S-6 Crib received more highly contaminated waste discharges.

PUREX Facility. A number of process vessels within the PUREX Facility required heating or boiling, so steam condensate was a large-volume waste stream at this plant. Steam condensate at the PUREX Facility was discharged via the 200-E-113 Process Sewer to either the 216-A-6, 216-A-30, or 216-A-37-2 Crib. The cribs were located at the southeast corner of the 202-A Canyon Building and were built sequentially as the active cribs began to lose percolation capacity. The 216-A-6 Crib was active between 1955 and 1970, with a break in service between 1961 and 1966 following several incidents of crib flooding caused by the lost percolation or greater-than-design discharge volumes (UPR-200-E-21 and UPR-200-E-29). The 216-A-30 Crib was built as a larger replacement in 1961 and operated until 1966 when rising water levels necessitated bringing the 216-A-6 Crib back on line. It continued in service until 1992. The 216-A-37-2 Crib, one of the largest cribs on site, was constructed in 1983, and received waste until 1995.

B Plant Processes. In the mid 1960s, the 221-B Plant was converted to recover isotopes from PUREX and REDOX tank waste under the Waste Fractionization Program. A series of ion exchange columns was used to recover cesium and technetium isotopes, while a sulfate-based precipitation process was used for strontium, promethium, and rare-earth radionuclides. Solvent extraction technology based on a variant of the TBP process also was applied to the recovery of strontium and cesium from selected PUREX waste streams and from other specific waste tanks. This last process, the Waste Fractionization Program, was run primarily to remove longer lived, heat-producing radionuclides from tank waste.

The WESF was constructed at the west end of the 221-B Plant as the 225-B Facility. A diversion capability for above-specification steam condensate was added in 1974 with the installation of the 216-B-64 Retention Basin. This was a concrete structure with two large rubber bladders, flow gates, and a pump for transferring diverted condensate water to either the crib or the 221-B Building. Beyond an initial test, the structure was never used. Both crib and retention basin were isolated in 1996-1997.

2.2.2 Representative Sites

The concept of using analogous sites to reduce the amount of site characterization and evaluation required to support remedial action decision making is discussed in the 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. One or more representative sites then are chosen for comprehensive field investigations, which includes sampling. Findings from site investigations at representative sites are extrapolated to apply to 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 the characterized sites. Limited-scope confirmatory investigations, rather than full characterization efforts, can be performed at the sites not selected as representative sites.

Data from representative sites are used to evaluate remediation alternatives and to select one or more alternatives to apply for the analogous waste sites (see Section 5.1.1). Confirmatory sampling of the analogous sites after remedy selection will be performed to the extent necessary to demonstrate that analogous conditions exist.

Several features common to waste sites in the 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 OUs make this characterization effort amenable to the analogous site concept. Of these attributes, the most significant are waste characteristics (i.e., effluent volume and waste stream chemistry), physical setting, and expected distribution of contaminants. Waste sites in this group all received primarily cooling water, steam condensate, and/or chemical waste streams.

High volumes, low contaminant concentrations, low salt, low organic contents, alkaline nature, and a pH between 4 and 10 are general characteristics of the majority of the waste streams. Radioactive contaminants common to these waste streams include uranium, plutonium, cesium, and strontium (DOE/RL-96-81).

Sites that represent typical and worst case conditions initially were identified as representative sites in DOE/RL-96-81 and later were confirmed in the RI DQO process performed for this project (BHI-01294, *200-CW-5 U-Pond and Z Ditches Cooling Water Operable Unit Remedial Investigation DQO Summary Report*). The representative sites chosen are the 216-U-10 Pond, the 216-U-14 Ditch, and the 216-Z-11 Ditch. The 216-U-10 Pond was chosen as a worst case representative site because of its reported high contaminant inventory, the large quantities of liquid discharged to the site, the level of characterization conducted under the 200-UP-2 OU limited field investigation (LFI) activities, and because it is a common end point for the Z Ditches and the 216-U-14 Ditch effluent. The 216-U-14 Ditch was selected as a representative site for its suspected high contaminant inventory, presence of laundry detergent waste discharges, long history of operations, and level of past characterization. The 216-Z-11 Ditch was chosen to document the contamination distribution because of its suspected high contaminant inventory (DOE/RL-96-81).

Sections 2.2.2.1 through 2.2.2.3 describe the representative sites in detail. The information was obtained from the WIDS database and WIDS historical files unless otherwise noted.

2.2.2.1 216-U-10 Pond

The 216-U-10 Pond (U Pond) was created from a natural topographic depression to act as a seepage area for the infiltration of wastewater from the 216-U-14 and 216-Z-1D Ditches. The pond was located in the southwest corner of the 200 West Area. The pond was later diked on the south and west edges and, in approximately 1952-1953, three overflow trenches were added on the east side to increase its capacity. At its maximum extent, including the overflow trenches, the pond covered an area of roughly 12 ha (30 ac). A representative stratigraphic column for the 216-U-10 Pond based on data from nearby wells is shown in Figure 2-6.

The pond was active from 1944 to 1985. The U Pond was deactivated and interim stabilized in 1985. Stabilization activities included scraping contaminated pond sediments from peripheral areas to a depth of 0.3 m (1 ft) or deeper and placing the sediments in the center of the pond. The peripheral areas were covered with at least 0.6 m (2 ft) of clean soil, and the central pond area was covered with at least 1.2 m (4 ft) of clean soil and seeded (DOE/RL-95-106). In 1990, 0.6 ha (1.5 ac) of contaminated soil on the south side of the pond were covered with an additional 0.6 m (2 ft) of clean fill to stabilize surface contamination that had been detected (DOE/RL-91-52, *U Plant Aggregate Area Management Study Report*). In November 1994, contamination was detected at a strip along the south and west perimeters of the pond (about 1 ha [2.5 ac]) and was stabilized with soil from the U-11 Borrow Pit (BHI-00621, *RARA FY 1995 Summary Report*).

The U Pond is estimated to have received 1.65×10^{11} L (4.3×10^{10} gal) of low-level liquid waste (DOE/RL-91-52). The following waste streams were directed into the 216-U-10 Pond at various times via the 216-U-14 Ditch and the Z-Ditches:

- 284-W Powerhouse cooling water, steam condensate, and wastewater from batch operations
- 282-W Reservoir cooling water, steam condensate, and wastewater from batch operations (WHC-EP-0679, *Groundwater Impact Assessment Report for the 284-WB Powerplant Ponds*)
- 283-W Water Treatment Plant filter steam condensate, cooling water, and wastewater from batch operations (WHC-EP-0679)
- 277-W (Fabrication Shop) Complex cooling water, steam condensate, and wastewater from batch operations (WHC-EP-0679)
- 231-Z Plutonium Isolation Plant Building steam condensate and laboratory waste
- 234-5Z Plutonium Fabrication Facility Building cooling water and steam condensate
- 2723-W Mask Cleaning Station solution
- 2724-W Laundry wastewater
- 221-U Plant and 271-U Office and Service Building cooling water, steam condensate, and chemical sewer waste
- 224-U Concentration Building cooling water
- 291-Z Exhaust Air Filter Stack Building cooling water and vacuum pump seal water
- Tank 241-U-110 condenser water

- 242-S Evaporator steam condensate and vacuum pump seal water.

More details on these building processes and wastewater streams, along with a summary of completed characterization work, are provided in Chapter 3.0.

2.2.2.2 216-U-14 Ditch

The 216-U-14 Ditch began operations in 1944 as one of the original effluent ditches to the 216-U-10 Pond. The ditch was an unlined, open excavation 1,731 m (5,680 ft) long; it ran from northeast to southwest across about 1.6 km (1 mi) of the 200 West Area. The ditch originated 500 m (1,600 ft) north of U Plant and terminated at the 216-U-10 Pond. It was excavated with a minimum bottom width of 2.4 m (8 ft) and side slopes of 2.5:1. The ditch includes a 1.2 m (4-ft)-diameter by 46 m (150-ft)-long culvert that passes under 16th Street and a 0.6 m (2-ft)-diameter culvert that passes under 19th Street (DOE/RL-91-52). Figure 2-7 shows the representative stratigraphy beneath the 216-U-14 Ditch.

The 216-U-14 Ditch operated until 1995. During its operation, the ditch received effluent from a number of sources that entered the ditch at several locations (WHC-EP-0707, *216-U-10 Pond and 216-Z-19 Ditch Characterization Studies*, attached to CCN 0512763, 02/01/1994, "216-U-10 Pond and 216-Z-19 Ditch Characterization Studies"). The head end of the ditch received wastewater from the 284-W Powerhouse and associated buildings and the 2723-W and 2724-W Laundry/Mask Cleaning Facility buildings via a common pipeline (Hanford Site Drawing M-2904-W, *Outside Lines Sewers*, sheet 14). The second waste discharge point into the ditch was located 1,050 m (3,444 ft) south of the ditch head, near where the ditch passed under 16th Street. Chemical sewer wastewater, steam condensate, and cooling water from the 221-U and 271-U Buildings were discharged through a 46 cm (18-in.) vitrified clay pipe (VCP) (Hanford Site Drawing M-2904-W, *Outside Lines Sewers*, sheet 19).

Cooling water from the 224-U Concentration Building was discharged through a 61 cm (24-in.) VCP (Drawing M-2904-W, sheet 19) into the 207-U Retention Basin. Effluent exited the 207-U Retention Basin through another 61 cm (24-in.) VCP and was discharged to the ditch via a culvert under 16th Street. Condenser water from the Tank 241-U-110 was discharged to the ditch through a pipeline south of 16th Street (Hanford Site Drawing H-2-31374, *MK-2X Details*). No information was found on the type or size of pipe. The last waste discharge point into the ditch was located 370 m (1,213 ft) downstream from the second waste discharge point, where the ditch turned westward. At this point, evaporator condensate and cooling water from the 242-S Evaporator Building entered and traveled the last length of the ditch to the 216-U-10 Pond (WHC-EP-0707). Construction drawings showing pipelines from the 242-S Evaporator Building to the 216-U-14 Ditch are not available.

In 1986, an accident led to the discharge of approximately 2,365 L (625 gal) of reprocessed nitric acid to the ditch through the 207-U Retention Basin in less than 1 day. This release occurred during the transfer of the acid from a storage tank to a railroad car for transport to the PUREX Facility. This release was diluted with cooling water originating from the 224-U Concentration Building that also flowed through the ditch. The residual effluent stream was measured at a pH <2.0 and was estimated to contain approximately 39 kg (86 lb) of uranium (Whiting 1988, "Unusual Occurrence Report, Public Information Release").

During the useful life of the ditch, the growth of live plants and the accumulation of dead plant material would cause localized damming. Buildup of fly ash, scale, and lint from the powerhouse and laundry discharges reduced the infiltration capacity of the ditch. To prevent discharge backups, the ditch was dredged periodically. Sediments removed from dredging activities were piled on a berm on the west bank. This berm was removed and buried in a low-level waste burial ground in 1979 to reduce the risk of contamination spread (WHC-EP-0707).

In 1981, effluent from the 2723-W and 2724-W Laundry/Mask Cleaning Facilities was rerouted to the newly constructed 216-W-LWC. In 1984, waste from the 221-U, 224-U, and 271-U Facilities was rerouted to the 216-U-16 Crib and no longer was discharged to the 216-U-14 Ditch. However, after it was discovered that the 216-U-16 Crib failed in 1986, the effluent was diverted back to the 216-U-14 Ditch and the 216-U-12 Crib. Although the 216-U-17 Crib (completed in 1988) replaced the 216-U-16 Crib, the 216-U-14 Ditch continued to receive effluent from the 224-U and 221-U Facilities until 1994. Discharge from the 284-W Powerhouse was rerouted to the 284-WB Powerhouse ponds in 1984 (WHC-EP-0698, *Groundwater Impact Assessment Report for the 216-U-14 Ditch*). The outlet pipe from the 207-U Retention Basin was plugged in 1994 to prevent effluent from entering the ditch. In 1995, the end of the effluent pipe into the 216-U-14 Ditch was capped to eliminate the discharge of steam condensate from the 242-S Evaporator.

The entire length of the ditch has been surface stabilized (DOE/RL-95-106). In 1985, the northern section of the ditch (from the head to the 207-U Retention Basin) was stabilized in conjunction with the 216-U-10 Pond. The lower portion of the ditch between Cooper Avenue and the 216-U-10 Pond was surface stabilized in 1992 with gravel and cobbles; however, this section of the ditch was still in use and received seal water effluent from an air-sampling pump at the 242-S Evaporator until 1995. The central portion was stabilized in 1995 by chemically killing all vegetation, consolidating the contaminated soil into the center of the ditch, and backfilling with clean backfill. The westernmost section that was stabilized with gravel and cobbles in 1992 was backfilled with clean soil and restabilized in 1997.

2.2.2.3 216-Z-11 Ditch

The 216-Z-11 Ditch began operations in 1959 to dispose of wastewater from the Z Plant operations to the 216-U-10 Pond (DOE/RL-91-52). It replaced the 216-Z-1D Ditch. The 216-Z-11 Ditch was 798 m (2,615 ft) long and 0.6 m (2 ft) deep. It was 1.2 m (4 ft) wide at the bottom and had side slopes of 2.5:1 with a 0.05 percent grade. The first 37 m (120 ft) of the ditch were in common with the 216-Z-1D Ditch and began at a point immediately east of the 231-Z Plutonium Isolation Plant Building. The middle section of the ditch ran parallel to the 216-Z-1D Ditch, then rejoined it for the last 203 m (665 ft) to the 216-U-10 Pond. The representative stratigraphy beneath the 216-Z-11 Ditch is presented in Figure 2-8.

The 216-Z-11 Ditch operated from 1959 until 1971. The ditch received laboratory waste and steam condensate from the 231-Z Plutonium Isolation Plant Building via a 46 cm (18-in.)-diameter VCP (Hanford Site Drawing H-2-10011, *216-Z-1 Ditch from 231-Z, Replacement with 18 in. V.C. Pipe*). Process cooling water and steam condensate from the 234-5Z Building and vacuum pump seal water and cooling water from the 291-Z Building entered the ditch via a 38 cm (15-in.) VCP process sewer (Hanford Site Drawing H-2-32528, *Z Plant Liquid Waste Disposal Sites, 216-Z Series*). A 30 cm (12-in.) storm sewer was connected to the ditch from an elevated water tank immediately south of the 234-5Z Building (Drawing H-2-32528). Total volumes of effluent discharged are not known for this site. The chemical inventory is reported as part of the 216-U-10 Pond inventory (WIDS). The 216-Z-11 Ditch was deactivated and replaced by the 216-Z-19 Ditch in 1971. The site was backfilled to grade when it was retired, and additional backfill material was added when the 216-Z-19 Ditch was deactivated in 1981. The 216-Z-11 Ditch has a reported contamination burden of 137 Ci of Pu-239 and 37 Ci of Pu-240 and is reported as a TRU[1]- contaminated soil site (DOE/RL-91-52).

Figure 2-9 is a graphical representation of the waste streams that discharged to the 216-Z-11 Ditch, the 216-U-14 Ditch and, ultimately, the 216-U-10 Pond.

2.3 CONCEPTUAL MODEL CONSIDERATIONS

The effluent discharged to the waste sites was mainly cooling water, with some steam condensate, laundry wastewater, and wastewater from lesser sources. Large quantities of effluent were released, and the effluent contained small quantities of contaminants that accumulated over time.

The following general observations were considered during construction of the representative sites conceptual models.

- Most of the contaminants were retained in the organic sediments at the bottom of the ponds or ditches or in the upper few meters of the soil column.
- The most significant contaminants, based on historical characterization data for the 216-U-10 Pond and 216-U-14 Ditch, were uranium and Cs-137. For the Z-Ditches, plutonium and americium were the most significant contaminants. The 216-U-10 Pond and 216-U-14 Ditch have been extensively studied; however, the 216-Z-11 Ditch has not been as well characterized.
- The contaminated pond/ditch bottom sediments have been surface stabilized with nominally 2 m (6.6 ft) of soil overburden and remain in place.
- Contaminant concentrations rapidly decrease with depth below the waste sites.
- Downward migration of effluent contributed trace amounts of mobile contaminants through the vadose zone to groundwater.
- The contaminants retained in the upper zone of the soil column have high distribution coefficients (K_d). Contaminants with lower K_d values (e.g., nitrate and uranium) are not as readily adsorbed onto soil particles and were carried downward through the soil column with large quantities of effluent.

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[1] Waste materials contaminated with 100 nCi/g of transuranic materials having half-lives longer than 20 years.

- Perched water zones under percolation areas developed during discharge periods but dissipated after effluent flows ceased. Contaminants were detected in these perched water zones.

- Lateral spreading may have occurred in the vadose zone, mainly in association with the perched water zones or fine-grained sediment layers.

- Effluent percolated through the vadose zone beneath the 216-U-10 Pond and reached the groundwater. The most significant effect of the discharge of large quantities of effluent to the groundwater was on the groundwater flow regime, causing contaminants from other facilities to move in the aquifer.

The conceptual model for the representative sites during the active periods of discharge is shown in Figure 2-10. The conceptual model postulates that the highest concentration of contaminants resides in the pond and ditch sediment layers.

Waste sites in the 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 OUs no longer receive effluent. Most of the sites in this group have been stabilized and covered with clean soil. With the cessation of artificial recharge, the downward flux of moisture through the vadose zone has declined. The moisture flux was significant beneath certain sites during their operational history, locally raising the water table and affecting the groundwater. When operations ceased at those sites, the moisture flux began to decrease, as expressed in the locally declining water table. Residual effluent from operations is expected to remain in the vadose zone and continue to drain, decreasing over time as moisture levels decrease and equilibrate with natural recharge from precipitation.

Figure 2-1. Location of the Hanford Site and Waste Sites in the 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 Operable Units.

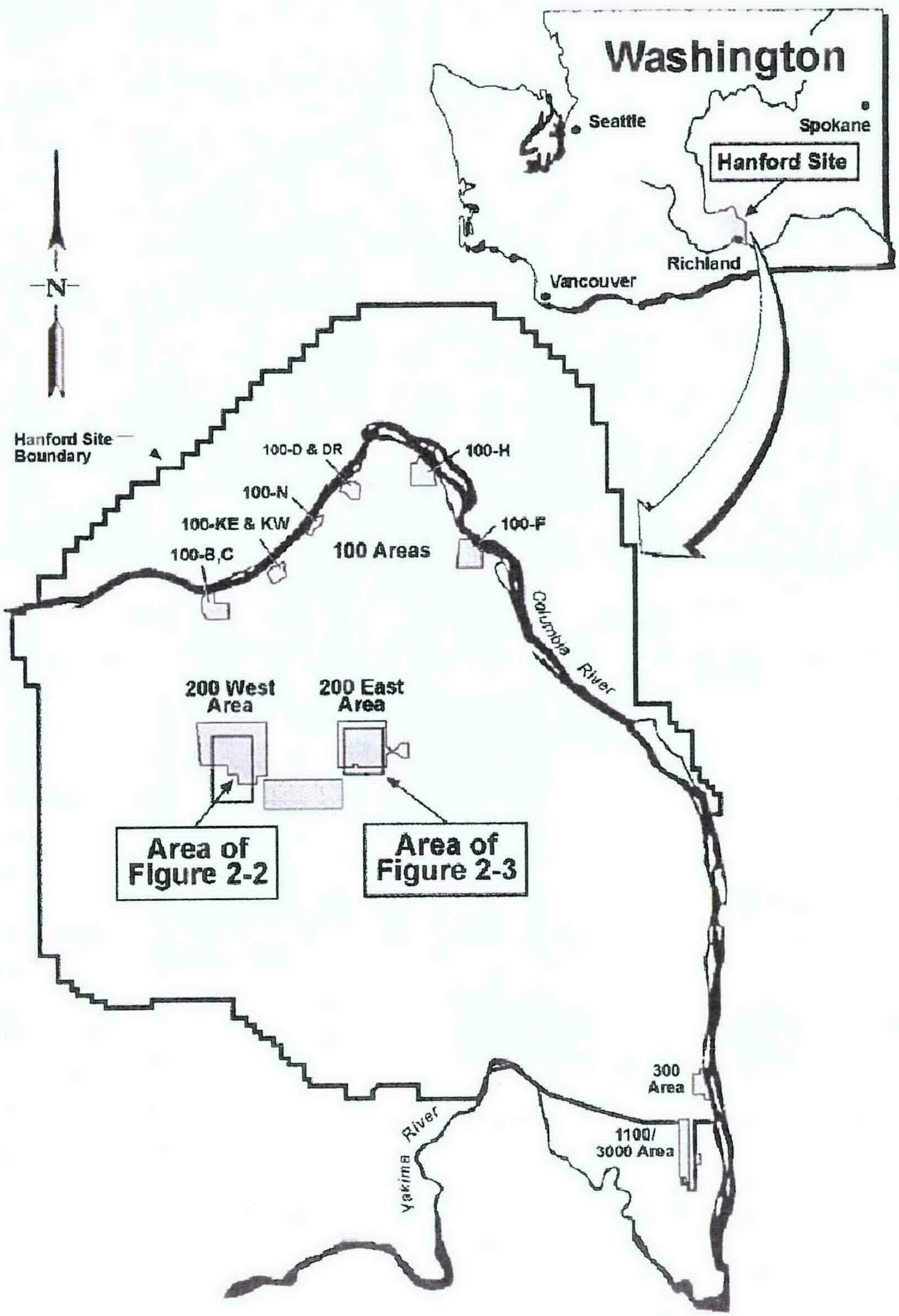


Figure 2-2. Location of the 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 Operable Unit Waste Sites in the 200 West Area.

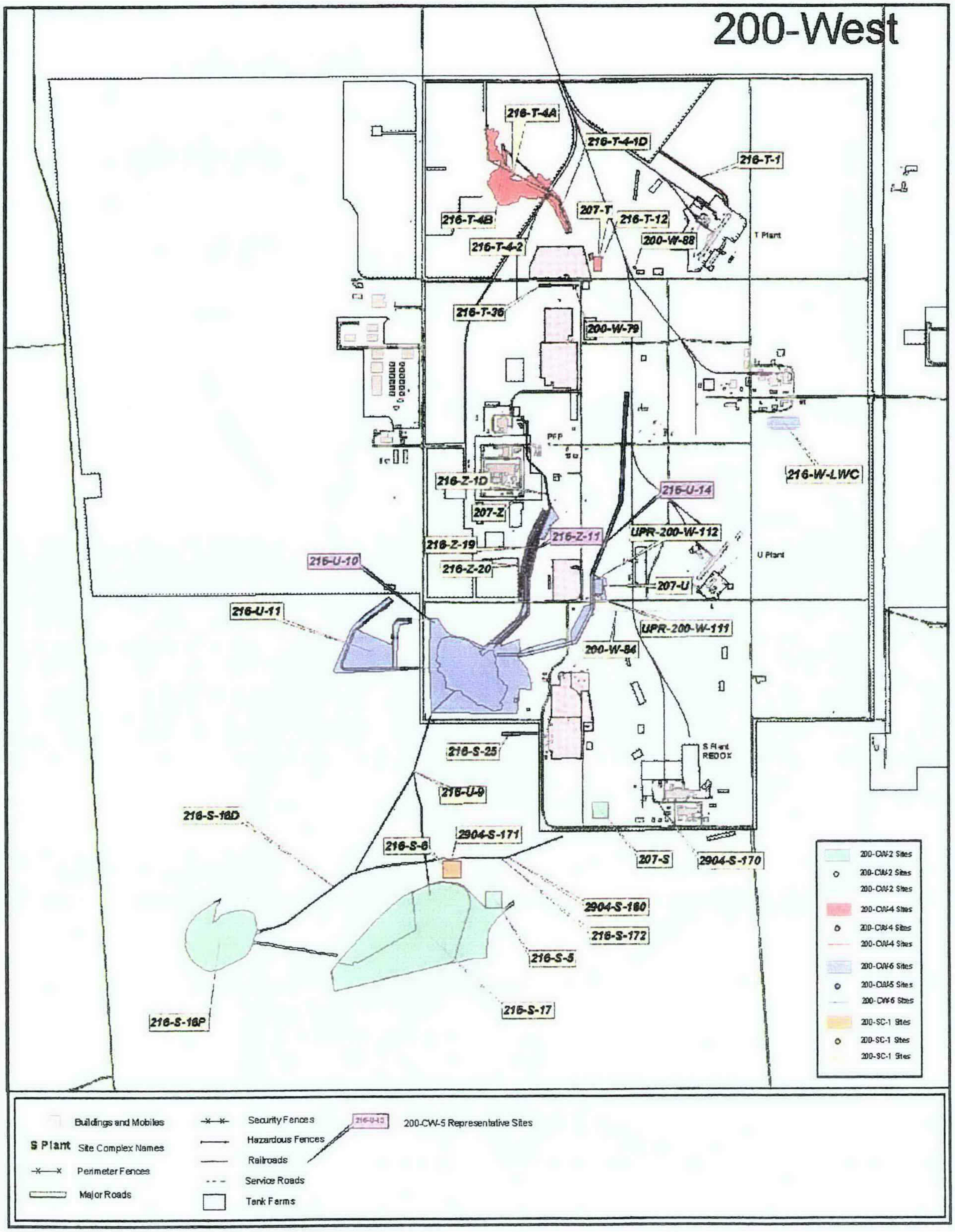


Figure 2-3. Location of the 200-SC-1 Operable Unit Waste Sites in the 200 East Area.

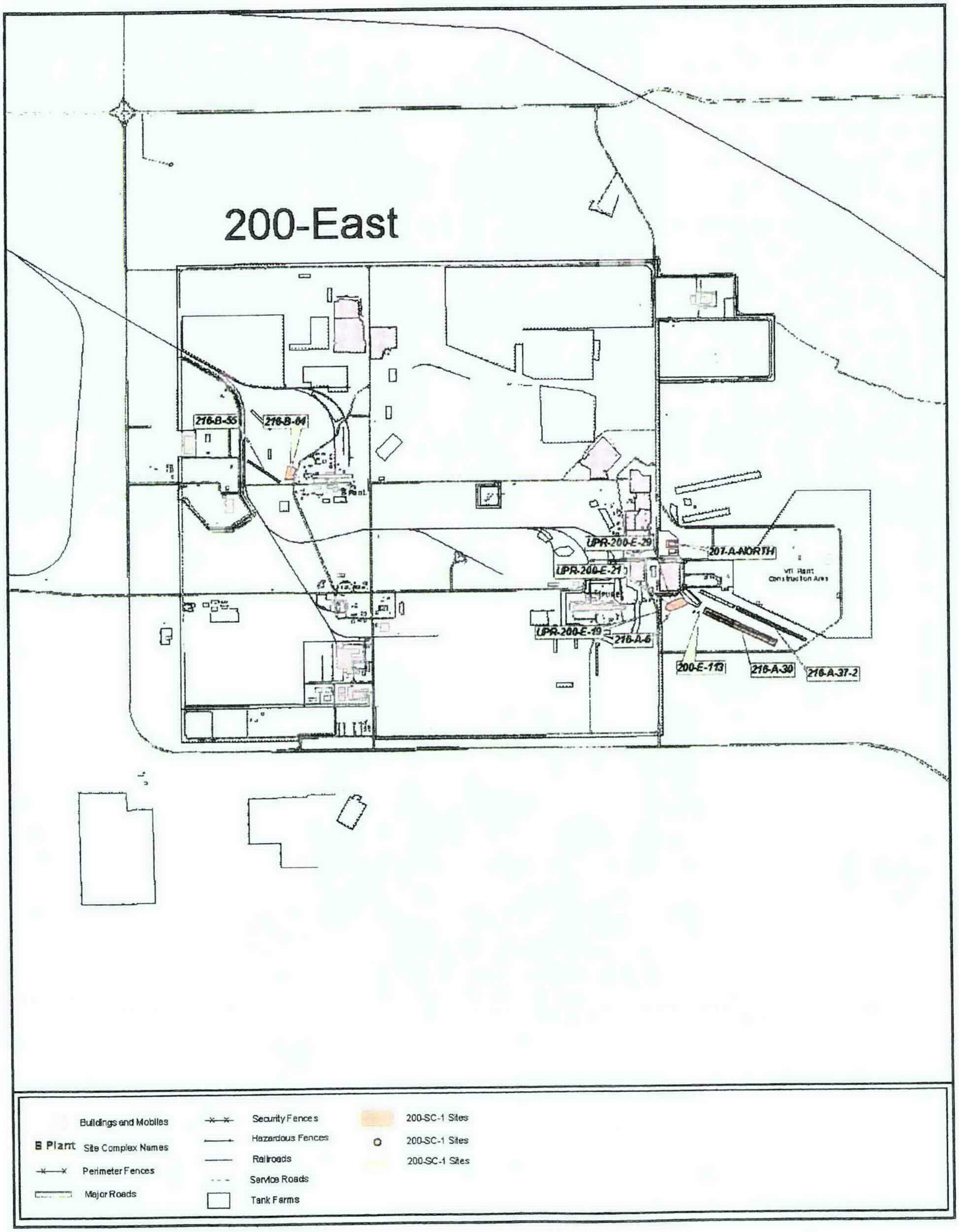
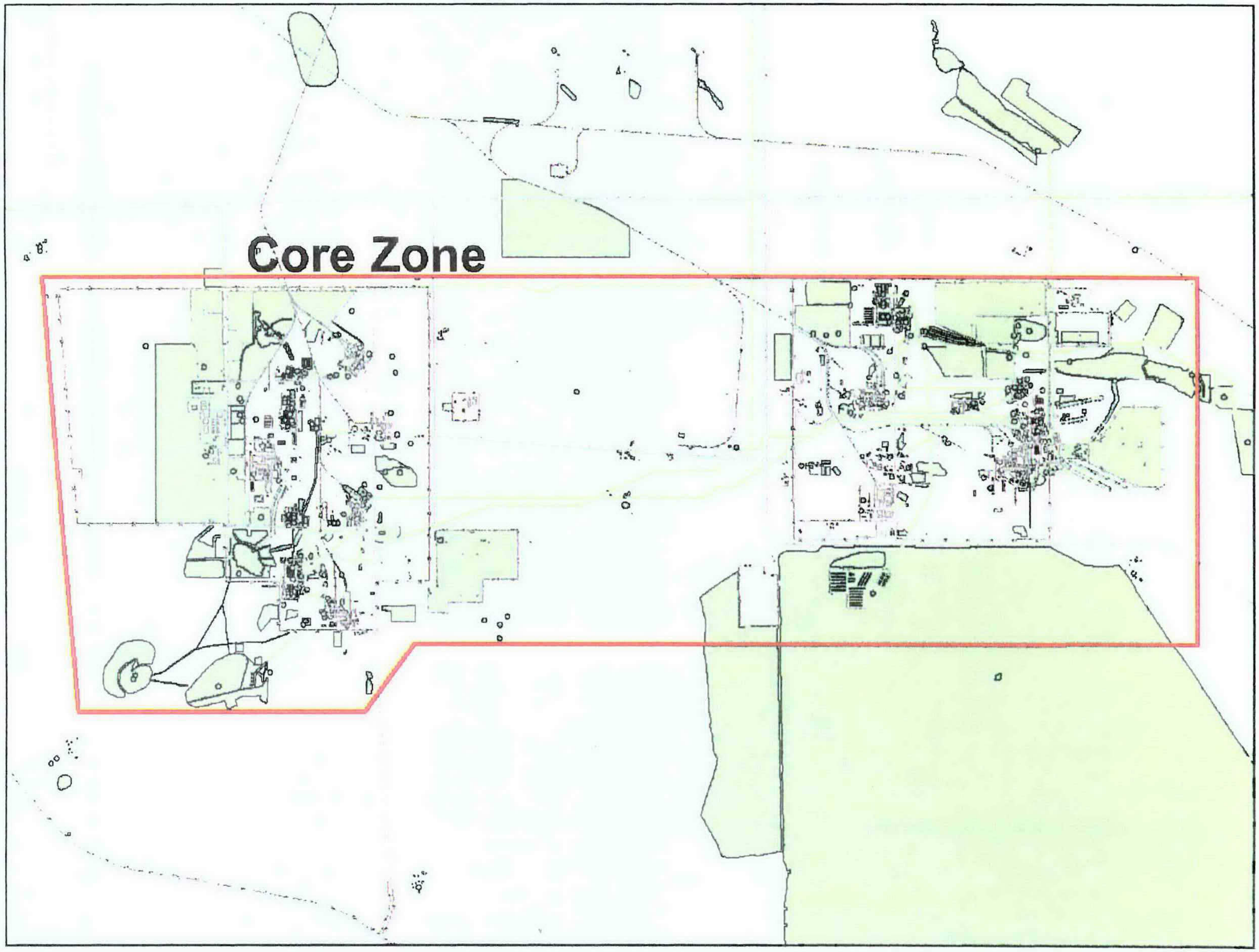


Figure 2-4. Central Plateau Core Zone Boundary, 200 Areas.



031110_Central_Plateau_Core_Zone_Webb_R1.mxd

Figure 2-5. Generalized Stratigraphic Column for the 200 Areas.

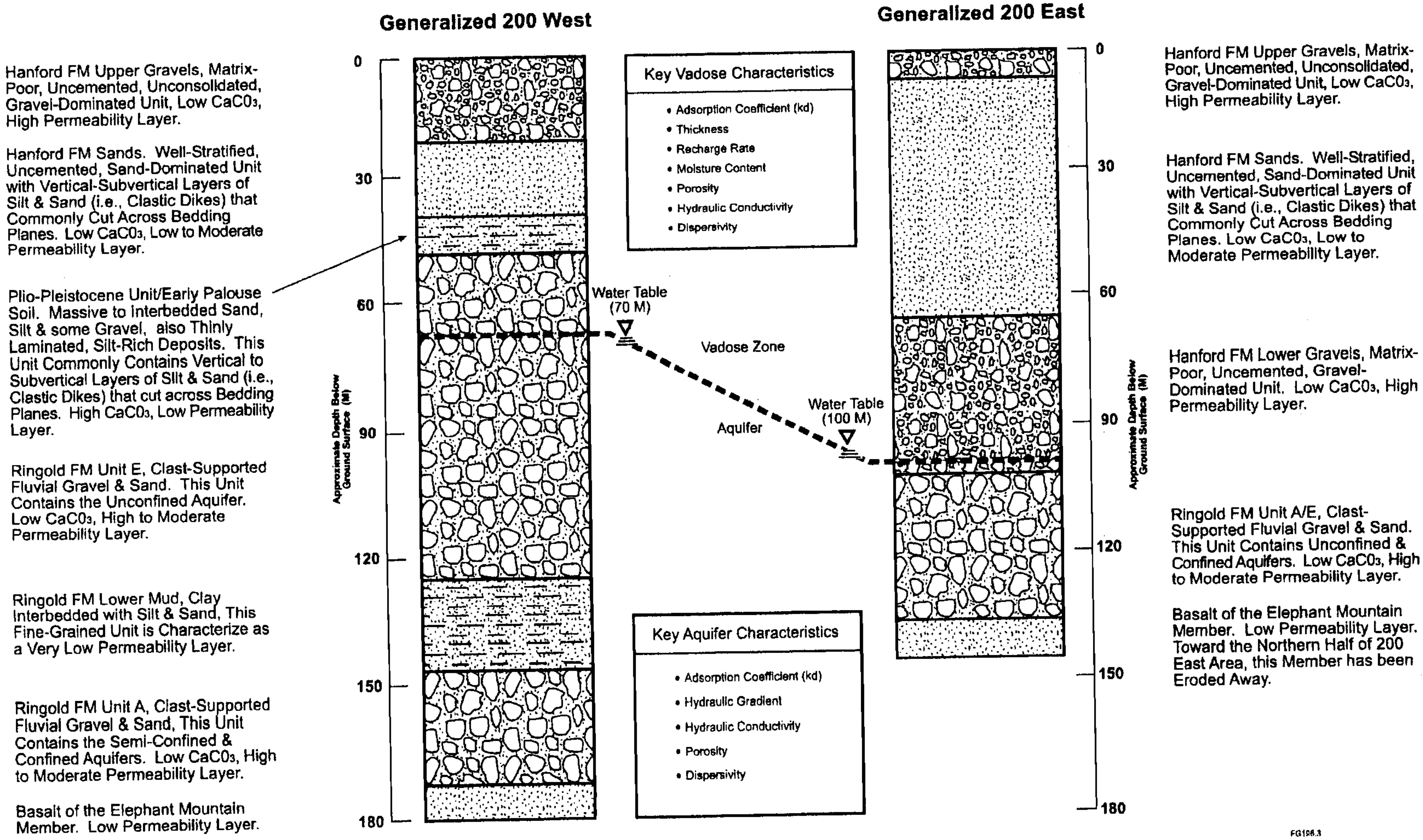


Figure 2-6. Representative Stratigraphy Beneath the 216-U-10 Pond.

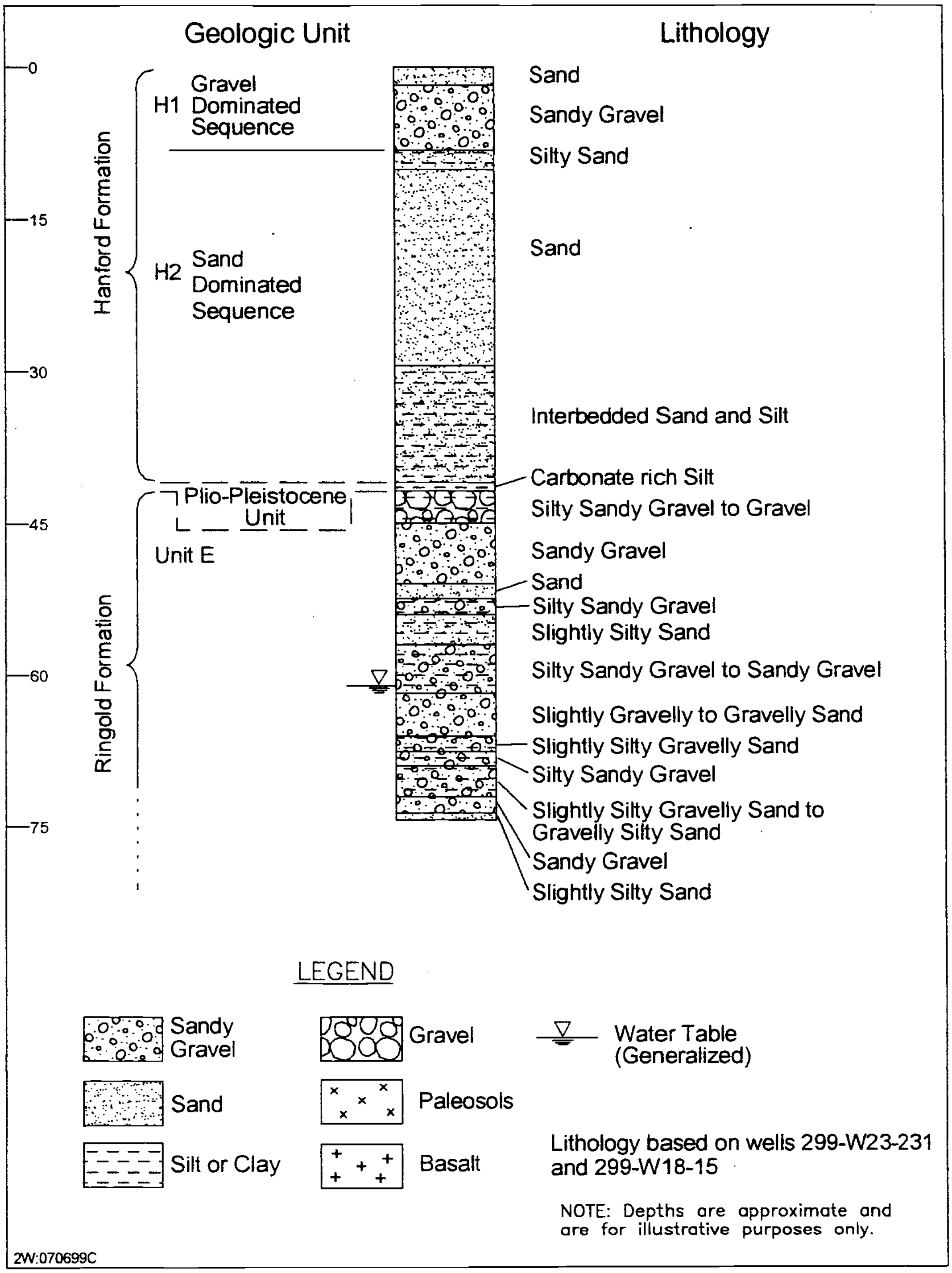


Figure 2-7. Representative Stratigraphy Beneath the 216-U-14 Ditch.

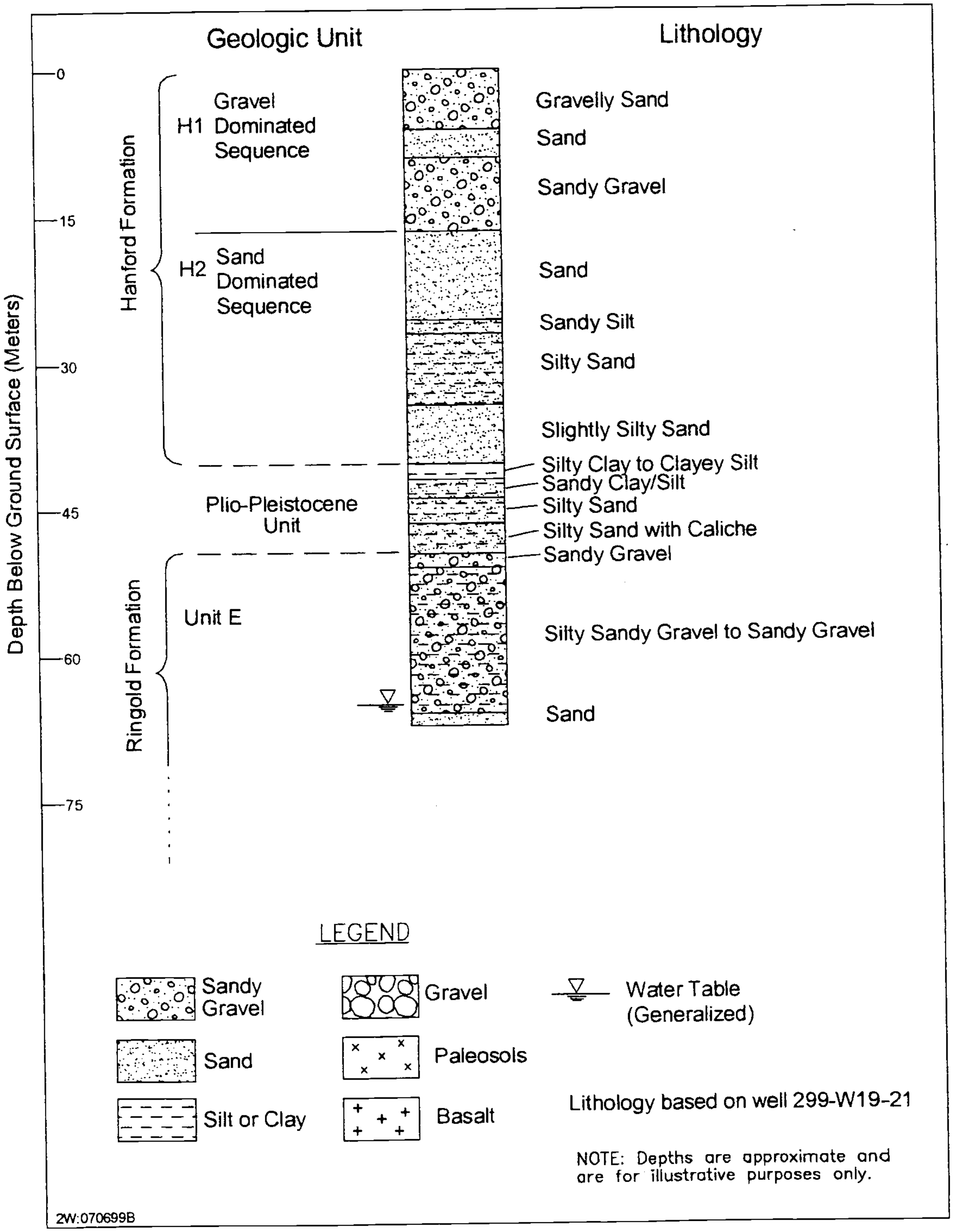


Figure 2-8. Representative Stratigraphy Beneath the 216-Z-11 Ditch.

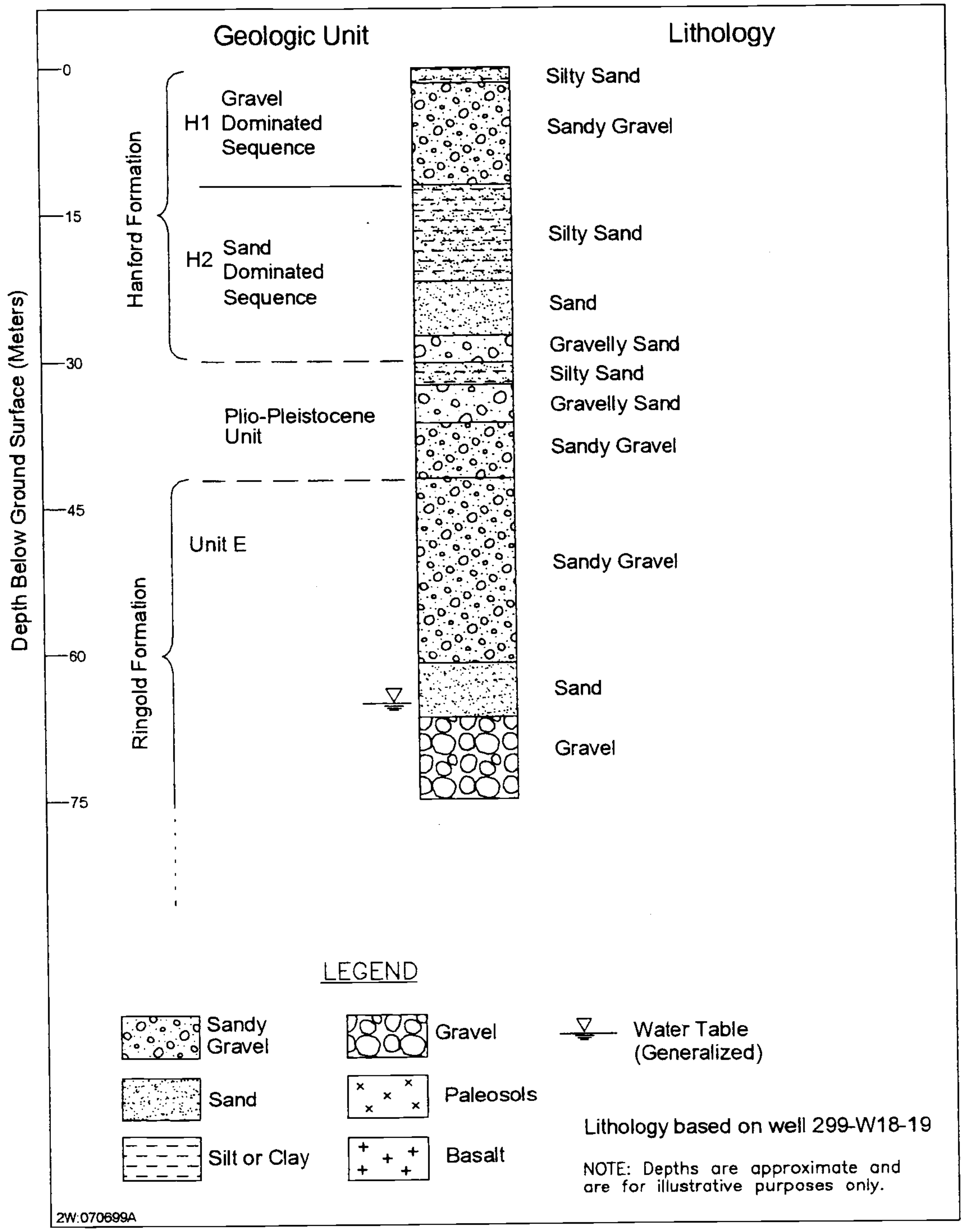


Figure 2-9. Graphical Representation of the Waste Streams and Discharge Paths of the Representative Sites.

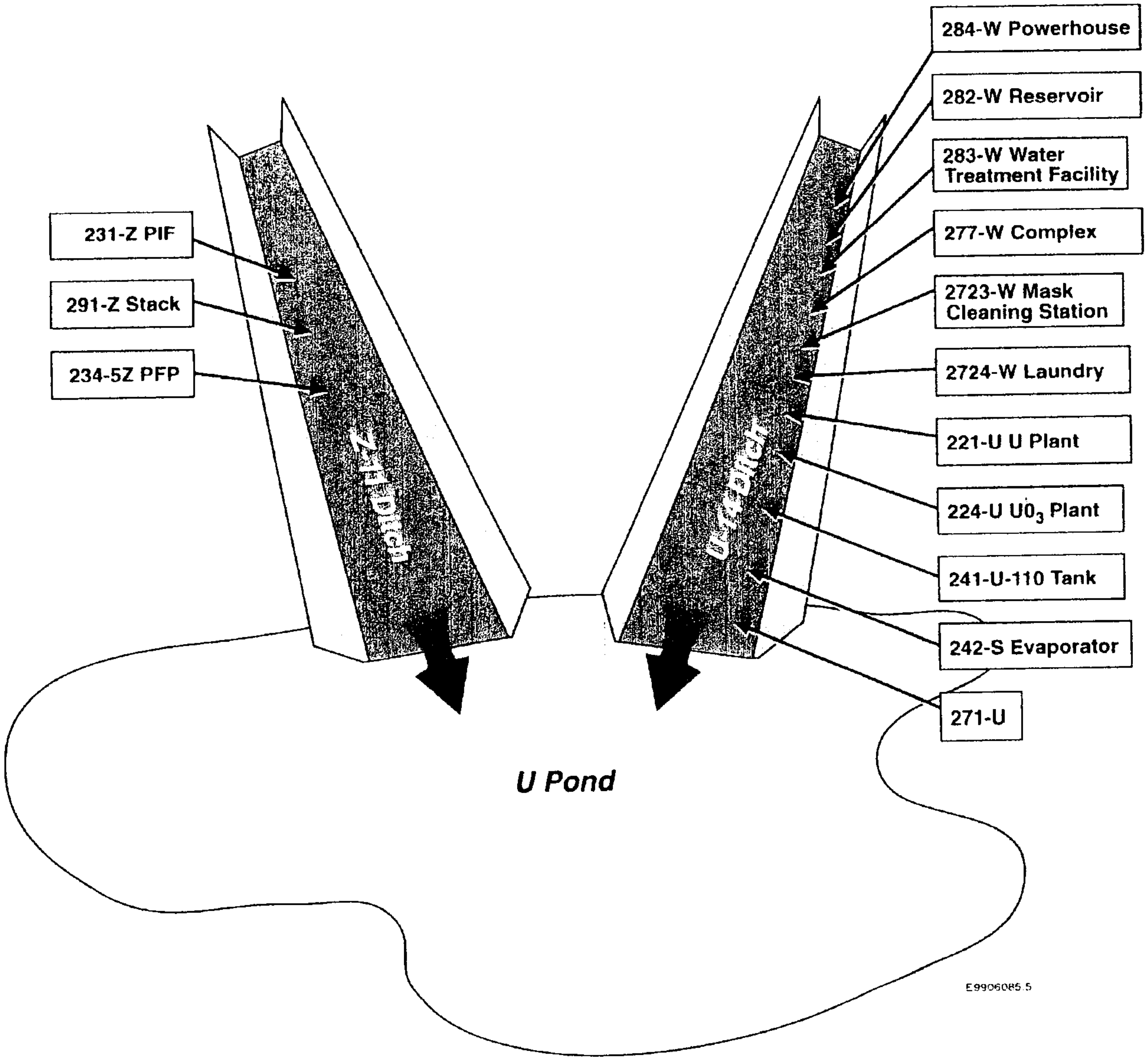
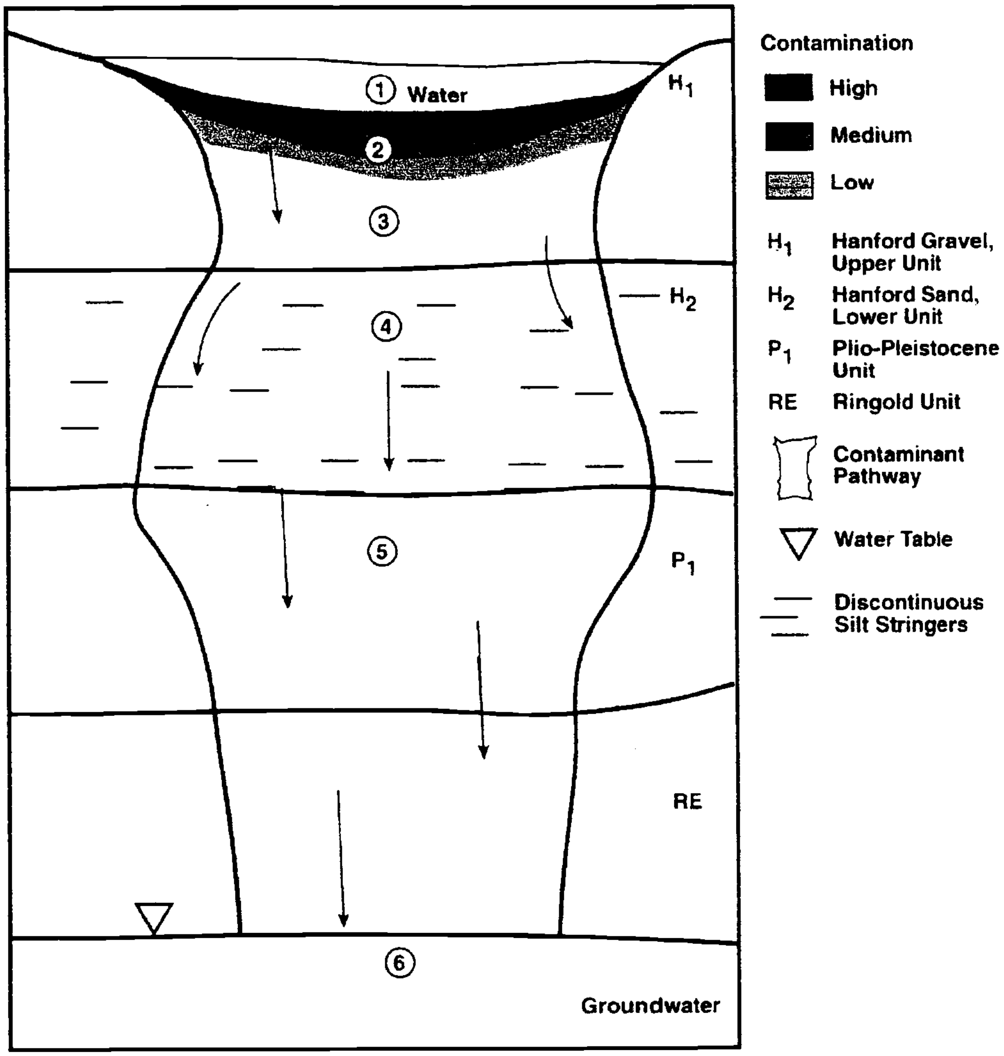


Figure 2-10. Conceptual Model of Contaminant Distribution at Representative Waste Sites During Periods of Active Discharge.



① High volume of alkaline, low salt, low organic solutions discharged to the ditches/ponds.

② Some particulates in solution (e.g., Pu-239/240, Am-241, Cs-137) settled out in the bottom of units. Most of the dissolved contaminants in solution sorbed to sediments within 2 m of the bottom of the units; concentrations decrease rapidly with depth.

③ Contaminant concentrations are very low compared to the bottom of the ditch.

④ Lateral spreading within the lower unit of the Hanford formation and at the top of the Plio-Pleistocene unit; areas of perched water that formed under some of the units.

⑤ Wetting front moves vertically down into Ringold Unit E.

⑥ High volumes of liquid exceeded vadose zone soil pore volumes and reach groundwater table.

E9910047.2

Table 2-1. Waste Sites in the 200-CW-5 Operable Unit. (2 Pages)

Site Name	Dates of Operation	Approx. Depth (bgs)	Analogous Representative Site	Dimensions	General Description	Source Facility
Representative Waste Sites						
216-U-10 Pond	1944 to 1985	(variable)	216-U-10	12 ha (30 ac)	Unlined topographic depression. Backfilled and surface stabilized in 1985.	284-W, 231-Z, 234-5Z, 2723-W, 2724-W, 221-U, 224-U, 241-U-110, 242-S, 271-U, 291-Z
216-U-14 Ditch	1944 to 1995	1.2 m (4 ft)	216-U-14	1,731 x 2.4 m (5,680 x 8 ft) (bottom width)	Unlined ditch. Backfilled and surface stabilized in sections, with last section completed in 1997.	284-W, 2723-W, 2724-W, 221-U, 224-U, 241-U-110, 242-S, 271-U
216-Z-11 Ditch	1959 to 1971	0.6 m (2 ft)	216-Z-11	797 x 1.2 m (2,615 x 4 ft)	Unlined ditch. Backfilled and surface stabilized in 1971.	231-Z, 234-5Z, 291-Z
Analogous Waste Sites						
200-W-84 U Plant Process Sewer	1952 to 1984	0.6 m (2 ft)	216-U-14	46 cm (18 in) dia. 800 m (2,600 ft) long	Underground, vitrified clay pipeline. It terminated at a timber headwall where the flow entered the 216-U-14 Ditch.	221-U
200-W-102 Process Sewer	1944 to 1981		216-U-14		Underground pipeline used to transfer laundry and mask cleaning effluent to the 216-U-14 Ditch.	2723-W and 2724-W Laundry and Mask Cleaning facilities
207-U Retention Basin	1952 to 1994	2 m (6.5 ft)	216-U-14	75 x 37 m (246 x 123 ft)	Plastic-lined concrete basin divided into halves.	221-U, 224-U
216-U-9 Ditch	1952 to1975		216-U-10	1,067 x 1.8 m (3,500 x 6 ft)	Unlined ditch. Backfilled in 1954; a portion was reopened in 1973 and used until 1975.	Overflow from 216-U-10 Pond
216-U-11 Ditch	1944 to 1957	1.8 m (6 ft)	216-U-10	1,375 x 1.5 m (4,510 x 5 ft)	Unlined ditch. Backfilled and surface stabilized in 1985 in conjunction with 216-U-10 Pond.	234-5Z, 291-Z, 231-Z
216-W-LWC	1981 to 1994	4.3 m (14 ft)	216-U-14	47 m by 40.5 m ((150 ft by133 ft) for each crib	Two independent crib structures (i.e., drain fields) consisting of a central distribution pipe and drain lines with rock fill beneath.	2723-W and 2724-W Laundry and Mask Cleaning facilities
216-Z-1D Ditch	1944 to 1959	0.6 m (2 ft)	216-Z-11	1,295 x 1.22 m (4,250 x 4 ft)	Unlined ditch. Backfilled and surface stabilized in 1959.	231-Z, 234-5Z, 291-Z
216-Z-19 Ditch	1971 to 1981	0.6 m (2 ft)	216-Z-11	843 x 1.2 m (2,765 x 4 ft)	Unlined ditch. Backfilled and surface stabilized in 1981.	231-Z, 234-5Z, 291-Z

Table 2-1. Waste Sites in the 200-CW-5 Operable Unit. (2 Pages)

Site Name	Dates of Operation	Approx. Depth (bgs)	Analogous Representative Site	Dimensions	General Description	Source Facility
216-Z-20 Ditch Replacement Tile Field	1981 to 1995	2.7 to 8.8 m (9 to 29 ft) (variable)	216-Z-11	463 x 3 m (1,519 x 10 ft)	Unlined underground gravel tile field covered with soil.	234-5Z, 231-Z, 291-Z, 232-Z, 236-Z, 2736-Z
Unplanned Releases						
UPR-200-W-110	One-time use in 1971	4.6 m (15 ft)	216-Z-11	130 m (425 ft)	Narrow trench east of, and adjacent to, the 216-Z-11 Ditch. It received contaminated backfill material generated during the construction of the 216-Z-19 Ditch. The contaminated backfill was from the 216-Z-1 Ditch. This trench is within the same underground radioactive material zone as the 216-Z-11 Ditch.	216-Z-1 Ditch
UPR-200-W-111	One-time use in 1960s	3.1 m (10 ft)	216-U-14	12.2 x 4.6 m (40 x 15 ft)	Narrow trench adjacent to the 207-U Retention Basin that was dug to bury approximately 21 m^3 (27 yd^3) of sludge scraped from the bottom of the south side of 207-U Retention Basin. Sludge was covered with 1.2 m (4 ft) of clean soil. Surface was stabilized in 1997.	207-U Retention Basin
UPR-200-W-112	One-time use in 1960s	3.1 m (10 ft)	216-U-14	12.2 x 4.6 m (40 x 15 ft)	Narrow trench adjacent to 207-U Retention Basin used to bury approximately 21 m^3 (27 yd^3) of sludge scraped from the bottom of the north side of 207-U Retention Basin. Sludge was covered with 1.2 m (4 ft) of clean soil. Surface was stabilized in 1997.	207-U Retention Basin

bgs = below ground surface
LWC = laundry waste crib.
UPR = unplanned release.

Table 2-2. Waste Sites in the 200-CW-2 Operable Unit. (2 Pages)

Site Name	Dates of Operation	Approx. Depth (bgs)	Analogous Representative Site/(Operable Unit)[a]	Dimensions	General Description	Source Facility
Representative Waste Sites						
216-S-17 Pond	1951 to 1954	0.3 to 0.6 m (1 to 2 ft)	216-U-10 Pond	292 m x 292 m (958 ft x 958 ft)	Pond formed by earthen dikes, approx. 1 m (3.3 ft) high on the north and west sides of the site.	Process effluent from 202-S Facility and overflow from 216-U-10 Pond via 216-U-9 Ditch
Analogous Waste Sites						
207-S Retention Basin	1951 to 1954		207-A South/ (200-PW-4 OU)	40 m x 40 m (130 ft x 130 ft)	A concrete structure with an overflow tank located in the center of the north end, and an outlet weir structure adjacent to the south wall. Removed from service after contamination release from a 202-S coil leak. Backfilled with dirt.	Process cooling water and steam condensate from the 202-S Facility en route to the 216-S-17 or 216-S-16 Pond.
216-S-16D Ditch	1957 to 1975		216-U-14 Ditch	518 m x 1.2 m (1700 ft x 4 ft)	A ditch that connected the 202-S Building to the 216-S-16 Pond. In 1973, a portion of the 216-U-9 Ditch was reopened and connected to the 216-S-16 Ditch to divert overflow from the 216-U-10 Pond to the 216-U-16 Pond. Backfilled and surface stabilized.	Process cooling water and steam condensate from the 202-S Facility
216-S-16P Pond	1957 to 1975		216-U-10 Pond		Four lobes separated by dikes and a leach trench. In 1973, the 216-U-9 Ditch was connected to the 216-S-16 Ditch to divert overflow from the 216-U-10 Pond to the 216-S-16 Pond. In 1975, the 216-S-16 Pond was backfilled and surface stabilized using soil from the dikes. Lobe #4 was never used.	Cooling water and steam condensate from REDOX.
216-S-172 Control Structure	1956 to 1976	2.1 m (7 ft)	207-A South/ (200-PW-4 OU)	4.1 m x 2.2 m (13 ft x 7 ft)	An underground concrete structure with interior sluice gates. Float wells were attached to the outside north and south walls. The structure has been covered with soil and posted with "URM/Cave-In Potential" signs.	Process cooling waste and steam condensate from the 202-S Facility to the 216-S-16 Ditch.

Table 2-2. Waste Sites in the 200-CW-2 Operable Unit. (2 Pages)

Site Name	Dates of Operation	Approx. Depth (bgs)	Analogous Representative Site/(Operable Unit)[a]	Dimensions	General Description	Source Facility
2904-S-160 Control Structure	1954 to 1976	2.74 m (9 ft)	207-A South/ (200-PW-4 OU)	3 m x 3 m (10 ft x 10 ft)	A below-grade pentagonal structure with reinforced concrete walls, floor, and roof with 60 cm (24-in.)-diameter vitrified clay inlet and outlet pipes. Surface stabilized and posted with "URM/Cave-in Potential" signs.	Process cooling waste and steam condensate from the 202-S Facility to 216-S-17 Pond, 216-S-6 Crib, and 216-S-16 Pond.
2904-S-170 Control Structure	1954 to 1976		207-A South/ (200-PW-4 OU)	4.9 m x 1.5 m (16 ft x 5 ft)	A below-grade concrete structure with 76 cm (30-in.)-diameter vitrified clay inlet and outlet pipes. The 2904-SA Sample Building is located over the south end of the weir structure.	Process waste from the REDOX Facility
2904-S-171 Control Structure	1954 to 1976	3.05 m (10 ft)	207-A South/ (200-PW-4 OU)	4 m x 2.6 m (13 ft x 9 ft)	A below-grade, rectangular concrete weir structure with 46 cm (18-in.)-diameter inlet and outlet piping and a hand-operated gate valve. The site has been backfilled with clean material.	Process waste being routed to the 216-S-6 Crib.
Unplanned Releases						
UPR-200-W-124	1959		216-U-10 Pond	305 m x 9 m (1,000 ft x 30 ft)	The release description in HW-60807 says that a release occurred when a dike broke at the "REDOX Swamp" southeast of 200 West Area. The text references Sketch G, reference 1. The pond located southeast of 200 West Area is 216-S-19. However, reference 1 on Sketch G is positioned southwest of 200 West Area and indicates the dike break occurred at 216-S-17.	Cooling water from 202-S Facility process tanks

[a] Operable units are identified for representative waste sites other than 200-CW-5.

HW-60807, *Unconfined Underground Radioactive Waste and Contamination in the 200 Areas.*

bgs = below ground surface.
OU = operable unit.
REDOX = Reduction-Oxidation (Faciliaty).
UPR = unplanned release.
URM = Underground Radioactive Material (area).

Table 2-3. Waste Sites in the 200-CW-4 Operable Unit. (2 Pages)

Site Name	Dates of Operation	Approx. Depth (bgs)	Analogous Representative Site/(Operable Unit)[a]	Dimensions	General Description	Source Facility
Representative Waste Sites						
216-T-4A Pond	1944 to 1972		216-U-10 Pond	6.5 ha (16 ac)	The pond was a natural surface depression in the desert floor. In 1972 the bottom of the original pond was scraped to a depth of 15 to 23 cm (6 to 9 in.) and the scrapings were placed in the 218-W-2A Burial Ground (Trench #27). The scraped area was covered with clean soil in February 1973	221-T and 224-T process cooling water; 221-T steam condensate; 242-T Evaporator condenser cooling water and steam condensate; 2706-T decontamination waste; 242-T condenser cooling water
Analogous Waste Sites						
200-W-88 Process Sewer	1944 to 1995		200-E-111/ (200-IS-1)	Northern 1829 m (6,007 ft); Southern – 750 m (2,464 ft)	Two vitrified clay process sewer pipelines. The southern line extends from the south end of T Plant to the 207-T Retention Basin. The northern process sewer line extends from the south end of T Plant and bypasses the retention basin, connecting to the 207-T discharge pipe.	Cooling water, air conditioning condensate, and floor-drain waste from 221-T, 224-T, and 242-T.
207-T Retention Basin	1944 to 1995		207-A South Retention Basin/ (200-PW-4)	75 m x 37 m (246 ft x 123 ft) (both basins)	A concrete structure, divided into two sections. Periodically the sludge that accumulated on the bottoms of the basins was cleaned out and placed in holes located around the perimeter of the basin and covered with clean dirt. One of these holes is documented as 216-T-12. Contaminated soil was placed inside the basins as fill material in 1996. The basin has been capped with 18 to 24 in. of clean dirt	T Plant process cooling and ventilation steam condensate; process cooling water from equipment jackets in 221-T and 224-T; 242-T Evaporator cooling water; flow from the 221-TA Building.
216-T-1 Ditch	1944 to 1995	3.1 m (10 ft)	216-U-14 Ditch	556 m (1,825 ft)	An earthen ditch with 2.5:1 side slopes and a 5 cm (2-in.)-diameter vitrified clay feeder pipe. RHO-CD-673, issued in 1979, states that only the first 46 m (150 ft) of the ditch was wet. Backfilled and stabilized.	Misc waste from pilot experiments, decontamination, other waste from the 221-T Building; 271-T blow-down vessel cooling water; 221-T condensate from steam-heated radiators; sodium hydroxide wash water (nonradioactive)

Table 2-3. Waste Sites in the 200-CW-4 Operable Unit. (2 Pages)

Site Name	Dates of Operation	Approx. Depth (bgs)	Analogous Representative Site/(Operable Unit)[a]	Dimensions	General Description	Source Facility
216-T-4-1D Ditch	1944 to 1972		216-U-14 Ditch	259.08 m x 2.44 m (850 ft x 8.0 ft)	An earthen ditch that was replaced by the 216-T-4-2 Ditch. By 1971, it was contaminated to a maximum of 20,000 c/min at the bottom and was badly overgrown with aquatic plants, shrubs, and small willow trees. Backfilled and surface stabilized.	T Plant cooling water and condensate waste
216-T-4B Pond	1972 to 1995	0.45 m (1.5 ft)	216-U-10 Pond	Wetted size estimated at 1.5 acres	This unit replaced the 216-T-4A Pond. It was a natural depression that received run off from the 216-T-4-2 Ditch. An earth dike was built to keep the pond water from seeping into the 216-W-2A Burial Ground. The volume of water in the new 216-T-4-2 Ditch usually was not enough to fill the pond, because it generally was absorbed in the first quarter of the ditch, leaving the pond area dry.	242-T Evaporator steam condensate and condenser cooling water; nonradioactive wastewater from 221-T air conditioning filter units and floor drains.
216-T-4-2 Ditch	1972 to 1995	1.22 m (4 ft)	216-U-14 Ditch	533.40m x 2.44m (1,750 ft x 8.0 ft)	The first 15 m (50 ft) of the ditch from the head of unit was part of the original 216-T-4-1 Ditch. A portion was parallel to the old 216-T-4-1 Ditch, leading to the 216-T-4B Pond. Most of the effluent was absorbed in the first quarter of the ditch. The end of the ditch and the 216-T-4B Pond often were dry. Backfilled and surface stabilized.	242-T Evaporator steam condensate and condenser cooling water; nonradioactive wastewater from 221-T air conditioning filter units and floor drains.
216-T-12 Trench	1954	2.44 m (8.0 ft)	216-T-26/ (200-TW-1)	4.57 m x 3.05 m (15 ft x 10 ft)	A sludge pit used to bury contaminated material from the 207-T Retention Basin. It was only used once. At the time of burial, 15 mrad/h was the maximum detected on the sludge (1954). Backfilled and stabilized.	Contaminated sludge from the 207-T Retention Basin.

[a] Operable units are identified for representative waste sites other than 200-CW-5.

RHO-CD-673, *Handbook 200 Area Waste Sites*.

bgs = below ground surface

Table 2-4. Waste Sites in the 200-SC-1 Operable Unit. (3 Pages)

Site Name	Dates of Operation	Approx. Depth (bgs)	Analogous Representative Site/(Operable Unit)[a]	Dimensions	General Description	Source Facility
Representative Waste Sites						
216-S-5 Crib	1954 to 1957	4.57 m (15 ft)	216-A-10 Crib/ (200-PW-2)	64 m x 64 m (210 ft x 210 f t)	A gravel-filled crib with two lengths of perforated, corrugated metal pipe that form a cross. A hole was cut along the top edge of the crib to discharge overflow to a nearby trench. Overflowed was 5% of the total flow. When the REDOX Plant A-2 dissolver and H-4 coils failed, the dose rates at the overflow area reached 17 rad/h. The crib has been surface stabilized.	REDOX Plant effluent with a low potential for contamination. Process vessel cooling water and steam condensate water from the 202-S Building.
216-S-6 Crib	1954 to 1972	4.6 m (15 ft)	216-A-10 Crib/ (200-PW-2)	64 m x 64 m (210 ft x 210 ft)	A square pit filled with gravel with perforated pipe running down the center, and six pipes branching off perpendicular to the main pipe. The northwest end of the crib is heavily populated with growing tumbleweeds, but no contamination was found.	Process cooling water and steam condensate from the 202-S Building waste. REDOX Plant effluent with a high potential for contamination.
Analogous Waste Sites						
200-E-113 Process Sewer			200-E-111/ (200-IS-1)	538 m (1,765 ft)	Waste is associated with the steel pipeline and adjacent contaminated soil from pipe leaks. In 1995, the distribution box was filled with concrete. Backfilled and stabilized.	Steam condensate waste from the PUREX Facility
200-W-79 Pipeline			200-E-111/ (200-IS-1)	225.00 m (738.19 ft)	Waste is associated with a 10 cm (4-in.)-diameter, vitrified clay pipeline and adjacent soil.	T Plant and U Plant effluent discharges to the 241-T-151 Diversion Box
207-A-North Retention Basin	1977 to 1999		207-A-South Retention Basin/ (200-PW-4)	16.8 m x 3.0 m x 2.1 m (55 ft x 10 ft x 7 ft) (each basin)	Three Hypalon[b]-lined, concrete basins. Before the liner was installed, the basins had been posted as a Contamination Area, but currently there is no radiological posting.	Steam condensate from the 242-A Evaporator
207-Z Retention Basin	1949 to 1959	3.1 m (10 ft)	207-A-South Retention Basin/ (200-PW-4)	15 m x 12 m (50 ft x 40 ft)	Two concrete basins in one concrete structure. The basins are separated by a 0.3 m (1-ft)-thick concrete wall. Each basin contains a sump with a sump pump.	Steam condensate and cooling water from Z Plant Complex

Table 2-4. Waste Sites in the 200-SC-1 Operable Unit. (3 Pages)

Site Name	Dates of Operation	Approx. Depth (bgs)	Analogous Representative Site/(Operable Unit)[a]	Dimensions	General Description	Source Facility
216-A-6 Crib	1955 to 1970	3.7 m (12 ft)	216-A-10 Crib/ (200-PW-2)	31 m x 31 m (100 ft x 10 0 ft)	The unit was constructed with a vitrified clay pipe placed horizontally over the length of the unit. Five lengths of perforated pipe are perpendicular to the first pipe. Periodically the crib exceeded flow capacity and contaminated the ground surface (UPR-200-E-21, UPR-200-E-29). A trench was dug connecting the crib with the 216-A-29 Ditch to collect the overflow water. UPR-200-E-19 occurred when low-level fission product seeped into the ground around the edges of the concrete pad at the 216-A-6 Proportional Sampler Pit. The release was caused by moisture dripping from the vent pipe bonnet.	Steam condensate, equipment disposal tunnel floor drainage, water-filled door drainage and the slug storage basin overflow waste from the 202-A Building
216-A-30 Crib	1961 to 1992	4 ft (1.2 m)	216-A-10 Crib/ (200-PW-2)		A gravel-filled crib that has been isolated and backfilled. During the winter of 1971 and early 1972, an alkaline deposit formed over the surface of the 216-A-30 Crib. Exploration into the crib revealed a salt deposit that condensed from vapors emitted through the soil. The ground was then covered with layers of sand and plastic.	Steam condensate, equipment disposal tunnel floor and water-filled door drainage, and the slug storage basin overflow waste from the 202-A Building.
216-A-37-2 Crib	1983 to 1995		216-A-37-1/ (200-PW-4)	427 m x 3.1 m (1,400 ft x 10 ft)	The crib was built as a replacement for the 216-A-30 Crib. There are two steel drain pipes. One is perforated and runs the length of the unit. The other is not perforated and runs from west to east only to the center of the unit, 1.5 m (5 ft) above the bottom.	PUREX Facility steam condensate waste
216-B-55 Crib	1967 to 1991		216-B-12 Crib/ (200-PW-2)	229 m x 3.1 m (750 ft x 10 ft)	The unit is filled with gravel and contains a perforated pipe that runs the length of the unit. The site had two gauge wells of 20 cm (8in.) steel pipe with a galvanized sheet metal cap.	Steam condensate from 221-B

Table 2-4. Waste Sites in the 200-SC-1 Operable Unit. (3 Pages)

Site Name	Dates of Operation	Approx. Depth (bgs)	Analogous Representative Site/(Operable Unit)[a]	Dimensions	General Description	Source Facility
216-B-64 Retention Basin	1974 to 1997	4.6 m (15 ft)	207-A-South Retention Basin/ (200-PW-4)	51 m x 13 m (167 ft x 42 ft)	An emergency diversion basin for steam condensate that exceeded crib release limits. The unit has not been used except for an initial test. The radiological speck contamination present in the basin has migrated from the adjacent surface contamination area by way of wind and animal (insect) intrusion.	The source of contamination appeared to be from the 270-E-1 Neutralization Tank riser. The contaminated area was named UPR-200-E-64 (alias UN-216-E-36).
216-S-25 Crib	1973 to 1992		216-A-10 Crib/ (200-PW-2)	175 m x 3.1 m (575 ft x 10 ft)	A gravel-filled site with a below-grade distribution pipe. Growing tumbleweeds were contaminated at levels from 12,000 to 36,000 d/min. Soil was contaminated from 1,000 to 4,000 d/min.	242-S Evaporator process steam condensate and 216-U-1 and 216-U-2 groundwater pump-and-treat effluent
216-T-36 Crib	1967 to 1970 or 1973	4.6 m (15 ft)	216-T-33 Crib/ (200-MW-1)	49 m x 3.1 m (160 ft x 10 ft)	The site consists of a single distribution pipe in a gravel layer in a rectangular trench. Backfill covers the pipe and gravel. A long, narrow area of posted contamination adjacent to the east side of the crib appears to be located over the buried pipeline that fed the crib.	Steam condensate, decontamination waste, and miscellaneous waste from the 221-T and 221-U Buildings; 2706-T Building decontamination waste
UPR-200-E-19	1959		216-A-10 Crib/ (200-PW-2)		Low-level fission product seeped into the ground around the edges of the concrete pad at the 216-A-6 Proportional Sampler Pit. The release was caused by moisture dripping from the vent pipe bonnet.	216-A-6 Crib effluents
UPR-200-E-21	1959		216-A-10 Crib/ (200-PW-2)		The 216-A-6 Crib overflowed and contaminated the adjacent area to 500 mrad/h.	216-A-6 Crib effluents
UPR-200-E-29	1961		216-A-10 Crib/ (200-PW-2)		The 216-A-6 Crib overflowed, contaminating surface soils. It was covered with 46 cm (18 in.) of sand and 10 cm (4 in.) of gravel.	216-A-6 Crib effluents

[a] Operable units are identified for representative waste sites other than 200-CW-5.

[b]Hypalon is a registered trademark of Dupont Dow Elastomers Limited Liability Company, Wilmington, Delaware.

bgs = below ground surface.
PUREX = Plutonium-Uranium Extraction (Plant).
REDOX = Reduction-Oxidation (Plant).
UPR = unplanned release.

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3.0 INITIAL EVALUATION OF REPRESENTATIVE SITES

This section presents results of previous characterization efforts at the representative sites and additional sites in the 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 OUs where data are available and provides a background for understanding the waste sites. The contaminant inventory, effluent volume, available soil and groundwater data, and current understanding of the distribution of contamination also are discussed for the representative sites. This information is used to develop site-specific contaminant distribution models for the representative sites.

The RI DQO process for the 200-CW-5 OU recognized that the 216-U-10 Pond and 216-U-14 Ditch were characterized as part of the 200-UP-2 OU and in WHC-EP-0698. The 200-UP-2 OU characterization activities were conducted under an approved work plan (DOE/RL-91-58, *Z Plant Source Aggregate Area Management Study Report*), and the results were compiled in an LFI report (DOE/RL-95-13). A focused FS (FFS) (DOE/RL-95-106) that evaluated immediate action requirements was submitted for regulatory review. The FS was never finalized, because the near-term risks were low for the evaluated waste sites and no interim actions beyond institutional controls were required. Therefore, these sites have been characterized but not fully evaluated for appropriate final remedial actions. When the OUs were reorganized in accordance with the Implementation Plan (DOE/RL-98-28), these two sites were assigned to the 200-CW-5 OU for completion of their RI/FS process. The characterization data previously obtained for these sites are sufficient to support the 200-CW-5 RI/FS process; therefore, characterization aspects of this work plan focus solely on the 216-Z-11 Ditch. The process history information pertaining to the 216-U-10 Pond and the 216-U-14 Ditch are provided in Sections 3.1 through 3.6 to support completion of the remedial decision-making process for those sites.

3.1 KNOWN AND SUSPECTED CONTAMINATION

As discussed in Chapter 2.0, waste sites in these OUs received dilute concentrations of a number of radionuclides in cooling water and the infrequent influxes of unusually high concentrations of waste associated with unplanned releases.

The estimated inventory of the primary radionuclides and chemicals that were discharged to representative waste sites was obtained from WIDS, aggregate area management study reports (AAMSR) for the 200 Areas (e.g., DOE/RL-91-60, DOE/RL-91-61, DOE/RL-91-52, DOE/RL-91-58), and Appendix A of DOE/RL-96-81, as well as other documents cited in Chapter 3.0. Where available, the estimated contaminant inventory for the representative waste sites is presented in Table 3-1. Only nitrate, carbon tetrachloride, uranium, plutonium, Am-241, Cs-137, and Sr-90 are tabulated, along with the effluent volumes.

The volumes and types of contaminants from the waste sites are difficult to quantify because they were not routinely monitored. However, lists of contaminants of potential concern (COPC) for the 216-Z-11 Ditch, developed from process information, are presented in BHI-01294.

3.2 ENVIRONMENTAL MONITORING

Currently, environmental monitoring at the Hanford Site consists of effluent monitoring, environmental surveillance, groundwater monitoring, and select characterization within the vadose zone. Environmental surveillance is performed for the following:

- Air
- Surface water and sediment
- Drinking water
- Farm and farm product
- Soil and vegetation
- External radiation.

Air, soil and vegetation, and external radiation are evaluated routinely in the 200 Areas as part of the Hanford Site near-facility and environmental monitoring programs. The most recent of these annual reports are PNNL-14295, Appendix 2, *Hanford Site Near-Facility Environmental Monitoring Data Report for Calendar Year 2002*, and PNNL-14295, *Hanford Site Environmental Report for Calendar Year 2002.* The near-facility document focuses on monitoring activities near facilities that have the potential to discharge or have discharged, stored, or disposed of radioactive or hazardous materials, including those in the 200 East and 200 West Areas. The Hanford Site environmental report covers the entire Hanford Site, including those areas not associated with operations, such as the 600 Area. This document examines the resources associated with the Hanford Site, including those media already listed and groundwater. Sites associated with the OUs where soil and vegetation samples have been collected include the 216-U-10 Pond, 216-U-11 Trench, 216-U-14 Ditch, 216-Z-11 Ditch, 216-S-16 Pond and Ditch, 216-S-17 Swamp, 207-T Retention Basin, 216-Z-19 Swamp, 216-A-30 Crib, 216-A-37-2 Crib, 216-B-64 Retention Basin, 216-S-25 Crib, and 216-T-36 Crib. The results of sampling are discussed in PNNL-14295, Appendix 2. Results of these monitoring efforts for the 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 OU waste sites are presented in Section 3.3, and data are reported in Appendix B, Tables B-2 and B-3. The potential impacts of contamination of these waste sites on human health and the environment are discussed in Section 3.4.

Groundwater also is routinely monitored Site wide. Over 600 monitoring wells are sampled annually to characterize groundwater flow; groundwater contamination by metals, radionuclides, and chemical constituents; and the area of contamination. Groundwater remediation, ingestion risk, and dose also are assessed. Results of groundwater monitoring and remediation are presented annually in the PNNL-14187, *Hanford Site Groundwater Monitoring for Fiscal Year 2002.* This document also summarizes vadose zone characterization activities conducted on the Site through other projects.

Investigative sampling of soil and biota is conducted as part of the Hanford Site environmental monitoring program to confirm the absence or presence of radioactive and/or hazardous contaminants where known or suspected contaminants are present, or to verify radiological conditions at specific project sites. Media sampled include soil, vegetation, nests (bird, wasp, ant), mammal feces (rabbit, coyote), mammals (mice, bats), and insects (fruit flies). Investigative wildlife samples are used to monitor and track the effectiveness of measures designed to deter animal intrusion. Wildlife-related materials, including nests, carcasses, and feces, are collected as part of the integrated pest management program or when encountered during a radiological survey. Samples are analyzed for radionuclides and/or other hazardous substances.

Several of the OU waste sites were historically monitored with investigative samples collected. The results of monitoring and sampling events between 1965 and 1992 were summarized in WHC-MR-0418. Monitoring events at the 207-S Retention Basin, 216-S-16 Pond and Ditch, 216-S-17 Pond, 207-T Retention Basin, 216-T-1 Ditch, 216-T-4-2 Ditch, 207-U Retention Basin, 216-U-9 Swamp Ditch, 216-U-10 Swamp, 216-U-11 Trench, 216-U-14 Ditch, 216-Z-19 Ditch, 216-A-6 Crib, 216-A-30 Crib, 216-A-37-2 Crib, 216-B-64 Retention Basin, 216-S-5 Crib, and the 216-S-6 Crib were summarized in WHC-MR-0418 and are listed in Appendix B, Table B-1.

3.3 NATURE AND EXTENT OF CONTAMINATION

This section uses previously published data to describe the contamination associated with the representative waste sites. The facilities that contributed to the waste stream generally did not keep facility-specific records of discharges. However, later records exist for these facilities. For example, since 1984, the powerhouse effluent was sampled and sent to the 284-W Powerhouse pond, which was constructed over part of the 216-U-14 Ditch. Records were documented in the 216-U-10 Pond inventory according to the U Plant AAMSR (DOE/RL-91-52).

Even though substantial quantities of water were disposed of to the OU waste sites, the OUs are not a major source of groundwater contamination (note, however, as discussed later in this section, that contaminants are present in the groundwater below the 216-U-10 Pond and the 216-U-14 Ditch). The largest impact of the 216-U-10 Pond on the hydrology has been on the flow system from the formation of a groundwater mound that drove contamination from other disposal facilities in the aquifer (WHC-EP-0707).

A summary of ecological resources for the 200 Areas is provided in DOE/RL-98-28, Appendix F, Chapters 8.0 and 9.0 (Implementation Plan). Site-specific ecological data are presented in the following subsections for the representative sites. Several other sources of information, while not pertinent to a specific representative site, provide useful data in the vicinity of the sites. These data sources include the following:

- WHC-MR-0418, *Historical Records of Radioactive Contamination in Biota at the 200 Areas of the Hanford Site*
- BHI-00032, *Ecological Sampling at Four Waste Sites in the 200 Areas.*

Eighty-five environmental monitoring records collected since 1965 of wildlife and vegetation at the 200 East and 200 West Areas were reviewed and summarized in WHC-MR-0418. The report indicates that waste sites in the OUs were sampled between 1965 and 1992. About 4,500 individual cases of monitoring for radionuclide uptake or transport in biota in the 200 Areas environs were included in the documents reviewed in WHC-MR-0418. Approximately 1,900 (42%) of these biota had radionuclide concentrations in excess of 10 pCi/g. These radionuclide transport or uptake cases were distributed among 45 species of animals (mostly small mammals) and their feces and 30 species of vegetation. Sites in the 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 OUs with available sampling data that are summarized in WHC-MR-0418 included the 207-S Retention Basin, 216-S-16 Pond and Ditch, 216-S-17 Pond, 207-T Retention Basin, 216-T-1 Ditch, 216-T-4-2 Ditch, 207-U Retention Basin, 216-U-9 Swamp Ditch, 216-U-10 Swamp, 216-U-11 Trench, 216-U-14 Ditch, 216-Z-19 Ditch, 216-A-6 Crib, 216-A-30 Crib, 216-A-37-2 Crib, 216-B-64 Retention Basin, 216-S-5 Crib, and the 216-S-6 Crib.

Wildlife species most commonly associated with uptake of radioactive contamination in the 200 Areas historically have been house mice and deer mice, but other animals, primarily birds (including waterfowl), coyotes, cottontail rabbits, mule deer, and elk have been sampled (WHC-MR-0418; PNNL-13230, Appendix 2, *Hanford Site Near-Facility Environmental Monitoring Data Report for Calendar Year 1999*). In 1999, the Pacific Northwest National Laboratory sampled elk, geese, and rabbits for gamma emitters and Sr-90. Samples of elk muscle, bone, liver, heart, kidney, intestine, and feces were collected from animals struck on Highway 240 and from individuals sampled on the Central Plateau. Cesium-137 was undetected in all elk samples (PNNL-13230, *Hanford Site Environmental Report for Calendar Year 1999*). PNL-10174, *A Qualitative Evaluation of Radionuclide Concentrations in Hanford Site Wildlife, 1983 Through 1992*, reported a consistent decline in Cs-137 concentration in elk since 1983. Geese were sampled from the Hanford Reach near the Vernita Bridge. Only one of the eight geese sampled showed a Cs-137 concentration above analytical detection. Eight rabbit samples consisting of jackrabbit and cottontail muscle and bone were taken from the 200 Areas in 1999. One of the eight rabbit muscles sampled showed a Cs-137 concentration above analytical detection. In 2000, deer and elk were sampled for radionuclides Cs-137 and Sr-90 (PNNL-13487, *Hanford Site Environmental Report for Calendar Year 2000*). Cesium-137 was undetected in all seven deer samples collected in 2000.

Tissues of three road-killed elk were sampled for radionuclide levels in 2000. With the exception of Sr-90, concentrations of all manmade radionuclides were reported at or below analytical detection limits. Strontium-90 was detected in bone samples of all three elk at levels comparable to Hanford Site mule deer samples. No offsite elk samples were collected in 2000. However, in 1999, radionuclide levels in elk collected on Site were compared to levels in elk collected in central Idaho and in the Rattlesnake Hills of Washington. Three muscle samples collected from Sun Valley, Idaho, contained Cs-137 at concentrations above analytical detection limits, consistent with previous years. Cesium-137 in elk muscle samples collected near Lewiston, Idaho, and in the Rattlesnake Hills of Washington in 1999 was below analytical detection. Strontium-90 was detected in bone samples from all locations, with average concentrations of 1.6 pCi/g from central Idaho and 0.3 pCi/g for the Rattlesnake Hills, as compared with 0.5 pCi/g for road-killed elk from the Hanford Site (PNNL-13230).

Plant species potentially can be exposed to contaminated soils and/or groundwater present in the vadose zone soil in the 200 Areas. WHC-MR-0418 demonstrated radionuclide uptake by plants in the 200 Areas. Plants live in direct contact with the soil and can take up contaminants through physical and biological processes. Exposure is a function of the plant species, root depth, physical nature of the contamination, and the contaminant concentrations and distributions in the soil. Plants generally are tolerant of ionizing radiation (IAEA 332, *Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards*), but potentially present a contaminant exposure pathway to wildlife through the consumption of contaminated seeds, leaves, roots, or stalks. The vegetative species most commonly associated with the contamination was the Russian thistle. The largest numbers and highest levels of radionuclide uptake or transport occurred at several sites unrelated to the 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 OU waste sites, including the 216-B-3 Ditches; 216-BC Cribs; and the B, BX, and BY Tank Farms. The 216-Z Ditches, however, had large numbers and high levels of radionuclide uptake or transport. Much of this information was collected before stabilization activities at the individual waste sites. Noticeable improvements in reducing the uptake and transport of radionuclide contaminants by biota were observed in areas where interim stabilization activities have taken place (WHC-MR-0418).

Vegetation and soil are sampled biennially, and results are reported in the near-facility environmental monitoring report (e.g., PNNL-13230, Appendix 2) for each sampling year. Vegetation and soil samples associated with the OUs were collected near the 216-U-10, 216-U-11, 216-U-14, 216-Z-11, 216-S-16, 216-S-17, 207-T, 216-Z-19, 216-A-30, 216-A-37-2, 216-B-64, 215-S-25, and 216-T-36 waste sites under the Sitewide monitoring project between 1994 and 2001. Perennial vegetation samples consisted of the current year's growth of leaves, stems, and new branches collected from sagebrush and rabbitbrush. Fission products were most common in the 200 Areas. Radionuclide analytes were detected at less than 1 pCi/g in all vegetation samples collected, except for Sr-90 (1.6 pCi/g Sr-90 in one vegetation sample at the 216-T-36 Crib waste site in 2001). Activities of Cs-137, U-238, and Tc-99 all were below nominal detection limits in vegetation samples.

Cesium-137, Sr-90, and Pu-239/240 were the only radionuclides detected in soil in 2000 and 2001. Cesium-137 was detected in soil at concentrations of 1.8 pCi/g at the 216-S-25 Crib waste site, 1.3 pCi/g and 1.6 pCi/g at the 216-T-36 Crib waste site, and 1.4 pCi/g at the 216-U-14 Ditch. Strontium-90 was detected at a concentration of 1.4 pCi/g in soil at the 216-U-10 Pond, and at 2.5 pCi/g and 1.5 pCi/g at the 216-T-36 Crib waste site. Plutonium-239/240 was detected in one sample at the 216-Z-11 Ditch at a concentration of 8.5 pCi/g. All other soil samples showed radionuclide detections less than 1 pCi/g in 2000.

Investigative wildlife sampling on the Hanford Site was used to monitor and track the effectiveness of measures designed to deter animal intrusion. Historical sampling of wildlife and wildlife-related materials was summarized in WHC-MR-0418 and included feces, small mammals, waterfowl, and terrestrial and aquatic vegetation. Aquatic vegetation samples and waterfowl samples were limited to the years when the pond and ditches were active and contained standing water. The results of these sampling efforts are not reported or discussed, because the pond and ditches are no longer active. They have been stabilized with clean fill, and the previous wildlife data have no ecological significance to these waste sites. No surface water currently is available for wildlife use in the 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 OUs.

Biological transport of contamination by ants is a source of concern on the Hanford Site. Harvester ants, which are present on the disturbed soils associated with waste sites, have shown extreme resistance to radioactive sources (PNL-2479, *Analysis of Small Mammal Populations Inhabiting the Enviros of a Low-Level Radioactive Waste Pond*). In a contamination area, ants are capable of bringing radioactive materials to the surface, where they could become available to transport by wind, plant uptake, birds, or mammals. The biological transport of contamination by harvester ants was documented during an annual radiological survey at the UPR-200-E-64 site in 1985. The source of contamination was assumed to be a small-diameter pipe visible on the west side of the 216-B-64 Retention Basin (in the 200-SC-1 OU), near tank 270-E-1. In 1985, the pipe had a dose rate of 30 mrad/h. Surrounding contamination was transported to the surface by harvester ants and further spread by wind. In 1995, the size of the posted contamination area was approximately 8,100 m^2 (2 ac). Additional contaminated soil and anthills were identified both north and south of 7th Street and around the 241-ER-151 Diversion Box in September 1998.

BHI-00032 summarized a sampling effort to collect ecological samples at four sites in the 200 Areas, including the 216-U-11 Ditch, which is located near the U Pond and is part of the 200-CW-5 OU. Control samples were collected from a site on the Saddle Mountain Wildlife Refuge. Soil, vegetation, small mammal, and insect samples were collected and analyzed for the EPA's target analyte list constituents (SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update III-A*), Sr-90, total uranium, and gamma-emitting radionuclides, using gamma spectroscopy. Soil and vegetation samples also were analyzed for Tc-99. The basis of the sampling strategy was to select some worst case sites on which to focus future biota sampling activities.

Vegetation analysis included two cheatgrass and two Russian thistle samples at the 216-U-11 Ditch. Strontium-90 was detected in one cheatgrass sample and both Russian thistle samples, and copper and zinc were detected in one cheatgrass sample and both Russian thistle samples; however, copper also was present in the associated sample blank. The only analytes detected in small mammal (pocket mouse) samples were Sr-90 (one out of four samples) and selenium (three out of four samples, but also detected in the associate sample blank). Strontium-90 was the only analyte detected in the composite insect sample. The following constituents were undetected in all samples: Tc-99, Co-60, Cs-137, cadmium, mercury, selenium, silver, and cyanide.

BHI-00032 concluded that Russian thistle is the preferred vegetative indicator for radionuclide and metal uptake, and pocket mice are the preferred mammalian indicators of contaminant uptake at terrestrial sites. BHI-00032 also recommended deleting the 216-U-11 Trench site from further study of surface contamination sites, based on the effectiveness of stabilization and isolation of the contaminants from the surrounding environment.

Ecological samples also were collected from the 216-U-11 Ditch as part of the LFI for the 200-UP-2 OU (DOE/RL-95-13). Plants were found to contain above background concentrations of copper, Cs-137, Sr-90, Pu-239, and total uranium. Concentrations of copper, cyanide, Cs-137, Sr-90, Pu-239, and total uranium that exceeded the 200 Areas reference locations were detected in small mammals.

Soil and vegetation samples are collected from Stations 104 and 110 in the vicinity of the 216-U-11 Ditch as part of the near-facility environmental monitoring. The 1998 analytical results for these stations are presented in Appendix B, Table B-2.

Ambient dose rates are measured by environmental thermoluminescent dosimeters (TLD) annually. The TLDs consist of two lithium fluoride (TLD-700) and two calcium fluoride dysprosium (TLD-200) chips sealed in a plastic holder supplied by Pacific Northwest National

Laboratory. Three TLDs are placed at each sampling location on a post at 1 m above the ground. Thirty-seven dosimetry monitoring stations were monitored in the 200 East and West Areas in 2000. The TLDs were collected and read quarterly. The two TLD-700 chips at each monitoring location were used to determine the average total environmental dose rate at that location. The average dose rate was computed by dividing the average total environmental dose by the length of time the dosimeter was in the field. Quarterly dose equivalent rates (millirem per day) at each location were converted to annual dose equivalent rates (millirem per year) by averaging the quarterly dose equivalent rates and multiplying by 365 days per year (PNNL-13487). Only one TLD monitoring station was located at a waste site associated with the 200-CW-5 consolidated OUs. A TLD sample collected in 2000 near the 216-Z-20 Ditch showed an annual dose rate of 82 mrem/yr at this site (PNNL-13487).

3.3.1 216-U-14 Ditch

Several facilities discharged waste streams to the 216-U-14 Ditch (and from there to the 216-U-10 Pond), as described in Chapter 2.0. The reported volume of liquids discharged to the 216-U-14 Ditch varies by author. HNF-1744, *Radionuclide Inventories of Liquid Waste Sites at Hanford*, reported a cumulative volume of 1.22×10^9 L (3.2×10^8 gal). However, WHC-EP-0698 reported that approximately this quantity was released almost every year of operation. The stream-specific report for the 242-S Evaporator in WHC-EP-0342, Addendum 29, *242-S Evaporator Steam Condensate Stream-Specific Report*, reported that 6.4×10^7 L/yr (1.7×10^7 gal/yr) were discharged from that facility to the 216-U-14 Ditch. WHC-EP-0679 reported that 1.56×10^8 L/yr (4.2×10^7 gal/yr) of effluent was discharged to the 216-U-14 Ditch from the 284-W Powerhouse in 1990.

3.3.1.1 Facilities Disposing Wastes to the 216-U-14 Ditch

242-S Evaporator. The 242-S Evaporator operated from 1973 to 1980. The evaporator was designed to reduce the volume of radioactive waste from the S Tank Farm through evaporation and concentration, thereby reducing the number of double-shell tanks required to store the waste. The steam condensate from the evaporation process was diverted to the 216-U-14 Ditch and from there to the 216-U-10 Pond. Approximately 6.44×10^7 L/yr (1.7×10^7 gal/yr) were discharged to the 216-U-14 Ditch during the evaporator's operation (WHC-EP-0342, Addendum 29). A thorough review of construction drawings reveals no evidence of pipelines from the 242-S Evaporator to the 216-U-14 Ditch.

Four contributors in the 242-S Evaporator made up the waste stream: reboiler steam condensate, steam condensate and raw water from the heating and cooling jackets, purging system steam trap condensate, and vacuum pump seal water. The evaporator process did not involve the intentional addition of constituents to the waste stream or its contributors. However, because the water was used to cool or heat process vessels that served to reduce the amount of radioactive material stored in the tanks, leaks in the system could have allowed these single-shell tank contents to contaminate the condensate disposed to the 216-U-14 Ditch. No sampling data are available from the period of operation, 1973 to 1980.

284-W Powerhouse. The wastewater streams from the 284-W Powerhouse included cooling water, backflush water, condensate, water from floor drains, and overflow (WHC-EP-0342, Addendum 27, *284-W Powerplant Wastewater Stream-Specific Report*). Samples from the powerhouse streams indicate high total salt concentrations and neutral to moderately basic pH, with some metals (e.g., aluminum, nonradioactive strontium, barium, and cerium) and ions present (WHC-EP-0679). In 1990 (WHC-EP-0342, Addendum 27; WHC-EP-0679) the estimated average flow rate for the 284-W Powerhouse wastewater effluent was 1.56×10^8 L/yr (4.2×10^7 gal/yr).

2723-W and 2724-W Laundry/Mask Cleaning Facility. The AAMSR states that 570,000 L (150,000 gal) of laundry wastewater per day were discharged to the 216-U-14 Ditch. The sources from the laundry include the washing machines, dryers (condensate), floor drains, cleanouts, sinks, and the heating, ventilation, and air conditioning system. Nonradioactive and potentially radioactive clothing was washed along with respiratory protective equipment (WHC-EP-0342, Addendum 11, *2724-W Laundry Wastewater Stream-Specific Report*). Detergents could have been important in reducing the retardation factor of contaminants in soil, thereby decreasing travel times to groundwater.

U Plant Sites. The U Plant buildings contributed wastewater to the 216-U-14 Ditch from cooling water, steam condensate, facility water drains, and rainwater drains (WHC-EP-0342, Addendum 7, *UO3/U Plant Wastewater Stream-Specific Report*). Low levels of contamination in large volumes of water were expected from those sources, but for many years the effluent was not sampled or evaluated.

The UO_3 Plant was a complex of several buildings, tank farms, storage areas, and loading facilities, which included the 224-U Concentration Building. PUREX-generated liquid uranyl nitrate hexahydrate (UNH) was converted to powdered uranium trioxide (UO_3) in the 224-U Concentration Building. Cooling water from 224-U processes was discharged as effluent to the 216-U-14 Ditch.

The chemical sewer stream from the 221-U Building (U Plant) also was discharged to the 216-U-14 Ditch (DOE/RL-91-52). Sewer streams in general contain a variety of hazardous constituents, including hydrazine; sulfuric, nitric, phosphoric, and formic acids; sodium hydroxide; sodium and aluminum nitrate; cadmium; and chromium. As with other waste sites, the quantities and types of nonradiological contaminants released to the chemical sewer are difficult to quantify because they were not routinely monitored.

Tank 241-U-110 discharged condenser water to the 216-U-14 Ditch.

Additional Releases. In 1986, approximately 3,000 L (800 gal) of 50% reprocessed nitric acid (pH <2.0) was released to the 207-U Retention Basin and 216-U-14 Ditch during the transfer of acid from a 211-U storage tank to a railroad car. The total release, including dilution water, was reported at 100,000 kg (225,000 lb) and 39 to 45 kg (86 to 100 lb) of uranium (DOE/RL-91-52; Whiting 1988).

Two smaller releases of UNH also occurred in 1992. On May 30, 1992, approximately 42.8 L (11.3 gal) of UNH were released to the 207-U Retention Basin and the 216-U-14 Ditch, releasing between 9 and 12 kg (21.6 and 26.4 lb) of uranium and 16.3 and 19.6 kg (36 and 43 lb) of uranyl nitrate. An incident on October 19, 1992, led to the discharge of approximately 11,171 L

(2,952 gal) of effluent to the 207-U Retention Basin, containing 7.3 kg (16.1 lb) of uranium. The mass of uranium discharged to the 216-U-14 Ditch at the outlet from the 207-U Retention Basin was reported as 3.5 kg (7.7 lb).

Pipelines Connected to the 216-U-14 Ditch. As stated in Chapter 2.0, several pipelines carried effluent from the discharge sources to the 216-U-14 Ditch. Wastewater from the 284-W Powerhouse and associated buildings and the 2723-W and the 2724-W Laundry/Mask Cleaning Facility entered the ditch via a common pipeline (Hanford Site Drawing M-2904-W, sheet 14). This pipeline system is now WIDS site 200-W-102 and is part of the 200-CW-5 OU. This pipeline increased in diameter as it progressed to the ditch. At the exit point from the 2723-W Mask Cleaning Station, the VCP pipeline is 20 cm (8 in.) in diameter; increasing to 25.4 cm (10 in.) diameter as it passes the 2724-W Laundry. It becomes an 81.2 cm (13-in.)-reinforced-concrete pipe (RCP) near the 282-W Reservoir; finally increasing to 107 cm (42 in.) after it passes the 282-W Reservoir. A manhole is located where the 107 cm (42-in.) RCP pipeline connects to the ditch at a wing headwall.

Cooling water from the 224-U Concentration Building was discharged through a 61 cm (24-in.) VCP (Hanford Site Drawing M-2904-W, sheet 19) into the 207-U Retention Basin. Effluent exited the 207-U Retention Basin through another 61 cm (42-in.) VCP and was discharged to the ditch via a culvert, then ran under 16th Street. A manhole is located immediately west of the 207-U Retention Basin.

Chemical sewer wastewater, steam condensate, and cooling water from the 221-U and 271-U Buildings were discharged through a 46 cm (18-in.) VCP that was south of and parallel to 16th Street (Hanford Site Drawing M-2904-W, sheet 19). A manhole is located 114.3 m (375 ft) from the timber headwall where the pipeline discharged to the ditch.

Condenser water from Tank 241-U-110 was discharged through a pipeline that connected to the 216-U-14 Ditch immediately south of 16th Street (Hanford Site Drawing H-2-31374, *MK-2X Details*). No information is available regarding the pipeline's type or size.

3.3.1.2 Summary of Previous 216-U-14 Ditch Characterization

In 1986, uranium concentrations in the groundwater below the ditch were slightly elevated, indicating that some uranium had migrated through the vadose zone (DOE/RL-91-52). By 1993, uranium concentrations in the groundwater below the ditch had declined below the drinking water standard of 20 p/b. The concentrations were still slightly elevated in 1995 (see Figure 3-3 in this document and WHC-EP-0573-4, *Westinghouse Hanford Company Operational Environmental Monitoring Annual Report, Calendar Year 1995*). The U Plant AAMSR (DOE/RL-91-52) reports that gamma logs acquired in 1986 and 1987 from six wells near the 216-U-14 Ditch showed that radionuclide contamination may be present in the upper 12 m (40 ft) of the wells, with a series of distinct peaks at depths of 4.3 and 11.9 m (14 and 39 ft) in well 299-W19-93.

The ditch bottom was sampled in 1987 to determine the effects of the accidental release of reprocessed nitric acid that occurred in 1986. Samples taken from three vadose zone wells showed uranium at levels only slightly above background. Data from core samples taken from the center of the ditch suggest that the uranium sorbed to sediments in the ditch bottom (WHC-SD-EN-AP-111, *Groundwater Impact Assessment Plan for the 216-U-14 Ditch*, Appendix A, "Impact of the Uranium Release [August 6, 1986] to the 216-U-14 Ditch," Westinghouse Hanford Company Internal Memo #65631-87-054, from R. C. Routson to V. W. Hall, July 8, 1987). A maximum of 185 pCi/g of uranium was measured in a core taken at depths of 15 cm to 30 cm (6 to 12 in.).

Three test pits were excavated to 3 m (10 ft) in March 1992 to support the development of WHC-SD-EN-AP-111. These pits were located in the section of the ditch between Cooper Avenue and the 216-U-10 Pond. This portion of the ditch was still active and received cooling water from the 224-U Plant; thus the test pits were excavated through approximately 0.6 m (2 ft) of standing water. Data collected from the excavations indicated that radiological contamination was concentrated within a few feet of the bottom of the ditch. Table 3-2 summarizes the maximum concentrations of radiological contamination detected. Test pit samples were not analyzed for metals or organic constituents.

WHC-EP-0698 continued the characterization of the 216-U-14 Ditch, using historical information and sampling from three groundwater monitoring wells, two perched water monitoring wells, and three additional test pits constructed for that purpose. Table 3-3 lists the results of the WHC-EP-0698 historical data and characterization sampling for selected contaminants in test pits, well sediments, the perched water zone, and groundwater. For some contaminants, the upgradient concentrations in groundwater also are presented. Overall, the conclusions in WHC-EP-0698 are as follows.

- Arsenic is slightly elevated in groundwater to maximum levels of 22 p/b (unfiltered water from the perched water zone) and 14 p/b in filtered groundwater.
- Aroclor-1254[2] was detected in only one sample, at 7 p/b from a depth of 1.8 m (6 ft) in a test pit.
- Carbon tetrachloride was not detected in sediments or perched water, but was detected at a maximum concentration of 140 p/b in groundwater below the U Pond and a maximum concentration of 17 p/b below the 216-U-14 Ditch.
- Cesium-137 was found almost entirely within 0.3 m (1 ft) of the ditch bottom; the highest concentration (2,740 pCi/g) was in the eastern end of the ditch. This is in contrast to the findings of WHC-EP-0707, which found the highest Cs-137 concentrations near the 216-U-10 Pond.
- Plutonium-238/239/240 contamination was detected at a maximum concentration of 10 pCi/g in ditch sediments, but was not detected in the perched water zone.

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[2] Aroclor is an expired trademark.

- Strontium-90 was observed in the perched water zone at the eastern end of the ditch at concentrations up to 24.6 pCi/g, but was not detected in the groundwater; sediment samples showed up to 6.6 pCi/g at depths up to 17 m (57 ft).
- Uranium-238 concentrations were highest within 1.2 m (4 ft) of the ditch bottom at levels up to 178 pCi/g. Below 1.2 m (4 ft), the maximum concentration was 7 pCi/g. Uranium-238 was found in the perched water zone in concentrations of up to 42.6 pCi/L and of up to 13.5 pCi/L in groundwater under the 216-U-14 Ditch.
- The maximum thickness of the perched water zone was 17 m (56 ft) below the eastern end of the ditch; the perched water zone is limited to the vicinity of the ditch.
- Subsurface contaminants that are attributed to the 216-U-14 Ditch are Am-241, arsenic, aroclor-1254, bis-(2-ethylhexyl) phthalate, Cs-137, Co-60, gross alpha, gross beta, manganese, plutonium, Sr-90, Tc-99, and U-238.
- Arsenic, cobalt-60, gross alpha, gross beta, manganese, Sr-90, and U-238 extended to the perched water zone. Arsenic, Co-60, gross alpha, gross beta, and manganese were detected in water samples from this zone; Sr-90 and U-238 were detected in soil samples.
- Only arsenic, carbon tetrachloride, manganese, and U-238 were detected in the groundwater.

Below a portion of the 216-U-14 Ditch, south of the 207-U Retention Basin, is an area of perched water above impermeable layers in the Plio-Pleistocene unit (DOE/RL-91-52). WHC-EP-0573-4 reported that water in the perched monitoring wells had drained away after input to the ditch was terminated. Anomalous occurrences of arsenic and Sr-90 were detected in these wells, suggesting that some contaminants had migrated through the soil column (WHC-EP-0573-4). Perched water also was detected in boreholes at the 216-U-14 Ditch in the section between the U Pond and Cooper Avenue. Seven contaminants were identified in soil samples collected from this perched water zone: arsenic, Co-60, gross alpha, gross beta, manganese, Sr-90, and U-238 (WHC-EP-0698).

RHO-CD-1119, *Radionuclide Distributions in Soils of the U-Pond Disposal System*, and WHC-EP-0707 sampled soil from the ditch and reported concentrations of Cs-137, Co-60, Sr-90, and Pu-239/240 from upgradient and downgradient of the 207-U Retention Basin outfall. For cesium, the contamination levels in samples from the ditch immediately upstream of the 216-U-10 Pond were higher than those found upgradient of the 207-U Retention Basin, which had a maximum value of 5,430 pCi/g (decayed to 3,509 pCi/g in 1999). Unlike cesium concentrations, Eu-154 concentrations were higher in the upper part of the ditch (36.9 pCi/g, decayed to 8.3 pCi/g in 1999). Strontium-90 was not as widespread or as well sampled for as Cs-137. Strontium-90 observed concentrations were consistently lower than those of Cs-137.

RHO-HS-EV-4, *Environmental Characterization of 216-U-14 Ditch*, collected 21 samples of the sediment in the bottom of the ditch at a depth of 5 to 30 cm (2 to 12 in.) from the head end to the outflow into U Pond. The conclusions were as follows.

- Cesium-137 contamination levels averaged 371 pCi/g (decayed to 245 pCi/g in 1999). Cesium concentrations tended to be higher in the western half of the ditch (west of Cooper Avenue) than in the eastern half.

- Cobalt-60 contamination levels averaged 33.5 pCi/g (decayed to 3 pCi/g in 1999).

- Total uranium contamination levels averaged 9.9 pCi/g.

Surface radiation surveys (DOE/RL-95-106) indicate that the greatest degree of surface contamination is near the 207-U Retention Basin.

HNF-1744 compiled and calculated the decayed inventory of many 200 Areas waste sites, including the 216-U-14 Ditch. HNF-1744 reported a contaminant volume of 1.22×10^9 L (3.22×10^8 gal) released to the site. The associated radionuclide inventory is shown in Table 3-4. However, as noted earlier, this total volume conflicts with information reported in WHC-EP-0698, which reports volumes disposed to the 216-U-14 Ditch annually from initial use to 1993. Thus, the radionuclide inventory shown in Table 3-4 may underestimate the quantities present.

DOE/RL-95-106 reports a contaminated soil volume for the 216-U-14 Ditch of 26,600 m^3 (34,800 yd^3) and an excavated soil volume of 85,540 m^3 (65,400 yd^3). The contaminated soil volume is based on a contamination area 2.4 m (8 ft) deep, 8.5 m (28 ft) wide, and 1,700 m (5,600 ft) long. The depth of 2.4 m is based on a vertical extent of contamination 1.2 m (4 ft) below the bottom of the ditch. Figure 3-1 (taken from DOE/RL-95-106) shows an estimated lateral extent of contamination for the waste sites in the 216-U-10 Pond system (including the 216-U-14 Ditch), based on a preliminary remediation goal (PRG) of 100 mrem/yr. Figure 3-1 is provided for information only and does not assume a PRG for these sites. Also, the waste site dimensions given in Figure 3-1 differ from those used in Table 2-1, which were obtained from WIDS.

No ecological data were collected for this site as part of the 200-UP-2 LFI (DOE/RL-95-13). However, soil and vegetation samples have been collected near the 216-U-11 Ditch as part of the near-facility environmental monitoring at Stations 004 and 031. The 1998 analytical results are presented in Appendix B, Table B-2.

3.3.2 216-Z-11 Ditch

The 216-Z-11 Ditch is not as thoroughly characterized as the other representative sites. The 216-Z-11 Ditch parallels the 216-Z-1D and 216-Z-19 Ditches and may be difficult to clearly distinguish from these other ditches in the field, because the ditches overlap in sections and all have been backfilled by a uniform soil cover. The total volume discharged to the site is not known, but WHC-EP-0707 reported that from 1969 to 1971, 6.7×10^8 L (1.77×10^8 gal) of water were released to the ditch. This area is reported as a TRU-contaminated soil site in WIDS and in (DOE/EIS-0113,*Disposal of Hanford Defense High-Level, Transuranic and Tank Wastes, Final Environmental Impact Statement.*

3.3.2.1 Facilities Disposing to the 216-Z-11 Ditch

The 231-Z Building was the site of the Plutonium Isolation Facility and was used to condense plutonium nitrate solution from the separations facilities into plutonium paste from 1945 to 1949. The building housed laboratories and offices after 1949. Effluents from this building were cooling water, steam condensate, and laboratory waste (DOE/RL-91-58).

The 234-5Z Building (PFP) converted plutonium nitrate solutions to other usable forms of plutonium. Discharges consisted of cooling water and steam condensate assumed to contain plutonium and other TRU elements (DOE/RL-91-58).

The 291-Z Building was an airflow emission stack. Effluents that were discharged from this facility included cooling and vacuum pump seal water (DOE/RL-91-58).

Pipelines Connected to the 216-Z-11 Ditch. As stated in Chapter 2.0, several pipelines connected discharge sources to the 216-Z-11 Ditch. Steam condensate and laboratory waste from the 231-Z Building entered the ditch via a 46 cm (18-in.)-diameter VCP (Hanford Site Drawing H-2-10011). A manhole to the pipeline is located approximately 61 m (200 ft) south of 19^{th} Street. Process cooling water and steam condensate from the 234-5Z Building and vacuum pump seal water and cooling water from the 291-Z Building entered the ditch via a 38 cm (15-in.) VCP process sewer (Hanford Site Drawing H-2-32528). The pipeline contains three manholes (Hanford Site Drawing H-2-14035, *Permanent Plot Plan 234-5 Building*). A 30 cm (12-in.) storm sewer also was connected to the ditch from an elevated water tank immediately south of the 234-5Z Building (Hanford Site Drawing H-2-32528).

3.3.2.2 Summary of Previous 216-Z-11 and Related Ditches Characterization

A characterization study of the 216-U-10 Pond and 216-Z-19 Ditch was conducted in 1980 and was published in 1994 (WHC-EP-0707). During this characterization work, the 216-Z-19 Ditch was active. Two deep monitoring wells and 17 shallow exploration boreholes were drilled along the 216-Z-19 Ditch and its two predecessors (216-Z-1D and 216-Z-11). The shallow exploration boreholes were drilled to locate the backfilled 216-Z-1D and 216-Z-11 Ditches and to sample for radioactive contamination present in the sediment. Limited analytical data exist for these boreholes; contamination estimates from the data and ditch locations were considered by the authors to be only rough approximations. However, in the absence of any other data sources, the data are provided for use in locating contamination "hot spots" and assessing vertical contaminant distribution and approximate concentrations.

This paragraph provides an overview of the data collected from these shallow exploration boreholes dug in the Z-Ditches (WHC-EP-0707). Four shallow exploration boreholes were dug in the area of the 216-Z-11 Ditch. Approximately 60 m (197 ft) from the outfall of the 234-5Z Building, samples taken at a depth of 0.9 m (3 ft) indicate a contamination level of 40,000 pCi/g of Pu-239/240. Six additional exploration boreholes were believed to have been located above the 216-Z-1D Ditch. Data from a borehole located approximately 160 m (525 ft) from the 234-5Z outfall in the 216-Z-1D Ditch showed Pu-239/240 contamination concentrations of 380,000 pCi/g at a depth of 2.1 m (6.9 ft) bgs. This depth was the previous bottom of the ditch (sediment and vegetation layer); the material above the former ditch bottom consisted of backfill added when the 216-Z-11 and 216-Z-19 Ditches were constructed. Another borehole

380 m (1,247 ft) from the 234-5Z outfall indicated 270,000 pCi/g of Pu-239/240 at a depth of 2.4 m (7.9 ft). The geology of these boreholes is documented as "slightly silty, slightly pebbly, medium to very fine sand, and decayed vegetation." Because plutonium has a very high K_d value, the plutonium probably adsorbed to the fine-grained soil and the decayed organic matter in the ditch bottom. Contaminant concentrations decrease rapidly with depth. Near-surface (<1 m [3.2 ft] deep) contamination data show one area of very high contamination near the U Pond delta area of 13,000,000 pCi/g of Pu-239/240. This sample was taken while the U Pond delta area was in operation.

WHC-EP-0707 reported historical plant operations estimates of plutonium inventory in the Z-Ditches that were based on Z-Plant discharge records. The historical inventory estimates were 8,075 g of plutonium in the 216-Z-11 Ditch, 138.5 g in the 216-Z-1D Ditch, and 143.0 g in the 216-Z-19 Ditch. However, WHC-EP-0707 indicated that these inventory values might be erroneous for four reasons.

- Calculations of Pu-239/240 could have been excessively high because of unknown amounts of Pu-239/240 in the waste streams.
- Assays of the waste streams from the Z Plant facilities were performed mostly by alpha count. Conversions of plutonium activity to weight from alpha counts could cause the contaminant concentrations to be overestimated.
- Periodic sampling of the waste streams could have missed some intermittent plutonium discharges, leading to a low estimate of plutonium concentration in the waste streams.
- In the early 1960s, during the Space Nuclear Auxiliary Power program, no plutonium releases to the 216-Z-11 Ditch were documented. In 1967, a simple estimated total of 7.86 kg for the previous years (1961 to 1967) was reported. The Space Nuclear Auxiliary Power program isolated Pu-238 and released Pu-239/240 to the 216-Z-11 Ditch as a waste product.

WHC-EP-0707 reported that previous studies had not been able to determine whether the plutonium discharged to the Z-Ditches was bound up in the sediments or eventually made its way to the 216-U-10 Pond. Most of the plutonium documented in their study was concentrated in the first 50 cm (20 in.) of soil in the ditch bottom, but contamination extended to depths of at least 6 m (19.7 ft) at very low concentrations. Americium-241 is reported to be the second dominant radionuclide in the ditch, with low concentrations (<1 pCi/g) at a depth of least 11 m (36 ft) below the neighboring 216-Z-19 Ditch.

WHC-EP-0707, Appendix A, included an analytical report from 1959 of total alpha and plutonium contamination in soils from the 216-Z-1D Ditch (known at that time as the 234-5 Ditch). The samples were collected at the inlet to the ditch and at 30 m (100-ft) intervals along the ditch (three samples at each 30 m [100-ft] interval; one sample at 0.3 m [1 ft] from the ditch edge, one at 0.9 m [3 ft] from the edge, and one at 1.5 m [5 ft] from the edge). Samples also were collected at 30 m (100-ft) intervals around the shore of the 216-U-10 Pond. The contaminant distribution generally decreased with increasing distance from the inlet, but the maximum reported concentration was 240 m (800 ft) from the inlet to the ditch. The three reported concentrations at any 30 m (100-ft) sampling interval varied up to three orders of magnitude, showing the heterogeneous nature of contaminant distribution.

Based on the 1959 sampling data, the results of their Z-Ditch characterization, and information obtained when the head end of the 216-Z-1D Ditch was mistakenly unearthed during excavation of the 216-Z-19 Ditch, WHC-EP-0707 concluded that the historical plant operations inventory estimates for the Z-Ditches were erroneous. The conclusion was that the 216-Z-1D Ditch likely contains from 3 kg to 10 kg of plutonium, with both the 216-Z-11 Ditch and the 216-Z-19 Ditch inventories an order of magnitude lower.

DOE/EIS-0113 reported total plutonium inventories for the 216-Z-11 and 216-Z-19 Ditches as follows: 8.1 kg over an area of 3300 m^2 with an average TRU concentration of 790 nCi/g for the 216-Z-11 Ditch and 140 g over an area of 1400 m^2 with an average TRU concentration of 100 nCi/g for the 216-Z-19 Ditch (DOE/EIS-0113). A TRU-contaminated site was defined as a site at which the average concentration of TRUs in the soil exceeds 100 nCi/g based on a soil density of 1.9 g/cm^3, or a site that received more than 80 g of plutonium per 100 m^2. The plant operating inventory estimates provided the bases for the TRU-contaminated soil estimates in the final environmental impact statement (EIS).

WHC-EP-0707 reported that one groundwater monitoring well for the U Pond system was sampled in 1979; this well reached the groundwater below the Z-Ditches. Water from the well showed average concentrations of less than 17 pCi/L total alpha contamination, less than 75 pCi/L total beta contamination, 22.5 pCi/L tritium, and 12 p/m NO_3.

DOE/RL-95-106 reported a contaminated soil volume for the 216-Z-11 Ditch of 6,200 m^3 (8,100 yd^3) with an excavated soil volume of 7,000 m^3 (9,100 yd^3). The contaminated volume does not include the sections shared with the 216-Z-1D Ditch and is based on a length of 560 m (1,830 ft), a depth of 0.6 m (2 ft), and a width of 4.3 m (14 ft). However, because the 216-Z-1D, 216-Z-11, and 216-Z-19 Ditches are located so close together, a total soil volume for all three could be more useful. The estimated contaminated soil volume for all three Z-Ditches is 31,500 m^3 (41,200 yd^3) contaminated and 41,057 m^3 (53,700 yd^3) excavated (DOE/RL-95-106).

The only ecological data available from the Z-Ditches are radionuclide concentrations in mice from the 216-Z-19 Ditch. The maximum Sr-90 concentration in the mice from this site was greater than the concentrations at the 200 Areas reference location. Plutonium-239 also was detected in the mice; however, reference data were not available for comparison. One soil and vegetation sampling station is located near the 216-Z-11 Ditch. Samples from Station 008 are collected every other year as part of the near-facility environmental monitoring program (e.g., PNNL-13230). The 1998 analytical results from this station are presented in Appendix B, Table B-2.

3.3.3 216-U-10 Pond

Several facilities discharged waste streams to the 216-U-14 and 216-Z-11 Ditches and from these ditches to the 216-U-10 Pond, as described in Chapter 2.0. The total effluent volume discharged to U Pond is difficult to quantify because total volumes discharged to the 216-U-14 Ditch as reported in the literature are inconsistent, and the total volume discharged to the 216-Z-11 Ditch is not known. Yearly volumes of wastewater released to the 216-U-10 Pond as reported in ARH-2761, *Input and Decayed Values of Radioactive Liquid Wastes Discharged to the Ground in the 200 Areas through 1971*, ranged from 1.62 x 10^8 L in 1944 to 1.19 x 10^{10} L in 1956, with a total volume through 1971 of 1.17 x 10^{11} L (3.0 x 10^{10} gal).

3.3.3.1 Facilities Discharging Waste to the 216-U-10 Pond

The 216-U-10 Pond was the final destination for waste discharged via the 216-U-14 and 216-Z-11 Ditches. The individual facilities that discharged to these ditches were discussed in Sections 3.3.1.1 and 3.3.2.1.

3.3.3.2 Summary of Previous 216-U-10 Characterization

The 216-U-10 Pond system has been extensively monitored and characterized. ARH-2761 summed discharges to the 216-U-10 Pond and reported that 1430 kg (3,146 lb) of uranium, 8.1 kg (17.6 lb) of plutonium, <16.8 Ci of Sr-90, and <12 Ci of Cs-137 were discharged to the pond system from 1944 to 1971.

In 1980, a comprehensive study was conducted on the pond and its associated trenches to prepare for their eventual closure (RHO-CD-1119). RHO-CD-1119 incorporated existing data into the study and took additional samples to fill in data gaps. WHC-EP-0707 summarized the results of the RHO-CD-1119 study and contains additional data. In addition, an LFI study (DOE/RL-95-13) completed additional characterization activities, including constructing 1 borehole, 1 test pit, and 10 cone penetrometer holes; conducting a surface radiological survey; and collecting surface soil and vegetation samples.

WHC-EP-0707 collected extensive core samples from the bottom of the pond and surface samples from the perimeter of the pond (sampling performed in 1979). Cesium-137 concentrations for surface soil samples from the perimeter of the pond ranged from 1.86 to 26,200 pCi/g (1.17 to 16,548 pCi/g decayed to 1999), with an average of 4,544 pCi/g (2,870 pCi/g decayed to 1999). The highest results were near the inlet of the Z-Ditches and the 216-U-14 Ditch. WHC-EP-0707 considered Cs-137 the "index" radionuclide to determine the lateral extent of contamination. An index radionuclide is the isotope whose distribution best estimates the maximum extent of contamination. The study also concluded that plutonium, Am-241, uranium, and Sr-90 were important nuclides to note for decommissioning, but used contamination limits in the tens-of-picocuries range to determine their significance.

For well sediment data, WHC-EP-0707 concluded that Sr-90 was a better index radionuclide than Cs-137 to determine depth of contamination, because it was found in higher concentrations at depth. In well 299-W23-228 (at the confluence of the 216-U-14 Ditch and the 216-U-10 Pond), the Sr-90 concentration was 13 pCi/g in the first 10 cm of the sediment and 0.77 pCi/g at a depth of 7 m. In the same well, the Cs-137 concentration was 2,000 pCi/g at the top of the sediment layer and 0.25 pCi/g at 7 m deep.

The LFI for the 200-UP-2 OU (DOE/RL-95-13) summarized the most significant results of its investigations from historic and LFI studies as follows.

- **Historical Data**. Pond sediments showed maximum concentrations of Cs-137 and Am-241 in the northern area of the pond. Both contaminants showed measurable levels in the 0 cm to 10 cm depth of the pond bottom (while the pond was operating) and concentrations of generally less than detection limits below this depth.

- **Test Pit**. The pond bottom was found at a depth of 1.8 m (6 ft). A 15 cm (6-in.)-thick organic-rich silt layer indicated the old pond bottom. The contaminant inventory was highest in this layer:

  - Cesium-137 = 4,800 pCi/g
  - Plutonium-238 = 23 pCi/g
  - Plutonium-239/240 = 36 pCi/g
  - Stronium-90 = 190 pCi/g
  - Uranium-233/234 = 85 pCi/g
  - Uranium-238 = 88 pCi/g (Figure 3-2).

  No additional layers of contaminants from previous stabilization activities were noted in the test pit.

- **Borehole 299-W23-231**. Americium-241 and Cs-137 were elevated at the depth of the former pond bottom, and Pu-239/240 and U-233/234 were at slightly above background levels at the caliche layer in the Plio-Pleistocene unit (41.2 m to 41.8 m [135 to 137 ft]). Figure 3-2 shows the sampling results from the LFI borehole and test pit.

- **Cone Penetrometer Test**. Results included elevated readings at the pond bottom (1.8 m to 2 m [6 to 6.5 ft]) deep, with some deeper contamination. Elevated levels also were seen above the former pond bottom in some places, possibly as a result of previous stabilization activities that scraped contamination from the perimeter to the center of the pond.

- **Surface Radiation Survey**. The pond's perimeter showed the highest amount of radioactivity.

- **Surface Soil and Vegetation Sampling**. Generally low concentrations of contamination were found, but peaks of Sr-90 (415 pCi/g) were detected in a vegetation sample in the southwestern corner of the pond. Peaks of Pu-239/240 (74.9 pCi/g) also were detected in the Z-Ditch delta region.

Before the LFI was conducted for the 200-UP-2 OU, the 200 West Area U Plant AAMSR examined historical data regarding contamination at the 216-U-10 Pond. Conclusions from the U Plant AAMSR (DOE/RL-91-52) include the following.

- High plutonium values were localized in the delta region of the pond and in the lowest reaches of the 216-Z-19 Ditch (adjacent to the 216-Z-11 Ditch). The maximum Pu-239/240 concentration in the U Pond sediments was 12,500,000 pCi/g in a sample from 1980. Total plutonium concentrations may be higher because Pu-238 was not included in the value. In 1974, the highest value reported for Pu-238 was 1,144 pCi/g, with an average of 390 pCi/g for 60 samples. These contaminants were concentrated in the organic-rich former pond bottom.

- The distribution of Am-241 mimicked the plutonium distribution, but at levels an order of magnitude lower. The highest Am-241 concentration was 28,000 pCi/g in the delta region, with an average concentration of 54 pCi/g for 32 samples from the entire basin area.

- The highest concentration of total uranium in the pond sediments was 1,238 p/m, with most of the pond area bottom containing between 100 and 1,000 p/m uranium.

- The highest Sr-90 concentration in the sediments was 724 pCi/g (450 pCi/g decayed to 1999); the highest concentration of Cs-137 in the pond sediments was 19,600 pCi/g (12,400 pCi/g decayed to 1999).

- Carbon tetrachloride was not detected in sediments or the perched water, but was detected at a maximum level of 140 p/b in groundwater below the 216-U-10 Pond.

PNL-5625, *A Research Report for Rockwell Hanford Operations, Inventory and Chemical Analysis of Sediments From U Pond and S-19 Pond*, examined the levels of polychlorinated biphenyls in the 216-U-10 Pond. The highest concentration from 21 samples of the pond sediment was 1.5 p/m from the delta region, with samples from other areas in the range of hundreds of parts per billion.

Groundwater monitoring at the 216-U-10 Pond indicates uranium at approximately 20 μg/L beneath the 216-U-10 Pond, indicating movement of uranium from the pond through the vadose zone (WHC-EP-0573-4). WHC-EP-0707 reported 1980 groundwater sampling results and found uranium at 41 pCi/L in well 299-W18-15 below U Pond, but provided no results for uranium in perched water from well 299-W23-228. Other 1980 radionuclide sampling results for well 299-W18-15 from WHC-EP-0707 were 32 pCi/L total alpha contamination, 2.4 pCi/L total beta contamination, <4.3 pCi/L Cs-137, <30 pCi/L Co-60, and 540 pCi/L tritium. Figures 3-4, 3-5, and 3-6 (from PNNL-12086, *Hanford Site Groundwater Monitoring for Fiscal Year 1998*) show contaminant plume maps for carbon tetrachloride, chloroform, and uranium under the 200 West Area, including the U Pond system. The chloroform plume in the 200 West Area is associated with the carbon tetrachloride plume; chloroform is a degradation product of carbon tetrachloride (PNNL-12086), which is believed to be the source of this plume.

The 200-UP-2 FFS (DOE/RL-95-106) reports an estimated contaminated volume of soil for the 216-U-10 Pond at 259,108 m^3 (338,900 yd^3), with an excavated soil volume of 265,300 m^3 (347,000 yd^3). The contaminated soil volume is based on a lateral area of 12 ha (30 acres) and a depth of 2 m (7 ft) and assumes 1.2 m (4 ft) of backfill. Figure 3-1 shows an estimated lateral extent of contamination based on an RAO of 100 mrem/yr (from the FFS). This is provided for information only; it is not provided to determine an appropriate RAO for these sites.

Ecological samples were collected from the 216-U-10 Pond as part of the LFI for the 200-UP-2 OU (DOE/RL-95-13). Plants were found to contain concentrations of copper, lead, zinc, Cs-137, Sr-90, and Pu-239 at concentrations greater than those detected from 200 Areas reference locations. Barium and vanadium concentrations were greater than those detected at the 100 Area reference locations. Concentrations of Cs-137 and Sr-90 were detected in small mammals that exceeded the 200 Areas reference locations.

Additional ecological samples are routinely collected in the vicinity of the 216-U-10 Pond as part of the near-facility environmental monitoring. Soil and vegetation data samples are collected every 2 years from Stations 001 through 004. The 1998 analytical results from these stations are presented in Appendix B, Table B-2; station locations are presented in PNNL-13230.

3.4 POTENTIAL IMPACTS TO HUMAN HEALTH AND THE ENVIRONMENT

This section describes the conceptual model developed to identify potential impacts on human health and the environment from waste sites in this group. Contaminant sources, release mechanisms, transport media, exposure route, and receptors are discussed to develop a conceptual understanding of potential risks and exposure pathways. This information will be used to support an evaluation of potential human health and environmental risk.

The largest sources of contamination at the waste sites in this work plan were major facilities (e.g., A Plant, B Plant, S Plant, T Plant, U Plant, Z Plant, and 242-S Evaporator) in the 200 Areas; lesser sources include the 2723-W and 2724-W Laundry\Mask Cleaning Facilities and the 284-W Powerhouse in the 200 West Area. These facilities routinely discharged low-level contaminated wastewater to unlined ponds and ditches. Releases to the environment have created secondary contaminant sources, which are the contaminated soils beneath the waste sites and the UPR sites. Secondary releases can occur through infiltration, resuspension of contaminated soil, volatilization, biotic uptake, leaching, and external radiation (gamma). The dominant mechanism of contaminant transport is related to infiltration. Residual moisture from effluent discharge has the potential to contaminate groundwater, because it could be migrating through the soil column by gravity drainage in some areas.

3.4.1 Human Health Risk

Potential receptors (human and ecological) could be exposed to the affected media through several pathways, including inhalation, ingestion, and direct exposure to external gamma radiation. Potential human receptors include current and future site workers and visitors (occasional users). Potential ecological receptors include terrestrial plants and animals. The conceptual exposure model for the 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 OUs is shown in Figure 3-7. Aquatic biota and surface water (Columbia River) are not included in the conceptual exposure model because the OUs contain no surface water, and groundwater contamination from these OUs is low enough that aquatic biota along the Columbia River are unlikely receptors. Future impacts to humans depend greatly on the land use. The type of future land use has been identified in DOE/EIS-0222F.

3.4.2 Ecological Risk

A screening-level ecological risk assessment for the Central Plateau waste sites was developed in 2002. Based on the results of the screening-level ecological risk assessment, the full EPA 8-step ecological risk assessment process was initiated in 2003. The U.S. Department of Energy (DOE) expects to complete the ecological risk assessment in conjunction with the ongoing RI/FS processes for the 200 Areas. The ecological risk assessment process may identify additional needs. Those needs could include soil sampling and analysis, biological studies (including sampling and analysis), or other studies. Any data needs may apply to one or more OUs. If they apply to this OU, they will be integrated with the RI/FS.

Ecological receptors have been identified and potential impacts to those receptors have been evaluated at waste sites in the 200 Areas (PNNL-13230; PNL-2253, *Ecology of the 200 Area Plateau Waste Management Environs: A Status Report*; WHC-SD-EN-TI-216, *Vegetation Communities Associated with the 100 Area and the 200 Area Facilities on the Hanford Site*). The vegetation cover on the Central Plateau is predominantly a rabbitbrush-cheatgrass and sagebrush-cheatgrass association with the incidental presence of herbaceous and annual species. Many areas are disturbed and void of vegetation or sparsely populated with annuals and weedy species such as Russian thistle. The contamination pathways to ecological exposures for the waste sites are minimized by the stabilization activities that have been conducted.

Ecological risks associated with exposure of the Great Basin pocket mouse to chemical and radiological contaminants were evaluated as part of the LFI for the 200-UP-2 OU (DOE/RL-95-13). The evaluation was conducted based on biological monitoring data (WHC-MR-0418) and modeling results using relative risks to evaluate the sites.

216-U-10 Pond. Chemicals and radionuclides were modeled from soil to the ecological receptors to estimate potential impacts on biota near the 216-U-10 Pond. No chemicals at a soil depth of 0 m to 1.9 m (0 to 6 ft) were predicted to be potentially hazardous to the mouse. Barium, copper, and zinc were found to have environmental hazard quotients (EHQ) greater than 1 for soil depths from 1.9 m to 4.5 m (6 to 15 ft). No radionuclides were found to result in a dose of greater than 1 rad/day to the mouse.

Modeling maximum concentrations measured in plants resulted in an EHQ greater than 1 for barium, copper, and vanadium. A total internal dose rate of less than 1 rad/day to the mouse was estimated from ingestion of the maximum activity measured in plant matter.

Data collected from mice living adjacent to the 216-U-10 Pond and 216-Z-19 Ditch from 1975 to 1977 (during operation) showed the highest exposure rate of 1.47 roentgens (R)/week or 0.21 R/day to the pocket mouse (PNL-2479). Soil data were collected along the same sampling transects for the mice. Results showed the highest gamma exposure of 37 mrad/yr or 0.1 mrad/day and neutron exposure of 75 R/yr or 0.2 R/day from soils 0 cm to 10 cm bgs.

216-U-11 Trench. Chemicals from the soil to the ecological receptors for the 216-U-11 Ditch biota were inferred from the modeling results from the 216-U-10 Pond, which incorporated the 216-U-10 Pond and 216-U-11 Ditch data. Radionuclides from the soil to the ecological receptor were modeled; no radionuclides were found to result in a dose greater than 1 rad/day to the mouse using soil concentrations from the 0 m to 1.9 m (0- to 6-ft) interval.

Modeling maximum concentrations measured in plants resulted in an EHQ greater than 1 for copper. A total internal dose rate of less than 1 rad/day to the mouse was estimated from ingestion of the maximum activity measured in plant matter.

216-U-14 Ditch. Radionuclides were modeled from soil to the ecological receptors to estimate potential impacts on biota near the 216-U-14 Ditch. No radionuclides were found to result in a dose of greater than 1 rad/day to the mouse for the sample interval of 0 m to 1.9 m (0 to 6 ft).

216-Z-11 Ditch. The only ecological data from the Z-Ditches are radionuclide concentrations in mice from the 216-Z-19 Ditch, therefore no modeling was conducted.

The risk modeling conducted for the 200-UP-2 LFI concluded that the ecological risk associated with the 216-U-10 Pond and 216-U-11 Ditch were considered medium, the risk for the 216-Z-11 Ditch was considered low to medium, and the risk for the 216-U-14 Ditch was considered low. Based on the ecological sampling and associated evaluations conducted at the sites in the 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 OUs, no additional site-specific ecological data are considered necessary to support the RI/FS process.

3.4.3 Summary

3.4.3.1 Environmental Information

This section introduces DOE/RL-2001-54, *Central Plateau Ecological Evaluation Report*, which serves as the basis for ecological evaluation activities in the Central Plateau. (The Central Plateau includes the 200 East Area, 200 West Area, and 200 North industrial areas and portions of the largely undisturbed 600 Area.) This section also summarizes existing OU-specific environmental information.

3.4.3.2 Central Plateau Ecological Evaluation Report

DOE/RL-2001-54 has been prepared to support ecological evaluations under the RI/FS process for Central Plateau waste sites. DOE/RL-2001-54 provides 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 (Interim Final)*. The first two steps of the process, the screening level assessment, are presented in the document (see DOE/RL-2001-54, Figure 1-1).

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 ecological evaluation document helps answer questions about the ecological resources in the Central Plateau 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 document includes descriptions of the habitats in the Central Plateau, including sensitive habitats and the plants and animals that inhabit them. The document identifies potential species of concern, including threatened and endangered species and new-to-science species. The Ecological Compliance Assessment Project conducted a detailed survey of the Central Plateau in 2000 and 2001,and it is incorporated in the ecological evaluation document. The information from the survey provides a detailed description of the ecological setting of the Central Plateau and augments the ecological information presented in this work plan.

3.5 DEVELOPMENT OF CONTAMINANTS OF POTENTIAL CONCERN

The development of the COPC list for the 216-Z-11 Ditch and refinement of the contaminants of concern (COC) list was one of the main objectives of the DQO processes for the 200-CW-5 OU. The DQO process is more fully described in Section 4.1. The preliminary list of COPCs included the complete set of contaminants that were potentially discharged to the ditch from the Z Plant, as discussed in Section 2.2. The master list of COPCs was developed during the DQO process from the Z Plant AAMSR (DOE/RL-91-58) and WHC-EP-0342, Addendum 8, *Plutonium Finishing Plant Wastewater Stream-Specific Report*. This list subsequently was evaluated against a set of exclusion criteria to enable the development of a final COC list. Chemical characteristics such as toxicity, persistence, and chemical behavior in the environment were considered. The criteria for exclusion, as detailed in the RI DQO summary report (BHI-01294), are as follows:

- Short-lived radionuclides (half-lives of less than 3 years)
- Radionuclides that constitute less than 1 percent of the fission product inventory. Historical sampling also indicates that these radionuclides have not been detected in the environment
- Naturally occurring isotopes that were not created during Hanford Site operations
- Constituents with an atomic mass greater than 242 that represent less than 1 percent of the actinide activities
- Progeny radionuclides that build insignificant activities within 50 years, and/or for which parent/progeny relationships exist that permit progeny estimation
- Constituents that have been diluted, neutralized, and/or decomposed by the facility processes (e.g., mixing constituents with large volumes of water or mixing acids and bases)
- Solid materials that could not have leaked past process tubes for release to the environment
- Chemicals in the gaseous state that cannot accumulate in soil media
- Chemicals used in minor quantities relative to the bulk-production chemicals consumed in the normal processes; these chemicals are not likely to be present in toxic or high concentrations because of their significant dilution during cooling water discharges
- Chemicals that are not persistent in the environment because of biological degradation or a natural mitigating feature.

The exclusion process resulted in a final list of RI COCs for the 216-Z-11 Ditch, which is presented in Table 3-5. The preliminary lists of COPCs and the excluded analytes and rationale for exclusion are presented in Tables 1-5 and 1-6 of the RI DQO summary report (BHI-01294). The exclusion rationale for the IDW DQO differed somewhat from that used in the RI DQO, resulting in a different list of COCs for waste designation purposes. Additional information about the COPCs is presented in the RI DQO summary report (BHI-01294) and the IDW DQO summary report (BHI-01591, *Data Quality Objectives Summary Report for the Designation of the 200-CW-5 Investigation Derived Wastes*) and Chapter 4.0 of this document.

3.6 SITE-SPECIFIC CONCEPTUAL MODELS

Site-specific conceptual models have been developed from the information presented in Chapter 3.0 for each representative waste site. These models, presented in Figures 3-8, 3-9, and 3-10, share certain waste deposition and transport properties with the generic conceptual model in Section 2.3, but have differences in their COCs, concentrations, and effect on the vertical contaminant distribution in the vadose zone. These site-specific differences are noted for each waste site in the figures.

Figure 3-1. 216-U-10 Pond System Lateral Contamination (from DOE/RL-95-106).

Waste Site Dimensions	
216-U-10 Pond	**- 12.2 hectares (30 acres)/1.8 m (6 ft.) deep**
216-U-14 Ditch	**- 1,700 m (5,600 ft.) long/1.2 m (4 ft.) deep**
216-Z-1D Ditch	- 1,311.5 m (4,300 ft.) long/.6 m (2 ft.) deep
216-Z-11 Ditch	**- 797.0 m (2,615 ft.) long/.6 m (2 ft.) deep**
216-Z-19 Ditch	- 843.3 m (2,765 ft.) long/1.2 m (4 ft.) deep
216-Z-20 Crib	- 463.3 m (1,519 ft.) long/5.5 m (18 ft.) deep
216-U-11 Trench	- 1,375.5 m (4,510 ft.) long/1.2 m (4 ft.) deep
216-U-9 Ditch	- 2,135 m (7,000 ft.) long/1.5 m (5 ft.) deep
207-U Basins	- 75 m (246 ft.) x 37.5 m (123 ft.)/2 m (6.5 ft.) deep

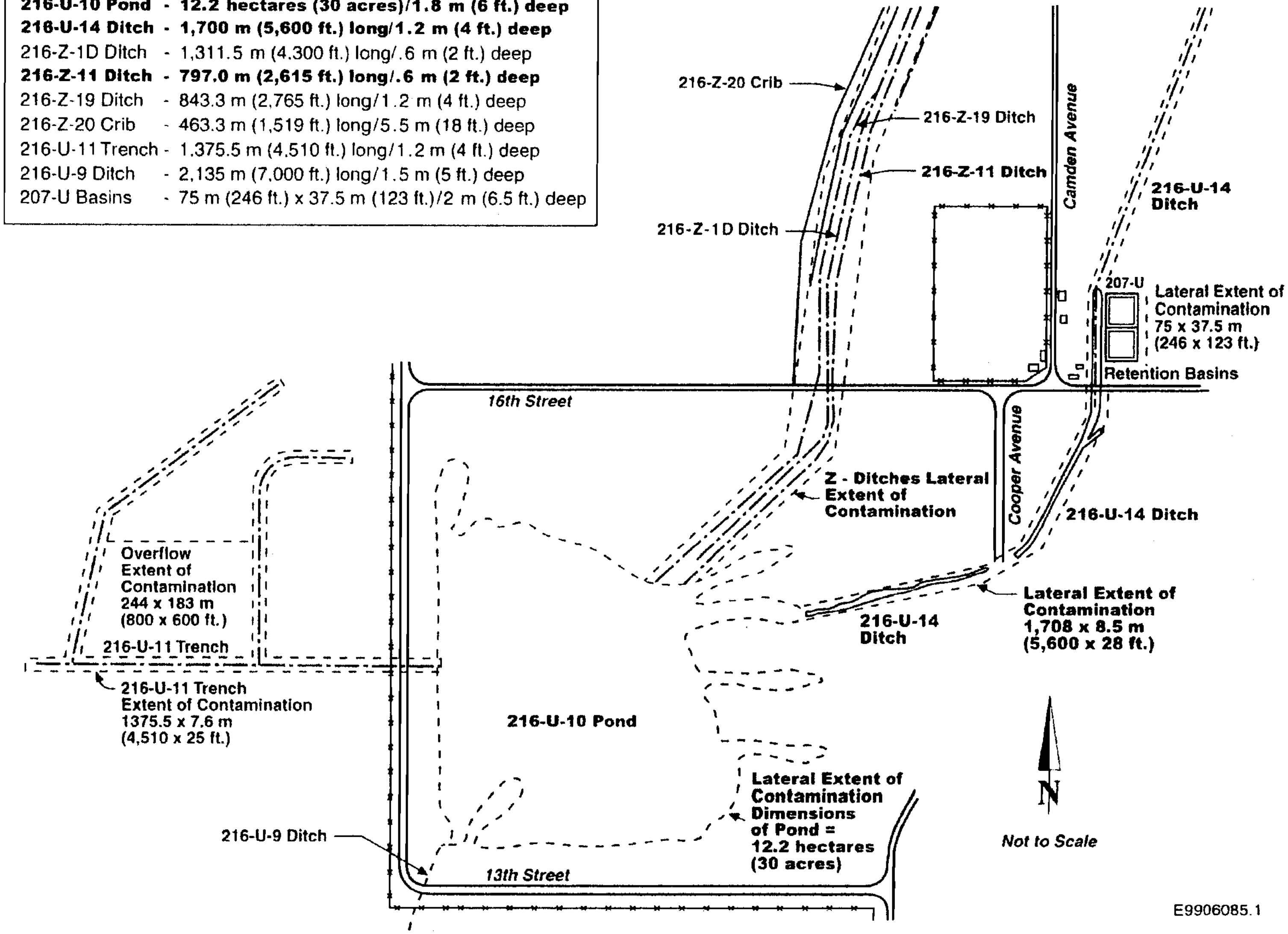


Figure 3-2. 216-U-10 Pond Borehole Data (from DOE/RL-95-106). (2 Pages)

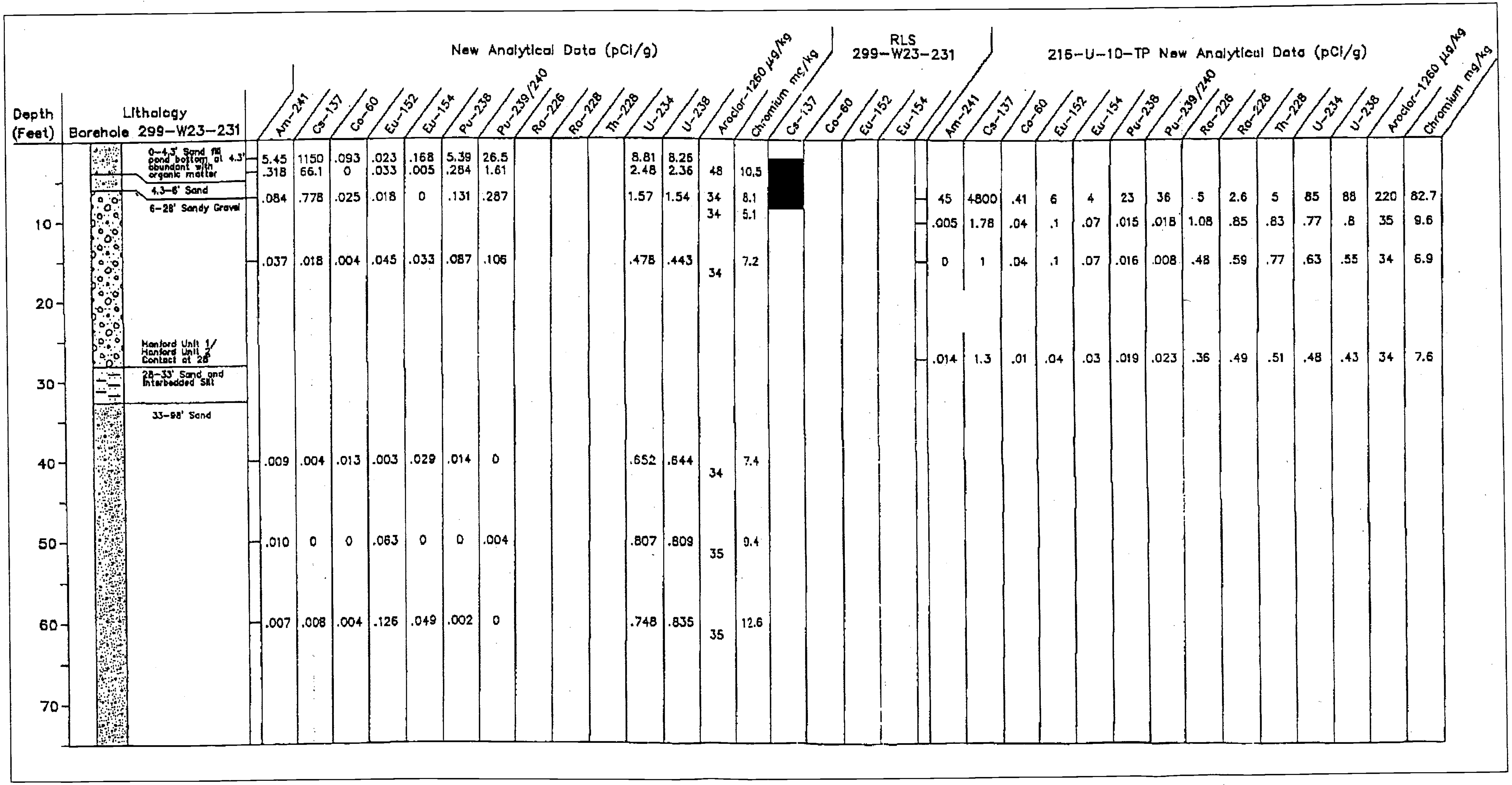


Figure 3-2. 216-U-10 Pond Borehole Data (from DOE/RL-95-106). (2 Pages)

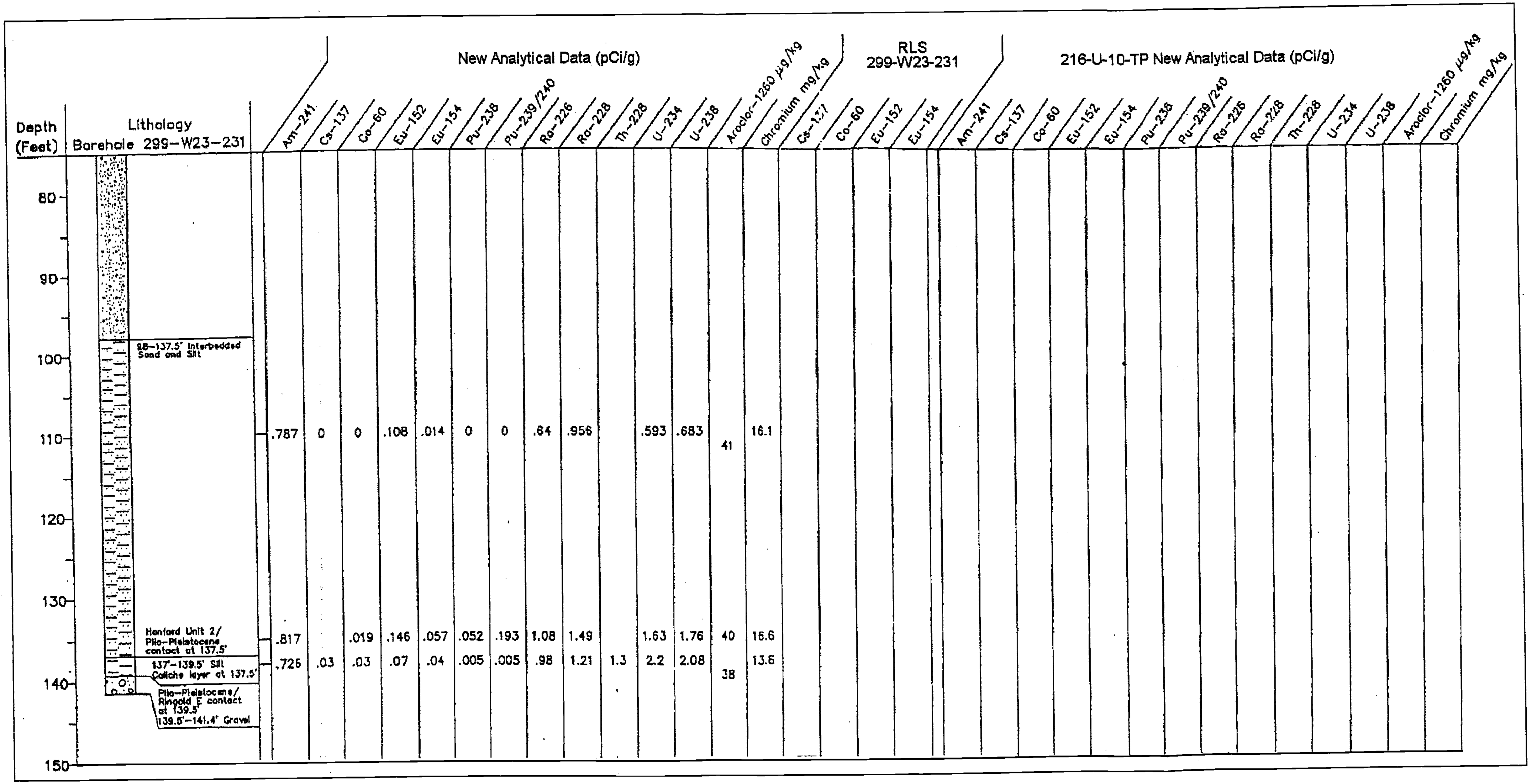


Figure 3-3. Uranium Concentration Versus Time Near the 216-U-14 Ditch.

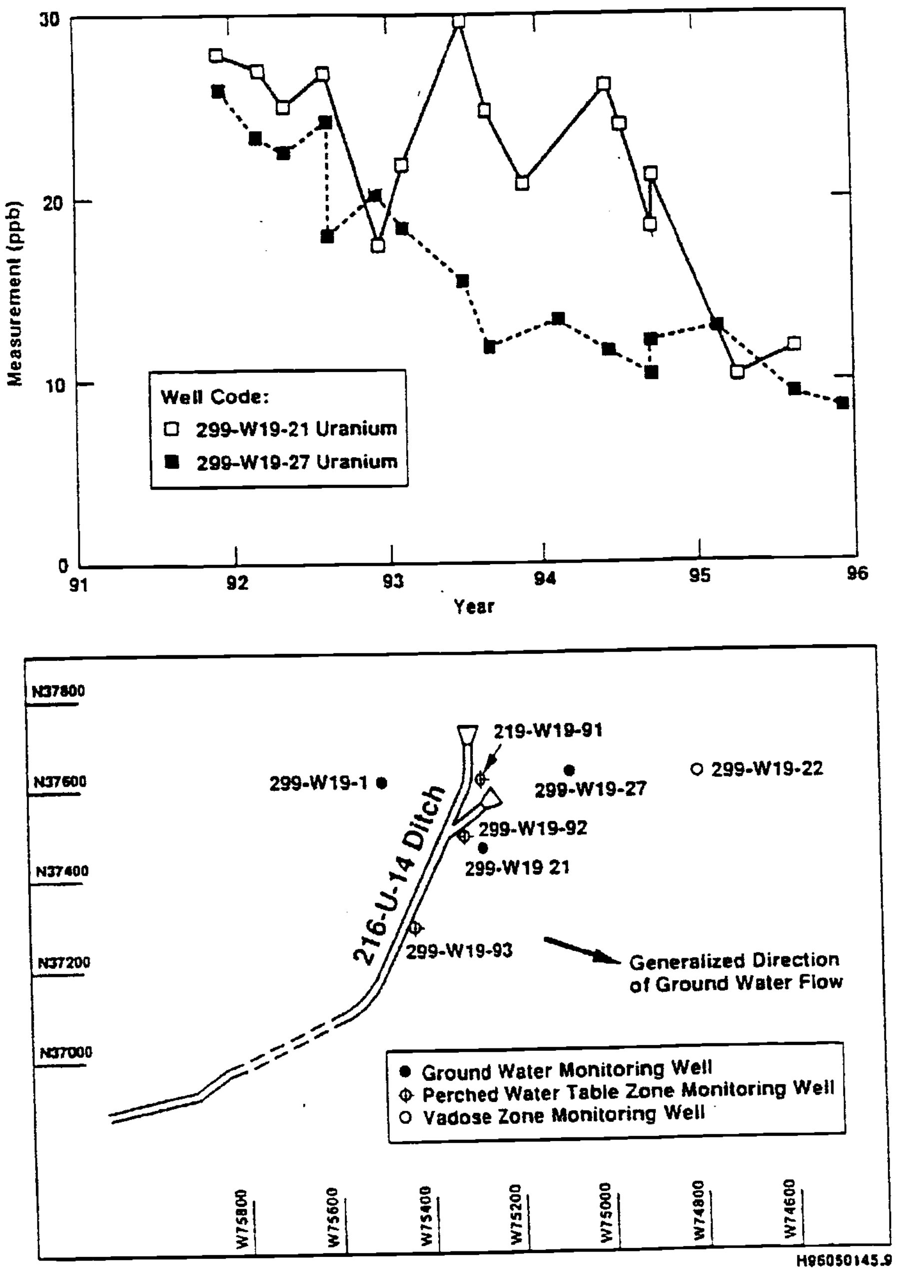


Figure 3-4. Carbon Tetrachloride Concentrations in Wells Monitoring the 200 West Area, Top of Unconfined Aquifer.

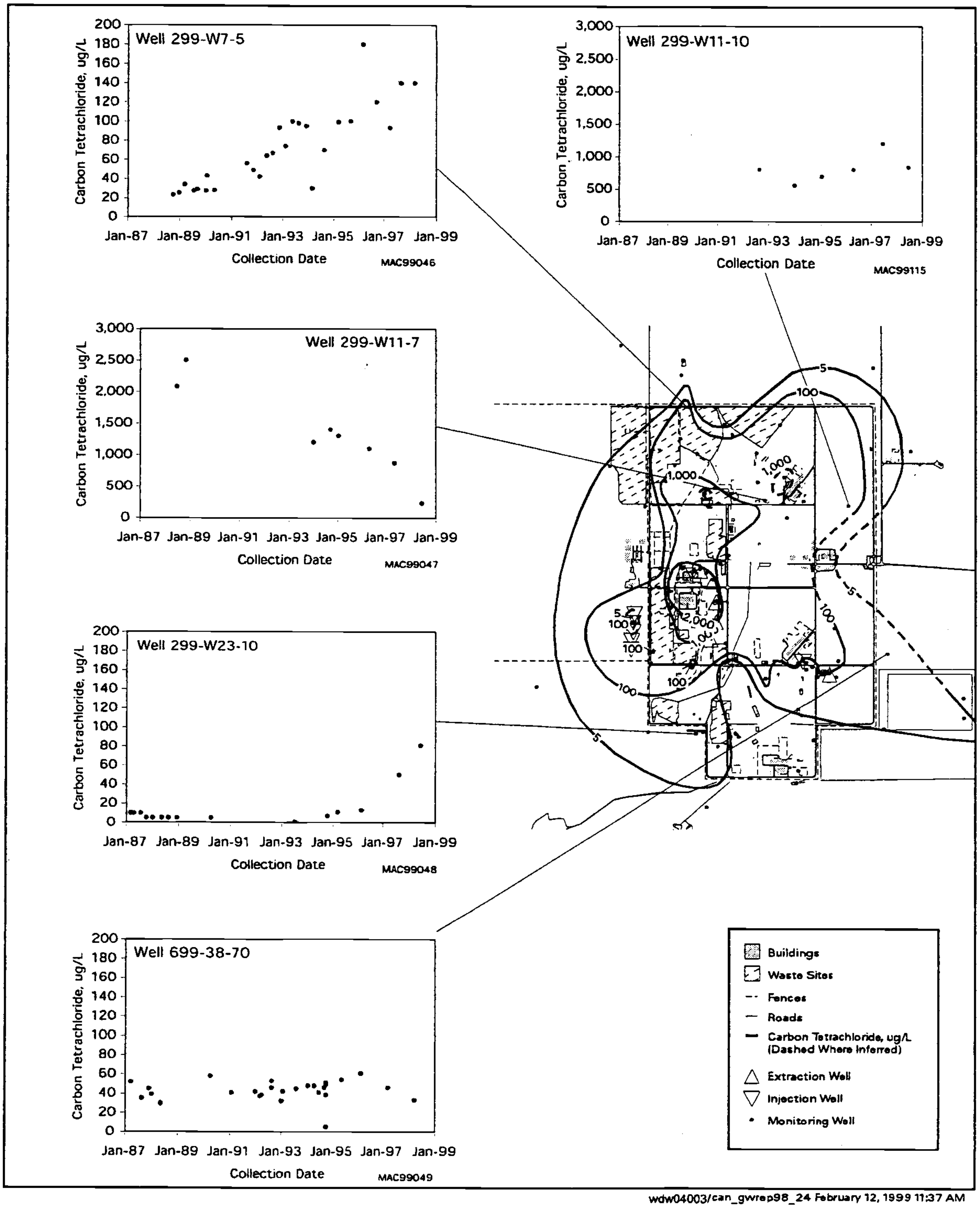


Figure 3-5. Average Chloroform Concentrations in the 200 West Area, Top of Unconfined Aquifer.

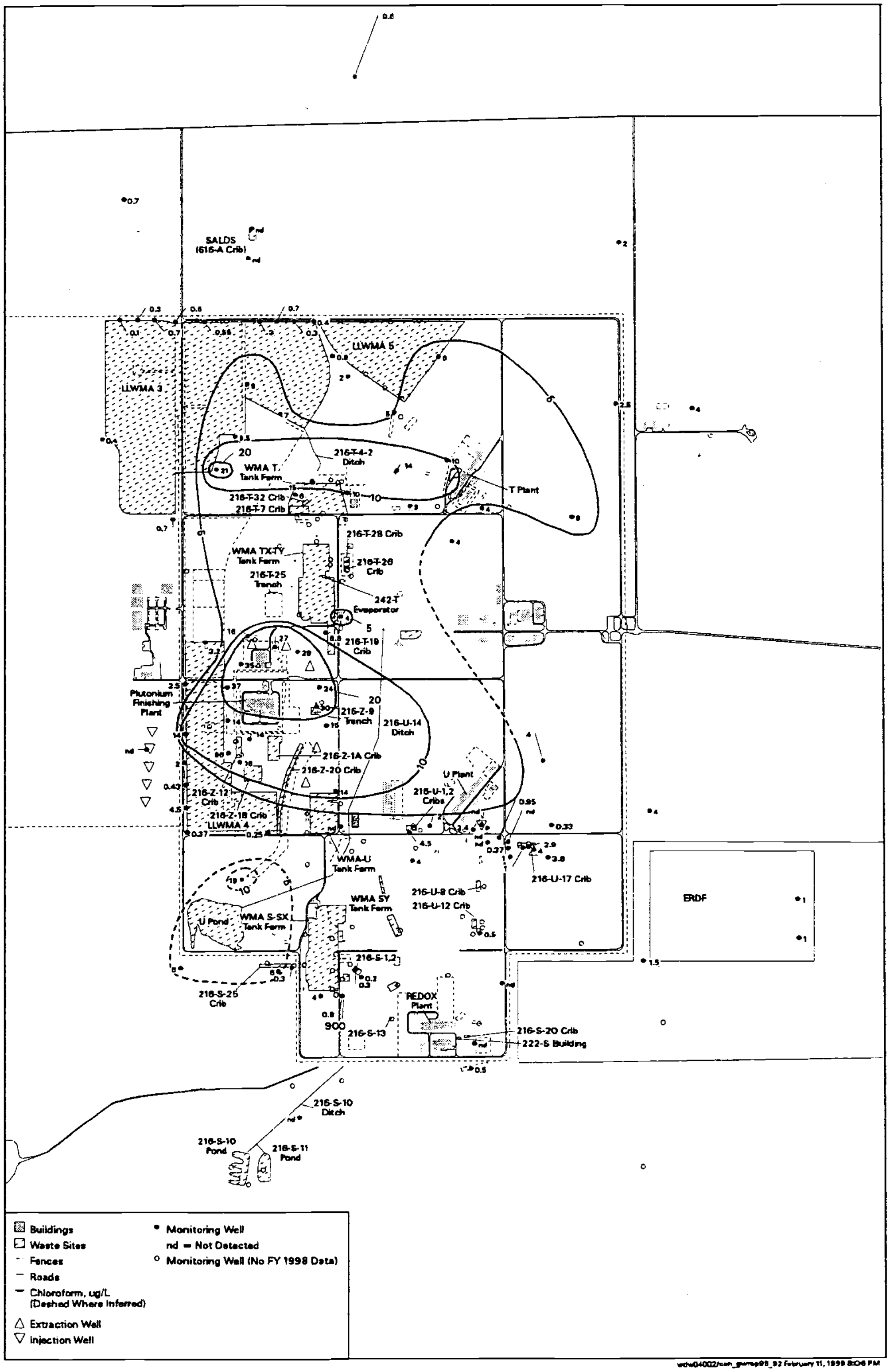


Figure 3-6. Average Uranium Concentrations in the 200 West Area, Top of Unconfined Aquifer.

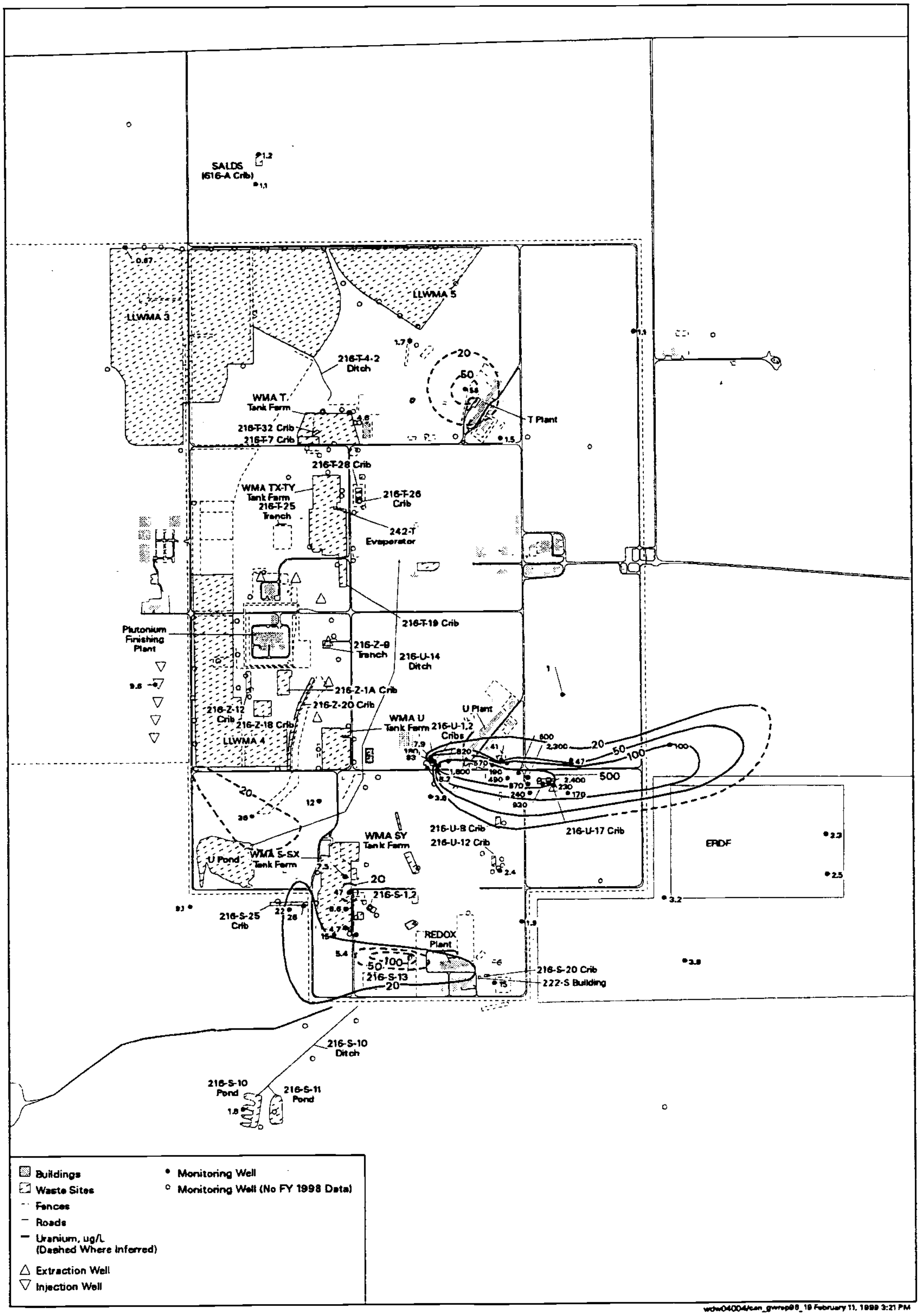


Figure 3-7. Conceptual Exposure Model for the 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 Operable Unit Waste Sites.

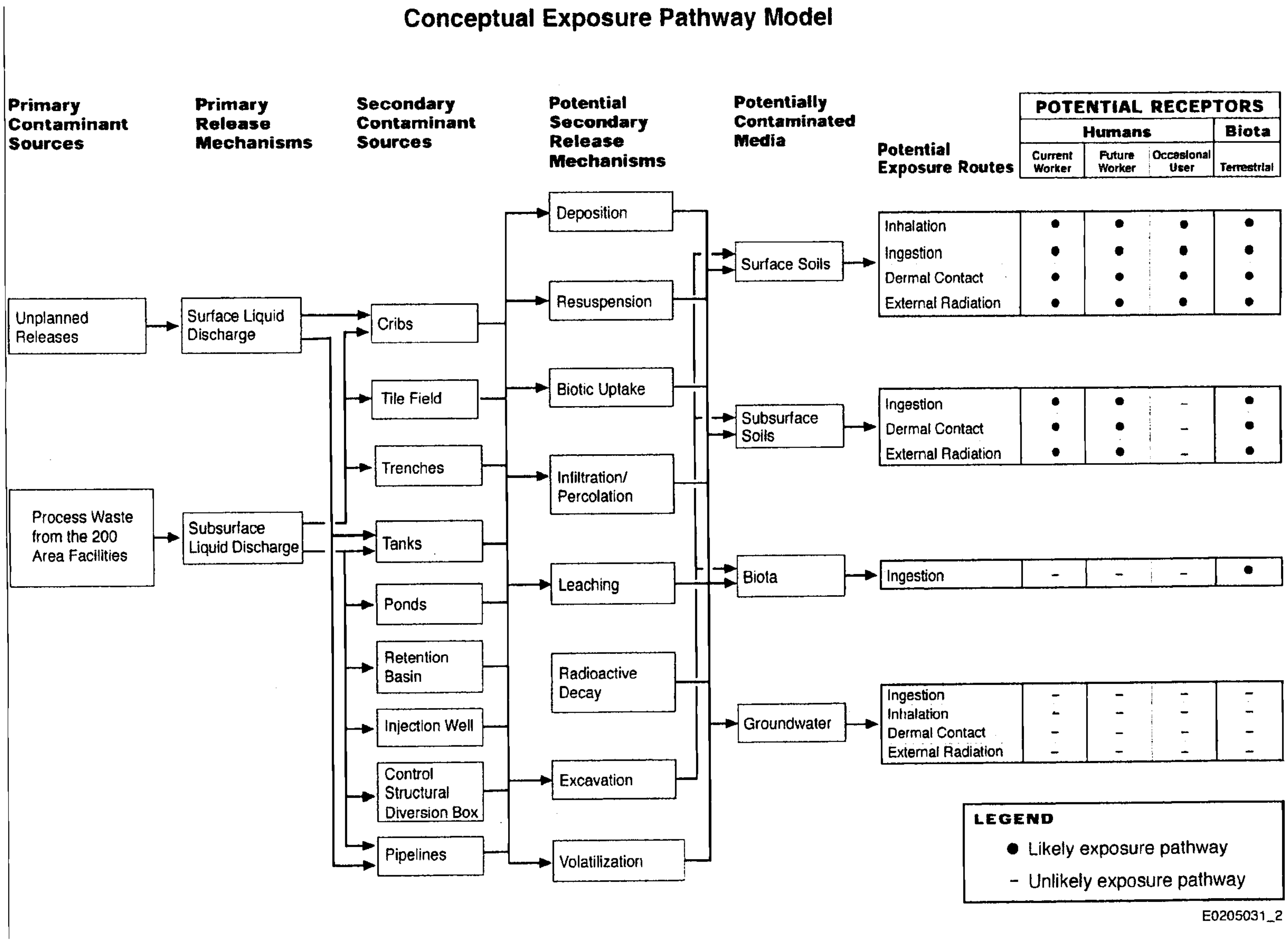
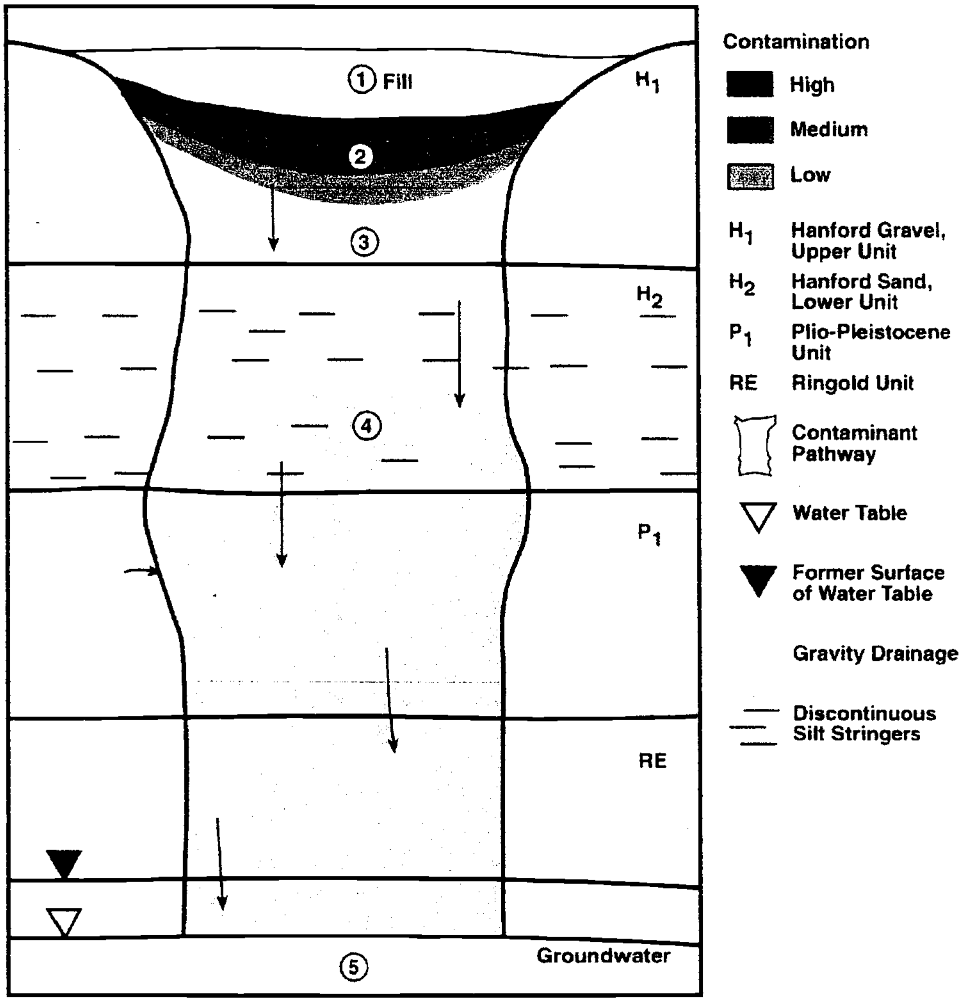


Figure 3-8. Conceptual Model of Contaminant Distribution at the 216-U-10 Pond After Cessation of Discharge.



① Site has been backfilled/stabilized with clean soil. Upward migration of contaminants has been noted in the clean fill on the Hanford site.

② Some particulates in solution (e.g.,Cs-137, Pu-239/240, uranium, Sr-90, metals, and PCB's) settled out in the bottom of the pond and sorbed to sediments. The highest concentrations are within 2 m of the pond bottom and decrease rapidly with depth. Some uranium complexed with carbonates in the soil and moved with the wetting front.

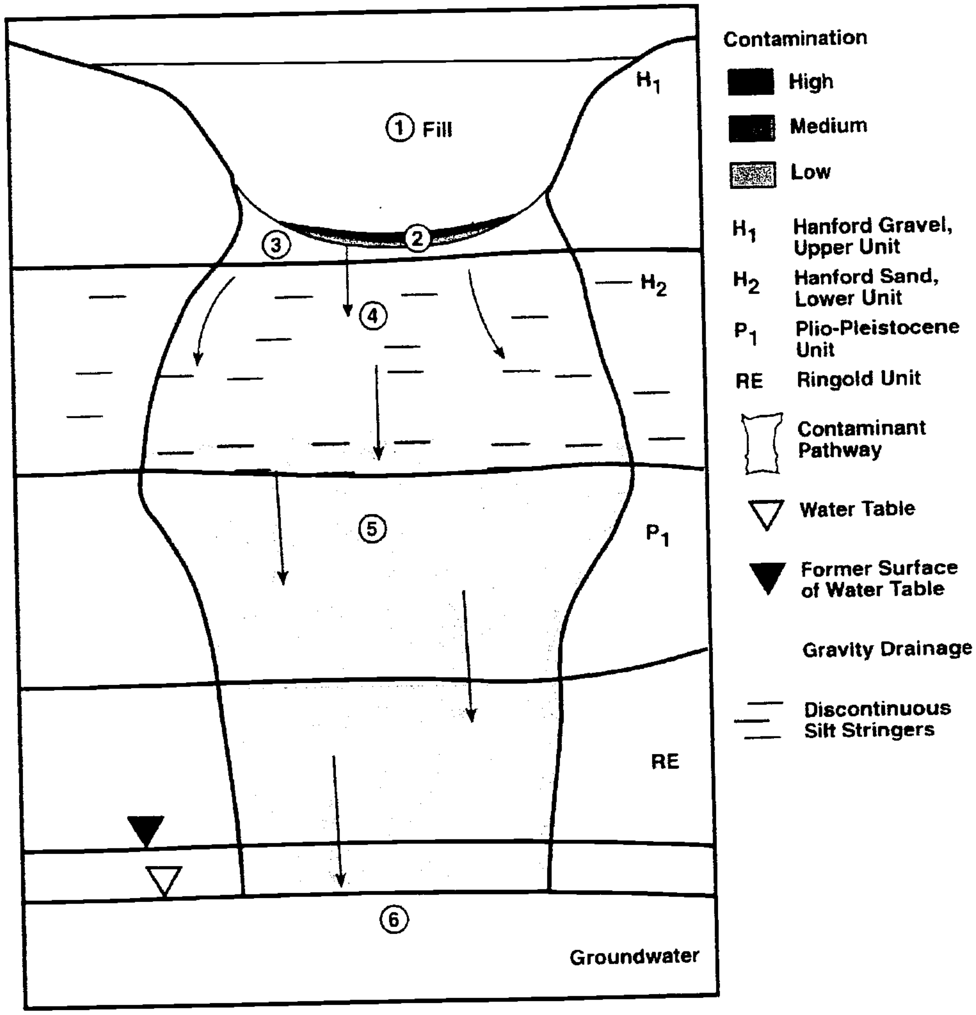
③ Contaminant concentrations are very low compared to the bottom of the pond. Uranium and Sr-90 may be detected in this zone.

④ High moisture zone. Lateral spreading within the lower unit of the Hanford formation and at the top of the Plio-Pleistocene unit. Moisture flux in this zone is decreasing over time. Wetting front moves vertically down into Ringold Unit E with gravity drainage. Residual contamination may remain in vadose zone after gravity drainage.

⑤ High volumes of liquid exceeded soil pore volumes and clastic dikes may have been mechanisms to allow low levels of contaminants to reach groundwater. Evidence suggests that uranium from the pond has impacted the groundwater.

E9906085.4

Figure 3-9. Conceptual Model of Contaminant Distribution at the 216-U-14 Ditch After Cessation of Discharge.



① Site has been backfilled/stabilized with clean soil. Upward migration of contaminants has been noted in the clean fill on the Hanford site.

② Some particulates in solution (e.g., Cs-137) settled out in the bottom of ditch. Most of the dissolved contaminants in solution sorbed to sediments within 2 m of the ditch bottom; concentrations decrease rapidly with depth. Some uranium complexed with carbonates in the soil and moved with the wetting front.

③ Contaminant concentrations are very low compared to the bottom of the ditch.

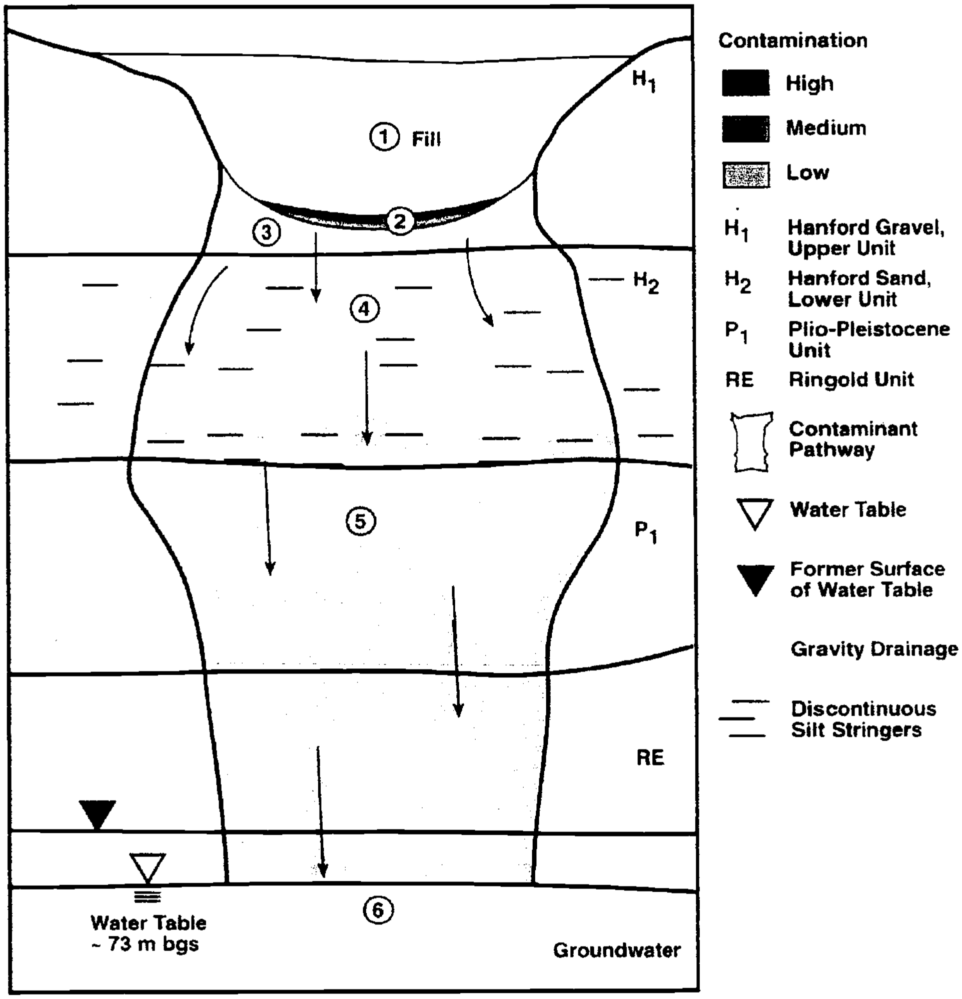
④ Lateral spreading within the lower unit of the Hanford formation and at the top of the Plio-Pleistocene unit; perched water zones formed under much of the ditch during period of active discharge. Contaminants that were detected in the perched water are: arsenic, manganese, Sr-90, Co-60, U-238, and gross alpha and beta.

⑤ High moisture zone. Moisture flux in this zone is decreasing over time as effluent is no longer discharged to the soil column. Wetting front moves vertically down into Ringold Unit E with gravity drainage. Residual contamination may remain in the vadose zone after gravity drainage.

⑥ High volumes of liquid exceeded soil pore volumes and clastic dikes may have been mechanisms to allow low levels of contaminants (e.g., manganese, U-238) to reach groundwater.

E9906085.3

Figure 3-10. Conceptual Model of Contaminant Distribution at the 216-Z-11 Ditch After Cessation of Discharge.



① Site has been backfilled/stabilized with approximately 2 m of clean soil. Upward migration of contaminants has been noted in the clean fill on the Hanford site.

② Some particulates in the effluent (e.g., Pu-239/240, Am-241) settled out in the bottom of ditch. Most of the dissolved contaminants in solution sorbed to sediments within 2 m of the ditch bottom; concentrations decrease rapidly with depth.

③ Contaminant concentrations are very low compared to the bottom of the ditch.

④ Lateral spreading within the lower unit of the Hanford formation and at the top of the Plio-Pleistocene unit.

⑤ High moisture zone. Moisture flux in this zone is decreasing over time. Wetting front moves vertically down into Ringold Unit E with gravity drainage. Residual concentrations of the more mobile contaminants may remain in the vadose zone after gravity drainage.

⑥ No contaminants have been attributed to the groundwater from the 216-Z-11 ditch.

E9910047.1

Table 3-1. Estimated Inventory for Representative Waste Sites.

Waste Site	Total U (kg)	Total Pu (g)	Am-241 (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	CCl_4 (kg)	Nitrate (kg)	Effluent Volume (m^3)
216-U-10	1.4 E+03	—[a]	—	1.2 E+01	1.7 E+01	—	—	>1.17 E+11
216-U-14	4.5 E+01	—	—	—	—	—	—	>1.22 E+09
216-Z-11	—	8.1 E+03[b]	4.92 E-01[b]	—	—	—	—	>6.7 E+08

[a] Not reported.

[b] Plutonium inventory for the Z Ditches in most documents is included with the inventory for the 216-U-10 Pond, but because most of the plutonium is expected to be remaining in the ditches; it is shown here as part of the 216-Z-11 Ditch.

CCl_4 = carbon tetrachloride

Table 3-2. Summary of Maximum Levels Detected from Three 1992 Test Pits in the West End of the 216-U-14 Ditch (from WHC-SD-EN-AP-111).

Constituent	Maximum Level Detected (pCi/g)	Depth (ft)
Am-241	1.6	0-0.05
Co-60	2.3	0-0.5
Cs-137	1600	0-0.5
Pu-238/239	2.1	0.5-1
Sr-90	6.6	5-6
Pb-214	0.1	3-4
Total U	350	0.05-1

Table 3-3. Summary of Contaminants Reported by WHC-EP-0698 at the 216-U-14 Ditch and 216-U-10 Pond. (4 Pages)

Contaminant	Location	Well 299-W18-15 (216-U-10 Pond) (min-max)	216-U-14 Ditch (1980-1992 max)	216-U-14 Ditch (1993 max)
Aroclor-1254 (p/b)	Test Pits	ND	ND	7
	Well Sediments	ND	ND	UD
	Perched Water Zone	ND	ND	UD
	Groundwater	UD	ND	UD
Arsenic (p/b)	Test Pits	ND	ND	2,200
	Well Sediments	ND	ND	3,700
	Perched Water Zone	ND	ND	22
	Groundwater	10-12	14	14

Table 3-3. Summary of Contaminants Reported by WHC-EP-0698 at the 216-U-14 Ditch and 216-U-10 Pond. (4 Pages)

Contaminant	Location	Well 299-W18-15 (216-U-10 Pond) (min-max)	216-U-14 Ditch (1980-1992 max)	216-U-14 Ditch (1993 max)
Acetone (p/b)	Test Pits	ND	ND	12
	Well Sediments	ND	ND	16
	Perched Water Zone	ND	ND	UD
	Groundwater	UD	UD	UD
Bis-(2-ethyl hexyl) phthalate (p/b)	Test Pits	ND	ND	97
	Well Sediments	ND	ND	UD
	Perched Water Zone	ND	UD	UD
	Groundwater	UD	UD	UD
Carbon tetrachloride (p/b)	Test Pits	ND	ND	UD
	Well Sediments	ND	UD	UD
	Perched Water Zone	ND	UD	UD
	Groundwater	89-140	17/8.2[a]	9.2/14
Manganese (p/b)	Test Pits	ND	ND	330,000
	Well Sediments	ND	ND	470,000
	Perched Water Zone	ND	ND	44
	Groundwater	UD/10	UD/53[a]	51/210[a]
Silver (p/b)	Test Pits	ND	ND	3,300
	Well Sediments	ND	ND	UD
	Perched Water Zone	ND	ND	UD
	Groundwater	UD	3	UD
Nitrate (p/b)	Test Pits	ND	ND	ND
	Well Sediments	ND	ND	7,000
	Perched Water Zone	ND	1,400	1,900
	Groundwater	UD-27,600	3,440/7,000[a]	600/18,000[a]
Nickel (p/b)	Test Pits	ND	ND	11,000
	Well Sediments	ND	ND	69,000
	Perched Water Zone	ND	ND	UD
	Groundwater	UD	UD	UD
Vanadium (p/b)	Test Pits	ND	ND	68,000
	Well Sediments	ND	ND	69,000
	Perched Water Zone	ND	ND	37
	Groundwater	21	40	35

Table 3-3. Summary of Contaminants Reported by WHC-EP-0698 at the 216-U-14 Ditch and 216-U-10 Pond. (4 Pages)

Contaminant	Location	Well 299-W18-15 (216-U-10 Pond) (min-max)	216-U-14 Ditch (1980-1992 max)	216-U-14 Ditch (1993 max)
Methyl ethyl ketone (p/b)	Test Pits	ND	ND	UD
	Well Sediments	ND	ND	47
	Perched Water Zone	ND	UD	UD
	Groundwater	UD	UD	UD
Pyridine (p/b)	Test Pits	ND	ND	ND
	Well Sediments	ND	ND	210
	Perched Water Zone	ND	ND	ND
	Groundwater	ND	ND	ND
Tetrahydrofuran (p/b)	Test Pits	ND	ND	UD
	Well Sediments	ND	ND	25
	Perched Water Zone	ND	UD	UD
	Groundwater	UD	UD	UD
Americium-241 (pCi/g)	Test Pits	ND	100/1.6[b]	1
	Well Sediments	ND	ND	UD
	Perched Water Zone	ND	UD	0.05
	Groundwater	UD	UD/0.77[a]	UD
Cobalt-60 (pCi/g)	Test Pits	ND	290/2.3[a]	1
	Well Sediments	ND	ND	ND
	Perched Water Zone	ND	UD	5.28
	Groundwater	UN-9.2	UD/5.93[d]	UD
Cesium-137 (pCi/g)	Test Pits	ND	1,500/1,600[d]	2,740
	Well Sediments	ND	ND	UD
	Perched Water Zone	UD	UD	UD
	Groundwater	UD-34	UD	UD
Gross alpha (pCi/g)	Test Pits	ND	ND	ND
	Well Sediments	ND	ND	ND
	Perched Water Zone	ND	182[c]	70.2
	Groundwater	23-334	26.3/6.26[a]	18.1/4.6[a]
Gross beta (pCi/g)	Test Pits	ND	ND	ND
	Well Sediments	ND	ND	ND
	Perched Water Zone	ND	413	67.8
	Groundwater	6.5-68.2	81.8/127[a]	17.7/430[a]

Table 3-3. Summary of Contaminants Reported by WHC-EP-0698 at the 216-U-14 Ditch and 216-U-10 Pond. (4 Pages)

Contaminant	Location	Well 299-W18-15 (216-U-10 Pond) (min-max)	216-U-14 Ditch (1980-1992 max)	216-U-14 Ditch (1993 max)
Plutonium-238,239,240 (pCi/g)	Test Pits	ND	2.1	10
	Well Sediments	ND	ND	UD
	Perched Water Zone	UD	UD	UD
	Groundwater	UD	UD	UD
Ruthenium-106 (pCi/g)	Test Pits	ND	ND	ND
	Well Sediments	ND	ND	ND
	Perched Water Zone	ND	49.1	68.8
	Groundwater	UD-68.3	72.8/47.1[a]	UD
Strontium-90 (pCi/g)	Test Pits	ND	6.6	1
	Well Sediments	ND	ND	0.97
	Perched Water Zone	ND	14.3	24.6[a]
	Groundwater	0.10-0.60	UD	UD
Technetium-99 (pCi/g)	Test Pits	ND	ND	12
	Well Sediments	ND	ND	ND
	Perched Water Zone	ND	UD	UD
	Groundwater	UD	3.73/521[a]	UD/1,970[a]
Tritium (pCi/g)	Test Pits	NA	NA	NA
	Well Sediments	NA	NA	NA
	Perched Water Zone	ND	537	UD
	Groundwater	42-3,200	219/1,550[a,c]	UD/582[a]
Uranium-234 (pCi/g)	Test Pits	ND	ND	ND
	Well Sediments	ND	ND	ND
	Perched Water Zone	ND	ND	14.2
	Groundwater	15.5/23.5	8.65	10.5
Uranium-238 (pCi/g)	Test Pits	ND	178	94
	Well Sediments	ND	ND	<1
	Perched Water Zone	ND	ND	42.2
	Groundwater	15.8-24.5	13.5	11/3.6[b]

[a]Upgradient concentration.

[b]Greater concentrations of the contaminant were reported before 1980; much of the contaminant burden was removed by dredging before 1980. The two values reported are 1982 and 1992 data, respectively.

[c]A data point from 1966 indicates that tritium was as high as 6,800 pCi/L.

[d]Outliers removed.

NA = not applicable.
ND = no data available.
UD = undetected.

Table 3-4. Radionuclide Inventory in the 216-U-14 Ditch, in Curies Decayed to December 31, 1998.

Tritium	Sr-90	Ru-106	Cs-137	Total U	Pu-239/240	Am-241	Total Alpha	Total Beta
2.08	5.34×10^{-2}	2.84×10^{-13}	5.74×10^{-2}	6.38×10^{-2}	1.60×10^{-4}	2.86×10^{-4}	3.11×10^{-2}	2.45×10^{-1}

Table 3-5. List of Contaminants of Concern for the 216-Z-11 Ditch. (2 Pages)

Final Contaminant of Concern	Rationale for Inclusion
Radioactive Constituents	
Americium-241	Process knowledge indicates potential presence. No basis for exclusion.
Cesium-137	
Cobalt-60	
Curium-243	
Europium-152	
Europium-154	
Europium-155	
Neptunium-237	Detected in Z Crib down-well logging results.
Nickel-63[a]	Present in 100 Area Decontamination and Decommissioning and remediation sites. Evaluated in 200-CW-5 OU as a precautionary measure.
Niobium-94	Process knowledge indicates potential presence. No basis for exclusion.
Plutonium-238	
Plutonium-239/240	
Radium-226	
Radium-228	
Strontium-90	
Technetium-99[a]	
Thorium-232	
Tritium[a]	
Uranium-234	
Uranium-235	
Uranium-236	
Uranium-238	
Chemical Constituents - Metals	
Arsenic	Process knowledge indicates potential presence. No basis for exclusion.
Barium	
Beryllium	
Cadmium	
Chromium	
Copper	
Hexavalent chromium	Present in sodium dichromate and potassium dichromate, which are potentially present, based on process knowledge.

Table 3-5. List of Contaminants of Concern for the 216-Z-11 Ditch. (2 Pages)

Final Contaminant of Concern	Rationale for Inclusion
Lead	Process knowledge indicates potential presence. No basis for exclusion.
Mercury	
Nickel	
Selenium	
Silver	
Zinc	
Chemical Constituents – Other Inorganics	
Fluoride	Constituent present in several compounds that were identified by process knowledge.
Nitrate	
Sulfate	
Sulfide	
Chemical Constituents - Volatile Organics	
Acetone	Process knowledge indicates potential presence. No basis for exclusion.
Acetonitrile	
2-Butanone (MEK)	
Carbon tetrachloride	
Chlorobenzene	
Chloroform (Trichloromethane)	
Dichloromethane	
Hexane	
Perchloroethylene	
Pseudo cumene (1,2,4 Trimethyl benzene)	
Tetrahydrofuran	
Toluene	
Trichloroethene	
Vinyl chloride	
Xylenes	
Semivolatile Organics	
Creosote	Process knowledge indicates potential presence. No basis for exclusion.
Cyclohexanone	
Kerosene[b]	
Normal paraffins[b]	
Paint thinner[b]	
Polychlorinated biphenyls	
Tar	
Tributyl phosphate	
Creosote	

[a]These contaminants of concern are deep zone sensitive only. No analyses are required for these in the shallow zone soils, as they are soft beta emitters in low abundance that have insignificant dose impact in the shallow zone.
[b]Analyzed as kerosene total petroleum hydrocarbons.

4.0 WORK PLAN APPROACH AND RATIONALE

4.1 SUMMARY OF DATA QUALITY OBJECTIVE PROCESS

The RI needs for the 200-CW-5 OU were developed in accordance with the DQO process (EPA/600/R-96/055, *Guidance for Data Quality Objectives Process*, EPA QA/G-4,). The DQO process is a seven-step planning approach used to develop a data collection strategy consistent with data uses and needs. The goals of the process are to provide the data needed to refine the preliminary site conceptual model and support remedial decisions.

A team of subject matter experts and key decision makers implemented the DQO process, providing input on regulatory issues, the physical condition of the sites, and sampling and analysis methods. Key decision makers from the DOE and EPA participated in developing the characterization approach outlined in the DQO summary report. The DQO process and involvement of the team of experts and decision makers provides a high degree of confidence that the right type and quality of data are collected to fulfill the RI informational needs. Results of the DQO process for characterization of the representative sites in the 200-CW-5 OU are presented in BHI-01294. During the DQO process, it was determined that the characterization data already obtained for the 216-U-10 Pond and 216-U-14 Ditch were sufficient to support the 200-CW-5 RI/FS process. Therefore, characterization activities outlined in this work plan focus only on the 216-Z-11 Ditch.

After this work plan was issued (DOE/RL-99-66, Rev. 0), the DOE Richland Operations Office, EPA, and the Washington State Department of Ecology (Ecology) thoroughly reviewed the cleanup approach that was being applied through the Implementation Plan (DOE/RL-98-28) and identified improvements to accelerate cleanup of these waste sites. As part of this risk-based approach to prioritizing work applied to the waste site cleanup, these parties agreed to consolidate the 22 process-based OUs into 12 distinct groups based on similarities between contaminant sources for the RI/FS process as documented in a modification (Ecology et al., 2002,) to the Tri-Party Agreement (Ecology et al. 1989).

This consolidation effort was accomplished by revising the 200 Areas work plans to incorporate designated analogous OUs in accordance with agreements reached among the decision-makers. Grouping the analogous OUs included preparing a detailed comparison of the consolidated OU waste sites against the conceptual models in this and other 200 Areas work plans. This was necessary to ensure that the consolidated OU waste sites would be aligned with appropriate representative waste sites and conceptual site models. Several characteristics of the consolidated OU waste sites were reviewed and compared with the representative waste sites to verify that the analogous sites were indeed similar to, and/or bounded, the representative waste sites.

The characteristics considered in the assignment of grouping analogous waste sites with representative waste sites and contaminant distribution models included the following:

- Waste site dimensions as indicated by WIDS, and physical configuration indicated by type of waste site (e.g., cribs were used to percolate waste, while ditches typically channeled waste to other waste sites)

- Vertical extent of contaminants was qualitatively compared based on calculated pore volumes and estimated effluent discharge volumes, as documented in Appendix A of the waste site groupings report (DOE/RL-96-81)

- Process information, including historical discharge operations, COCs, and physical properties, such as retardation factors, that would influence K_d values. These are illustrated by the known inventories of important radionuclides, key inorganic chemicals, and known organic chemicals released to the ground as documented in Appendix A of the waste site groupings report (DOE/RL-96-81).

The physical setting, geology, and characterization data (if available and applicable) of the analogous waste site were compared to those of the representative waste site in this evaluation. A more detailed look at earlier characterization data will be performed during the FS.

The assessment of consolidated waste sites against the 200 Areas representative waste sites is documented in Appendix C in a series of tables that provide the following information:

- Table C-1provides an overall listing of the waste sites, their WIDS classification status (accepted versus rejected), and an indication of where these sites have been placed in subsequent tables.

- Table C-2 indicates which waste sites have been rejected or reclassified by the WIDS classification procedures (per Tri-Party Agreement Guideline MP-14 [RL-TPA-90-0001]).

- Table C-3 lists the waste sites that align well with the 200-CW-5 representative waste site conceptual contaminant distribution models in this work plan.

- Table C-4 identifies waste sites that do not align well with the representative waste site conceptual contaminant distribution models in the 200-CW-5 Work Plan, but are better represented or bounded by the conceptual contaminant distribution models of representative waste sites or TSD units from other OUs. For analogous waste sites in this category, the appropriate conceptual contaminant distribution model figures from other OUs are provided in Appendix C, Figures C-1 through C-7, behind Table C-4.

Because the waste sites listed in Table C-4 are not aligned with the 200-CW-5 OU representative waste sites, they will rely on the RI data being collected from the analogous representative waste sites in other OUs. Those data and the associated conceptual models will be evaluated in the FS.

Although a fifth table ordinarily would be used to identify waste sites that did not align with any of the existing conceptual contaminant distribution models, all of the 200-CW-2, 200-CW-4, and 200-SC-1 consolidated OU waste sites aligned well with the 200-CW-5 OU representative waste sites or representative waste sites from other OUs, so another table was not required. Thus, new conceptual contaminant distribution models are not needed, and the extent of characterization planned in this and other OU work plans is sufficient to support RI/FS characterization for all of the consolidated waste sites.

4.1.1 Investigation-Derived Waste Data Quality Objectives Process

A second DQO process was conducted in support of waste designation for the IDW planned during the characterization of the 216-Z-11 Ditch. The waste-designation DQO summary report (BHI-01591) reviewed the initial COPC list and developed a set of waste designation exclusions that were more in line with waste designation requirements than with RI/FS requirements. The resulting list of waste designation COCs was compared to the RI COCs, which resulted in the identification of data needs for the waste designation process (i.e., sample collection and analyses beyond those planned for RI characterization needs). The additional analyses identified as a result of this IDW DQO effort were included in the SAP (Appendix A).

4.1.2 Data Uses

Data generated during characterization of the 216-Z-11 Ditch representative site will consist mainly of soil contaminant data. These contaminant data will be used, along with existing data from the 216-U-10 Pond and 216-U-14 Ditch representative sites, to define the nature and extent of radiological and chemical contamination, support an evaluation of risks; and assist in the evaluation and selection of a remediation alternative. By defining the type and distribution of contamination, the conceptual model for contaminant distribution can be verified or refined. Verification of the current model will direct the application of the analogous site concept at the OU waste sites. A limited amount of data will be collected to characterize the physical properties of soils that will be used to support an assessment of risk (the RESidual RADioactivity [RESRAD] dose model [ANL, *RESRAD for Windows*, Version 6.21] or other risk modeling, as required). Contaminant and soil property data will be obtained by sampling and analyzing soils.

In addition, representative waste site data from other OUs will be used to support conceptual models for contaminant distribution verification in certain of the consolidated OU waste sites as discussed in Section 4.1.

4.1.3 Data Needs

A considerable amount of information has been presented in Chapters 2.0 and 3.0 regarding the 200-CW-5 OU waste sites. Existing data were sufficient to develop an understanding of contaminant distribution for the 216-U-10 Pond and 216-U-14 Ditch; however, the data are insufficient to develop a distribution model for the 216-Z-11 Ditch. The most pertinent existing information was used to develop a site-specific conceptual model for the 216-Z-11 Ditch waste site, and additional information is provided by reference. For the representative waste sites (and the other waste sites in the OUs in general), information is available regarding location, construction design, major types of waste disposed, and radiological contaminants associated with the bottom of the waste site. However, the data needed to verify and/or refine the site conceptual model at the 216-Z-11 Ditch, and the data needed to develop a contaminant distribution model, are limited. These data are needed to support remedial decision making at the 216-Z-11 Ditch and any analogous sites.

As defined by the DQO process, the focus of the RI is to determine the nature and extent of contamination in the vadose zone within the boundary of the waste site. Specifically, determinations of the type, concentration (particularly the highest concentration), and vertical distribution of radiological and chemical contamination in the vadose zone at the 216-Z-11 Ditch are the major data needs. Data also are required to determine the physical properties of soils; these data will provide additional input to support an evaluation of risk through the use of models for fate and transport of contaminants through the vadose zone to groundwater, exposure to radionuclides, and exposure to chemicals.

4.1.4 Data Quality

Data quality was addressed during the DQO session. The data quantity and quality for the 216-U-10 Pond and the 216-U-14 Ditch were determined to be sufficient; COCs were identified for these sites based on data that had been collected under an approved work plan. During the DQO process, data quality for the 216-Z-11 Ditch was addressed by identifying potential COCs and establishing associated analytical performance criteria. The process of identifying potential COCs is summarized in Section 3.5. Analytical performance criteria were established by evaluating potential ARARs and PRGs, which are regulatory thresholds and/or standards or derived risk-based thresholds. These potential ARARs and PRGs represent chemical-, location-, and action-specific requirements that protect human health and the environment. Regulatory thresholds and/or standards or preliminary action levels provide the basis for establishing cleanup levels and dictate analytical performance levels (i.e., laboratory detection limit requirements). Detection limit requirements and standards for precision and accuracy are used to define data quality.

To provide the necessary data quality, detection limits should be lower than preliminary action levels. Additional data quality is gained by establishing specific policies and procedures for the generation of analytical data and field quality assurance/quality control requirements. These requirements are discussed in detail in the SAP (Appendix A). Analytical performance requirements are specified in Table 3-7 of the DQO summary report (BHI-01294). The potential ARARs and PRGs for 200 Areas waste sites are discussed in Sections 4.0 and 5.0 of the Implementation Plan (DOE/RL-98-28).

4.1.5 Data Quantity

Data quantity refers to the number of samples collected. The number of samples needed to refine the site conceptual model and make remedial decisions is based on a biased sampling approach. Biased sampling is the intentional location of a sampling point within a waste site based on process knowledge of the waste stream and expected behavior of the potential COCs. Using this approach, sampling locations can be selected that increase the likelihood of encountering the highest contamination in the local soil column. Biased sampling is the preferred sampling approach as defined in Section 6.2.2 of the Implementation Plan (DOE/RL-98-28) for the RI phase.

Sample locations at the 216-Z-11 Ditch representative site were selected based on the preliminary conceptual model presented in the DQO summary report. Sampling locations in the ditch will be identified through a four-step characterization approach designed to locate areas that contain the highest contamination. Sampling points will be located with the goal of intersecting the highest areas of contamination and determining the vertical and lateral extent (i.e., along the ditch) of contamination within the historical boundary of the ditches. Soil samples will be taken from one deep borehole at specified depth intervals to evaluate the vertical extent of contamination. Extra soil samples may be collected as warranted by observations such as changes in lithology and visual indications of contamination. This biased sampling approach was designed to provide the data needed to meet the DQOs for this phase of the RI/FS process.

4.2 CHARACTERIZATION APPROACH

This section provides an overview of planned characterization activities to collect the required data identified in the DQO process. Characterization will be performed through four separate activities, including the following:

- Surface geophysical surveys
- Gross gamma and passive neutron (GG/PN) logging in driven soil probes
- Borehole drilling, soil sampling, and geophysical logging
- Pipeline sludge characterization.

This sampling strategy is designed to minimize worker exposure by first using nonintrusive methods to locate contamination "hot spots." Sample collection will be guided by field screening efforts and a sampling scheme that identifies critical sampling depths.

The sampling designs for the analogous representative waste sites in other OUs discussed in Section 4.1 also are developed through the DQO process, and reflect the waste site-specific sampling needs. Therefore, those sampling designs are appropriate for the consolidated OU waste sites listed in Appendix C, Table C-4.

4.2.1 Surface Geophysical Surveys

Ground-penetrating radar (GPR) and electromagnetic induction (EMI) surveys will be performed along transects at up to seven locations (Figure 4-1). Because of the close proximity of the 216-Z-1D, 216-Z-11, and 216-Z-19 Ditches and the difficulty in distinguishing the ditches from each other under the uniform stabilization cover materials, the surface geophysical surveys will be conducted across the entire width of the Z-Ditches. The geophysical information gained from this phase will be used to determine the ditch bottom profiles and to determine if the three parallel ditch locations can be discriminated in plan view.

4.2.2 Gross Gamma and Passive Neutron Logging of Driven Soil Probes

The GG/PN logging will be used to determine areas of high Am-241 and Pu-239/240 concentrations using a series of shallowly driven small-diameter soil probes. The soil probes will be installed to a depth of approximately 4.9 m (16 ft) bgs at up to five locations along the ditch. The GG/PN data will be used to construct logs of radiological activity in the probe locations. The logs will be evaluated to identify the preferred borehole sampling location for soil sampling and geophysical logging.

The GG/PN system uses bismuth-germanium- (BGO-) detector instrumentation for gross counting of the gamma-emitting radionuclides in the soil probes as a function of depth. The PN logging instrument is a helium-3 detector configured to detect the neutron flux present in the below-ground environment.

4.2.3 Borehole Drilling, Soil Sampling, and Geophysical Logging

Areas of high contamination identified during the GG/PN logging of the driven soil probes will be chosen as locations for drilling one deep borehole for soil sampling and geophysical borehole logging. The borehole is necessary to determine the contaminant concentrations in the ditch sediment layer and in the soil immediately beneath the ditch sediments. The sample collection strategy has been designed to characterize the ditch sediments and the underlying vadose zone materials to the top of the groundwater table. Sampling will begin at the ditch sediment layer, but if contamination is detected in backfill materials, additional samples may be taken in the backfill.

The borehole is planned for the area of highest contamination, as determined by the soil probe GG/PN logging results. This borehole is required to determine TRU and other contaminant concentrations through the vadose zone to groundwater. This characterization step is designed to confirm the preliminary site conceptual model for vertical contaminant distribution. Samples will be collected at 15 cm (6-in.) intervals at the ditch bottom/sediment layer elevation, then at 0.8 m (2.5-ft) intervals from depths of 0.8 m, 1.5 m, and 2.3 m (2.5, 5.0, and 7.5 ft) below the ditch sediment layer. Sampling will continue at depths of 4 m to 4.9 m and 7.0 m to 8 m (13.5 to 16 ft and 23.5 to 26 ft) bgs. Critical sample intervals are at the ditch sediment layer, 4 m to 4.9 m (13.5 to 16 ft) bgs, and 7.0 m to 8 m (23.5 to 26 ft) bgs. In addition, samples will be taken every 15 m (50 ft) from a depth of 8 m (25 ft) bgs to groundwater. A soil sample also will be collected just above the water table. The maximum total depth of the investigation at the Z-Ditches will be approximately 73 m (238 ft), based on the depth to water in nearby wells. The presence of water-saturated soils will indicate the end of the borehole and will be determined by the site geologist.

Additional samples may be collected at the discretion of the geologist/sampler based on field screening and geologic information. Actual conditions during drilling may warrant changes in sampling design, borehole location, or drilling depth; the changes may be implemented after approval of the task lead and site technical representative. Changes that result in impacts to the DQO will require EPA concurrence.

The sampling design is presented in the SAP (Appendix A). Key features of the sampling design are presented in the SAP, Table 3-1. Field screening methods are provided in the SAP, Table 3-2, and sampling details are provided in the SAP, Table 3-3.

After borehole sampling is complete, a spectral gamma logging (SGL) system and a neutron moisture logging system will be used to geophysically log the borehole. This logging will provide continuous vertical logs of gamma-emitting radionuclides and moisture. The neutron moisture logging system uses a weak radioactive neutron source in combination with a passive neutron detector to determine the hydrogen atom distribution in the soil surrounding the borehole.

The geophysical logs will be used to supplement the laboratory radionuclide and moisture content data to determine the vertical distribution of radionuclides in the vadose zone beneath the Z-Ditches and aid in geological interpretation of subsurface stratigraphy.

Existing wells in the vicinity of the Z-Ditches may be logged with the SGL system to expand the Z-Ditches SGL database. Logging can be performed only in existing wells that have one casing string and lack annular seals (i.e., the casing is in contact with the formation). One nearby well with logging potential has been identified in the SAP (Appendix A, Table 3-1).

The drilling method used must allow the use of a 13 cm (5-in.)-outside-diameter split-spoon sampler. The drilling method must not use any system that circulates air or water into the formation to be sampled.

4.2.4 Pipeline Sludge Characterization

This step involves in situ radiological measurement within the Z-Ditch discharge piping via the manholes. Figure 4-2 identifies the Z-Ditch discharge pipelines and manhole locations being considered for field assay. Figure 4-3 shows typical section views of manholes in the Z-Ditch pipelines.

4.2.5 Field Screening

All samples and/or cuttings from the borehole will be field screened for evidence of radionuclides. Radioactivity screening of the soils will assist in the selection of sampling intervals besides those already identified as critical sampling depths.

4.2.6 Analysis of Soil

Soil samples will be collected for chemical and radionuclide analysis and for the determination of select soil properties. A fairly broad and comprehensive list of analytes has been selected for this investigation; this list was developed based on an evaluation of all potential contamination that was discharged to the Z-Ditches. Development of this list of COCs is presented in Section 3.5 and Table 3-5. Tables 2-1 and 2-3 of the SAP (Appendix A) list detailed descriptions of analytical methods, holding times, and quality assurance and quality control procedures for each contaminant. A limited number of samples also will be analyzed to determine soil physical properties, such as moisture content and particle size.

Figure 4-1. Location of Planned Surface Geophysical Surveys at the 216-Z-Ditches (216-Z-19 Ditch Shown as Open).

Figure 4-2. Z-Ditch Discharge Pipelines and Manhole Locations.

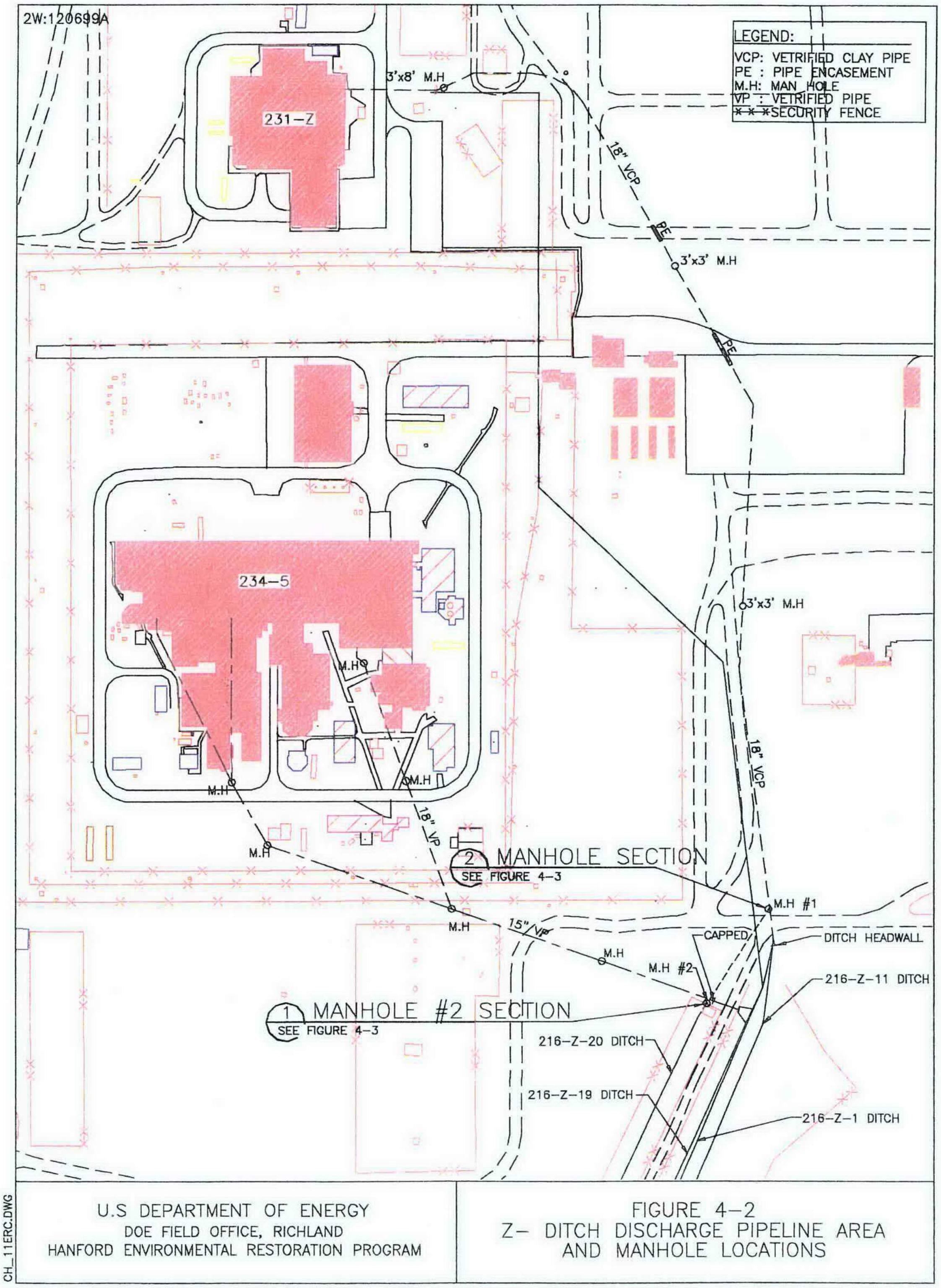
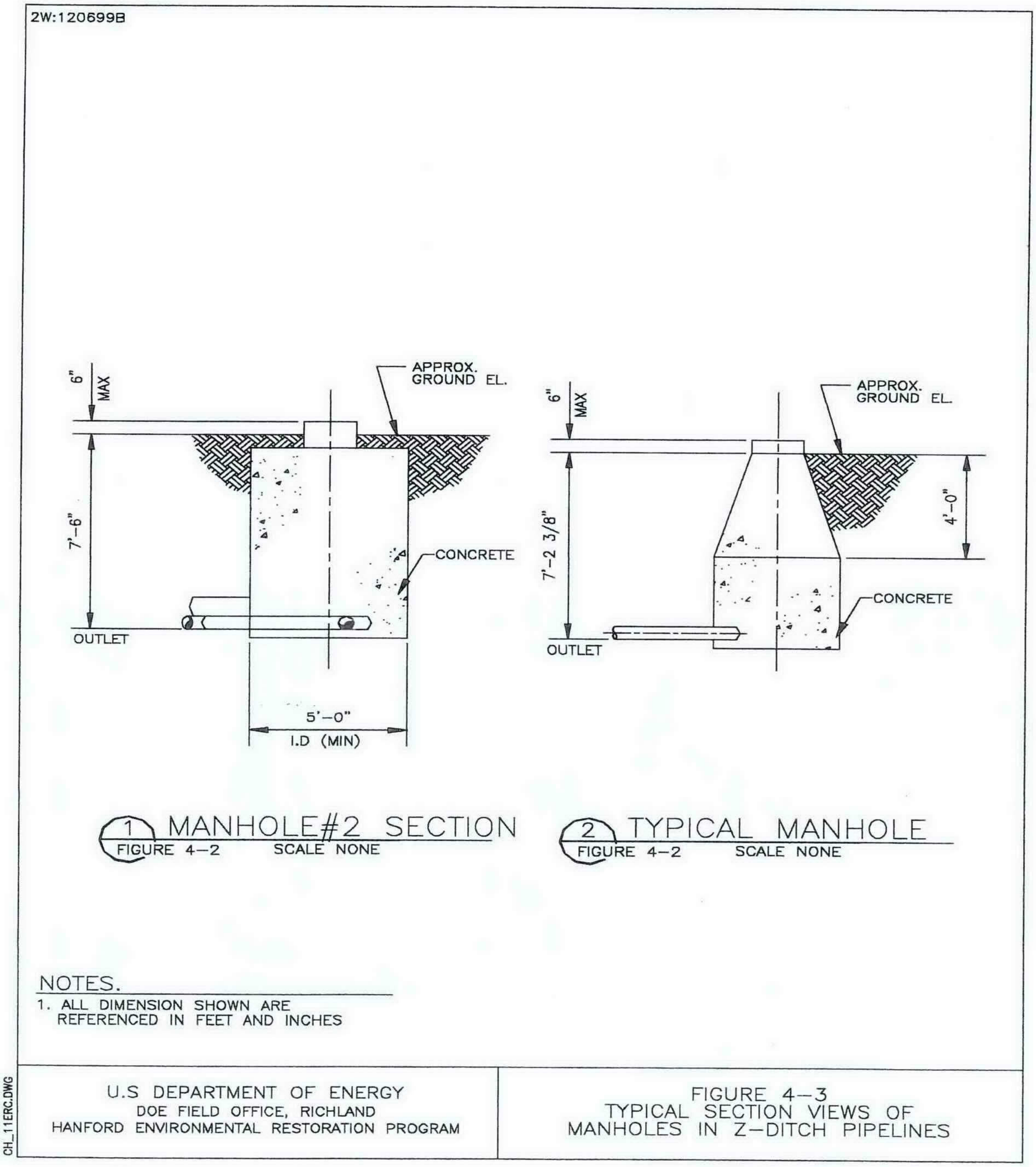


Figure 4-3. Typical Section Views of Manholes in Z-Ditch Pipelines.



5.0 REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROCESS

This section describes the RI/FS process for the 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 OUs. The development of, and rationale for, this process is provided in the Implementation Plan (DOE/RL-98-28) and is summarized in Figure 1-1. The process follows the CERCLA format. A summary of the regulatory process is provided in Section 5.1.

Section 5.2 outlines the tasks to be completed during the RI phase, including planning and conducting field sampling activities and preparing the RI report. These tasks are designed to effectively manage the work, satisfy the DQOs identified in Chapter 4.0, document the results of the RI, and manage waste generated during field activities. The general purpose of the RI is to characterize the nature, extent, concentration, and potential transport of contaminants and provide data to determine the need for and type of remediation. The detailed information that will be collected to carry out these tasks is presented in the SAP (Appendix A) and the WCP (WCP-2002-0001). Tasks to be completed following the RI include an FS (Section 5.3) and a proposed plan, followed by an ROD (Section 5.4).

Project management occurs throughout the RI/FS process. Project management is used to direct and document project activities to ensure that the objectives of the work plan are met and that the project is kept within budget and on schedule. The initial project management activity will be to assign individuals to roles established in Section 7.2 of the Implementation Plan (DOE/RL-98-28). Other project management activities include day-to-day supervision of, and communication with, project staff and support personnel; meetings; control of cost, schedule, and work; records management; progress and final reports; quality assurance; health and safety; and community relations.

Appendix A of the Implementation Plan (DOE/RL-98-28) provides the overall quality assurance framework that was used to prepare a specific quality assurance project plan (Appendix A, Chapter 2.0) for the 200-CW-5 RI SAP. Appendix C of the Implementation Plan reviews data management activities that apply to the 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 OU RI/FS and describes the process for the collection and control of data, records, documents, correspondence, and other information associated with the activities in these OUs. A correlation between the EPA/240/B-01/003, *EPA Requirements for Quality Assurance Project Plans*, (QA/R-5) requirements and information in the SAP (Appendix A) is provided in Appendix D of this document.

5.1 REGULATORY PROCESS

The process for characterizing the 200-CW-5, CW-2, 200-CW-4, and 200-SC-1 OUs uses this work plan in combination with the Implementation Plan (DOE/RL-98-28) to satisfy the requirements for an RI/FS work plan. General facility background information, potential ARARs, preliminary RAOs, and preliminary remedial technologies developed in the Implementation Plan are incorporated by reference into this work plan. Following the completion of the work plan, an RI will be performed that will be limited to the investigation of representative waste sites. A report summarizing the results of the RI then will be prepared.

After the RI is complete, remedial alternatives will be refined and evaluated against performance standards and evaluation criteria. The evaluation process for the remedial alternatives includes preparing an FS.

The decision-making process for the OUs will be based on the use of a proposed plan and a ROD. Based on the FS, a proposed plan will be prepared that identifies the preferred remedial alternatives for waste sites within the OUs. The proposed plan will be issued for a 45-day public review and comment period. Supporting documents, including the FS, also will be made available to the public at this time. A combined public meeting/public hearing may be held during the comment period to provide information on the proposed action and to solicit public comment. After the public review, the EPA will respond to comments and make a final decision on the proposed action. The decision will be documented in a ROD.

Additional guidance is provided in Section 2.4 of the Implementation Plan (DOE/RL-98-28).

5.2 REMEDIAL INVESTIGATION ACTIVITIES

This section summarizes the planned tasks that will be performed during the RI phase for the 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 OUs, including the following:

- Planning
- Field investigation
- Management of IDW
- Laboratory analysis and data verification
- Data evaluation and reporting.

These tasks and subtasks reflect the work breakdown structure that will be used to manage the work and to develop the project schedule provided in Chapter 6.0.

5.2.1 Planning

The planning subtask includes activities and documentation that must be completed before field activities can begin. These activities include preparing a hazard classification analysis, an activity hazards analysis, a site-specific health and safety plan (HASP), radiation work permits, a WCP, excavation permits and supporting surveys (e.g., cultural, radiological, wildlife, and utilities), work instructions, personnel training materials, and the procurement of materials and services (e.g., drilling and geophysical logging services).

Appendix B of the Implementation Plan (DOE/RL-98-28) provides a general HASP that outlines health and safety requirements for RI activities. Site-specific HASPs will be prepared for drilling, following the requirements of the general HASP. Initial surface radiological surveys will be performed to document any radiological surface contamination and background levels in and around the sampling locations. This information will be used to document initial site conditions and prepare HASPs and radiation work permits.

5.2.2 Field Investigation

The field investigation task involves data-gathering activities performed in the field that are required to satisfy DQOs. The field characterization approach is summarized in Section 4.2 and detailed in the SAP (Appendix A). The scope includes geophysical surveys and logging, followed by soil sampling and analyses to characterize the vadose zone at one representative waste site (216-Z-11 Ditch) and effluent pipeline sampling and analyses. Major subtasks associated with the field investigation include the following:

- Surface geophysical surveys
- GG/PN logging in driven soil probes
- Borehole drilling, soil sampling, and geophysical logging
- Pipeline sludge characterization
- Preparation of field report.

5.2.2.1 Surface Geophysical Surveys

This task involves surveys of the combined stabilized Z-Ditches (216-Z-1D, 216-Z-11, and 216-Z-19) using the GPR and EMI methods. The intent of this initial activity is to distinguish the ditch bottom profiles for the three parallel ditches in the subsurface.

5.2.2.2 Gross Gamma and Passive Neutron Logging of Driven Soil Probes

Small-diameter soil probes will be driven along the ditch to a depth of at least 4.9 m (16 ft) and logged with a GG/PN system to determine areas of high Am-241 and Pu-239/240 activity. Results of the GG/PN readings will be evaluated to identify the preferred location for borehole soil sampling.

After GG/PN operations have been completed, the soil probes will be abandoned in accordance with *Washington Administrative Code* (WAC) 173-160, "Minimum Standards for Construction and Maintenance of Wells," and initial site conditions will be reestablished.

5.2.2.3 Borehole Drilling, Soil Sampling, and Geophysical Logging

This characterization activity involves drilling one borehole to collect soil samples for chemical, radionuclide, and physical property analyses. Geologic and geophysical (SGL and neutron moisture logging) logs also will be prepared. These data are significant for determining the contaminant concentrations through the vadose zone to groundwater, as well as for confirming the conceptual contaminant distribution model.

Samples will be collected with split-spoon samplers and packaged for shipment to an offsite laboratory, provided that their radioactivity levels do not exceed laboratory radiological limits. Samples taken from radiological hot spots may have sufficiently high radioactivity that they will require analysis at an onsite laboratory. At the completion of sampling, the borehole will be abandoned in accordance with WAC 173-160, and initial site conditions will be reestablished. Alternatively, the borehole may be completed as a groundwater monitoring well if needed by the Hanford Site groundwater monitoring program. Other drilling-related activities include work zone setup, mobilization/demobilization of equipment, equipment decontamination, and field analyses. Planned field analyses include radiological field screening and geologic characterization. A geologic log will be prepared for the borehole.

Borehole geophysical logging also will be used to gather in situ radiological and physical data from existing wells as specified in Section 3.3.3.3 of the SAP (Appendix A). Spectral gamma-ray logging will be performed to assess the distribution of gamma-emitting radionuclides, and neutron logging will be performed to determine moisture content distribution over the borehole or well interval. A geologic log also will be prepared for the borehole.

5.2.2.4 Pipeline Sludge Characterization

The Z-Ditches discharge piping sludge will be characterized through manhole access ports. Visual inspection will be performed by remote video camera, followed by in situ radiological measurements. Sodium iodide and/or high-purity germanium detectors may be employed for this purpose.

5.2.2.5 Preparation of Field Reports

At the completion of the field investigation, a field report will be prepared to summarize the activities performed and the information collected in the field. Information to be collected will include, but will not be limited to, surface geophysical survey data; borehole geophysical logging data; the number, location, and types of soil samples collected and the associated *Hanford Environmental Information System* numbers; an inventory of IDW containers; geological logs; and field screening results. If available, laboratory analytical results also will be summarized. Otherwise, laboratory analytical results will be included in the RI report.

5.2.3 Management of Investigation-Derived Waste

Waste generated during the RI will be managed in accordance with a WCP. Appendix E of the Implementation Plan (DOE/RL-98-28) provides general waste management processes and requirements for this IDW and forms the basis for activity-specific WCPs. The EPA-approved WCP (WCP-2002-0001) addresses the handling, storage, and disposal of IDW generated during the RI phase. Furthermore, the plan identifies Environmental Restoration Contractor procedures that apply and discusses types of waste expected to be generated, the waste designation process, and the final disposal location. The IDW management task begins at the start of the field investigation, when IDW is first generated, through waste designation and disposal.

All IDW and remediation waste generated in the 216-Z-11 and 216-Z-19 Ditches, the 216-U-10 Pond, and the 216-U-9 and 216-U-11 Ditches will be designated with an F001 listed waste code because of the carbon tetrachloride discharges associated with the 231-Z Laboratory waste streams. The other 200-CW-5 OU waste sites did not receive the 231-Z Laboratory discharges and will not be assigned the F001 listed waste code. An additional waste designation DQO evaluation will be completed for the 200-CW-2, 200-CW-4, and 200-SC-1 OU waste sites before any remedial activities and/or confirmatory sampling is conducted at these waste sites.

The waste designation of materials coming into contact with groundwater will include a review of the groundwater monitoring wells in the vicinity of this site. Because of the known contamination in the groundwater beneath the 200 West Area, all materials that come in contact with the groundwater will be labeled "F001," "F002," "F003," "F004," "F005" waste (CCN 081034, "Application of Listed Waste Codes to Secondary Solid Waste Related to Well Construction, Maintenance, and Sampling").

5.2.4 Laboratory Analysis and Data Validation

Soil samples collected from the borehole will be analyzed for a comprehensive suite of radionuclides and chemicals and for select physical properties, based on established DQOs and as defined in the SAP. This task includes the laboratory analysis of samples, the compilation of laboratory results into data packages, and the validation of a representative number of laboratory data packages.

5.2.5 Remedial Investigation Report

This section summarizes data evaluation and interpretation subtasks leading to the production of an RI report. The primary activities include performing a data quality assessment (DQA); evaluating the nature, extent, and concentration of contaminants based on sampling results; assessing contaminant fate and transport; refining the site conceptual models; and evaluating risks through a qualitative risk assessment (QRA). These activities will be performed as part of RI report preparation.

5.2.5.1 Data Quality Assessment

A DQA will be performed on the analytical data to determine if they are the right type, quality, and quantity to support their intended use. The DQA completes the data life cycle of planning, implementation, and assessment that began with the DQO process. In this task, the data will be examined to see if they meet the analytical quality criteria outlined in the RI DQO summary report (BHI-01294) and are adequate to resolve the decisions in the RI DQO process.

5.2.5.2 Data Evaluation and Conceptual Model Refinement

This task will include evaluating the information collected during the investigation. The chemical and radiological data obtained from sampling activities will be compiled, tabulated, and statistically evaluated to gain as much information as possible to satisfy the data needs. Data evaluation tasks may include the following:

- Graphically evaluating the data for vertical distribution of contamination within the borehole.
- Stratifying the data and computing basic statistical parameters such as mean and standard deviation for individual depths.
- Constructing contour diagrams and variograms to evaluate spatial correlations within each stratum, which will indicate if contamination is concentrated in a particular area.

- Performing analyses on the data to evaluate the presence or absence of contamination. This step has many facets, including determining the distribution of the data and selecting the appropriate statistical tests. The initial screening for contamination should evaluate the data with respect to background by using simple comparisons of an upper bound of the data to background concentrations, or more complex comparisons, such as nonparametric hypothesis tests.

All of these statistical evaluations will aid in refining the conceptual model for these OUs and selecting the appropriate remedial alternatives. However, because the sites within these OUs represent point-source type releases, statistical analysis may not always be possible. Single boreholes are planned at the sites. If the data are not sufficient for statistical analysis, maximum or average concentrations will be used in the evaluation process.

The analytical and physical properties and the geophysical data will be used to refine the conceptual model and as inputs to a QRA. Data on the soil physical properties will be used to develop input parameters for contaminant fate and transport modeling, if needed (see Section 5.2.5.3). For example, lithology, moisture conditions, and grain-size distribution will assist in selecting representative unsaturated hydraulic conductivity values and moisture retention curves.

5.2.5.3 Risk Assessment

The Tri-Parties recently undertook the task of developing a risk framework to support risk assessments in the Central Plateau. This included a series of workshops 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 HAB 132, "Exposure Scenarios Task Force on the 200 Area," in the Tri-Parties response to the HAB advise (Klein et al. 2002, "Consensus Advice #132: Exposure Scenarios Task Force on the 200 Area"), and in HAB 2002, *Report of the Exposure Scenarios Task Force*. The following items summarize the risk framework description from the Tri-Parties response to the HAB.

1. The Core Zone (200 Areas including B Pond (main pond) and S Ponds) (see Figure 2-4) will have an industrial scenario for the foreseeable future.

2. The Core Zone will be remediated and closed, allowing for "other uses" consistent with an industrial scenario (environmental industries) that will maintain 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. An assumption of industrial land use will be used to set cleanup levels.

3. DOE will follow the required regulatory processes for groundwater remediation (including public participation) to establish the points of compliance and remedial action objectives. 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 yr). It is assumed that the tritium and iodine-129 plumes beyond the Core Zone boundary will exceed the drinking water standards for the period of the next 150 to 300 yr (less for the tritium plume). It is expected that other groundwater contaminants will remain below, or will be restored to, drinking water levels outside the Core Zone.

4. 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.

5. Waste sites outside the Core Zone but within the Central Plateau (200 North 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 land use, institutional control cost, and long-term stewardship.

6. 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 yr)
   - Sites near the Core Zone perimeter to analyze opportunities to "shrink the site"
   - Early (precedent-setting) closure/remediation decisions.

7. This framework does not deal with the tank retrieval decision.

These items form the basis for the OU risk assessments to be conducted in the RI and FS reports.

5.2.5.3.1 Human Health Risk Assessment

For the 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 OUs, a quantitative, baseline human health risk assessment for the representative sites will be prepared, as part of the RI report, to evaluate risk to human receptors from potential exposure to contaminants in accessible surface sediments and shallow subsurface soils. The risk assessment also will evaluate the potential for contaminants currently in the vadose zone beneath the waste sites to impact groundwater in the future. Risks from current groundwater contamination will not be evaluated; this evaluation will be conducted as part of the RI/FS process for the groundwater OUs.

The risk assessment in the RI report will focus on the representative sites, because data collected through the RI at these sites are sufficient to allow quantification of risk. The risk assessment will follow the risk guidelines identified through the Risk Framework Workshops as documented in the Tri-Parties response to HAB Consensus Advice 132 (Klein et al. 2002).

The human health risk assessment will be conducted in accordance with appropriate subsections of WAC-173-340, "Model Toxics Control Act - Cleanup," and with the following DOE and EPA guidance documents:

- DOE/RL-91-45, *Hanford Site Risk Assessment Methodology*

- EPA/540/1-89/002, *Risk Assessment Guidance for Superfund (RAGS), Volume I -- Human Health Evaluation Manual, (Part A) Interim Final*

- EPA 1991, *Risk Assessment Guidance for Superfund, Vol. I, Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors, (Interim Final)* (OSWER Directive 9285.6-03)
- EPA/600/P-95/002Fa, *Exposure Factors Handbook*
- EPA/540/R/99/005, *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim*
- EPA/600/P-92/003C, *Proposed Guidelines for Carcinogen Risk Assessment*
- EPA 1992, *Supplemental Guidance to RAGS: Calculating the Concentration Term* (OSWER Directive 9285.7-081).

Risks initially will be evaluated by comparison to risk-based standards such as WAC 173-340-745, "Soil Cleanup Standards for Industrial Properties." Contaminants present at concentrations exceeding these risk-based standards will be considered further in the risk assessment process. Risks from nonradiological noncarcinogens will be evaluated by calculating hazard quotients (HQ) for individual constituents and a hazard index (HI) for cumulative risk. Risks from nonradiological carcinogens and radionuclides will be evaluated by calculating incremental cancer risks for individual constituents and a cumulative cancer risk.

The computer program RESRAD (ANL/EAD-4, *User's Manual for RESRAD, Version 6*) will be used to obtain dose estimates from direct-contact exposure to radiological constituents present in the shallow zone of the waste sites. The RESRAD model also will be used to obtain dose estimates for the protection of the groundwater pathway. The results obtained from the RESRAD model for the groundwater protection model are limited to screening purposes only. Additional analysis will be performed using an appropriate fate and transport model (e.g., PNNL-11216, *STOMP -- Subsurface Transport Over Multiple Phases: Application Guide*) (STOMP) to assess impact to the groundwater from chemicals and radionuclides in the vadose zone.

Waste sites within the 200 Areas boundary will have a risk assessment performed for an industrial exposure scenario to establish the baseline risk. As part of the FS, additional risk assessment may be performed to evaluate other scenarios, such as a Native American scenario or an intruder scenario, to evaluate post-remediation residual risks.

Analogous waste sites will be evaluated in the FS following the analogous site approach described in DOE/RL-98-28, Section 2.5.1. Important considerations in determining the appropriate representative site for an analogous waste site include the following:

- Waste site configuration and construction (e.g., pond, trench, surface structure)
- Volume of effluent received in relation to the available pore volume for the waste site
- Types and amounts of contaminants received; contaminant inventory

- Method of discharge and purpose of waste site
- Expected distribution of contamination based on method of discharge and purpose of waste site
- Geological setting
- Neighboring waste sites, structures, or utilities
- Potential for hydrologic and contaminant impacts to groundwater.

The available information from each waste site will be evaluated in the FS against information from the representative sites. In cases where characterization data are available from an analogous waste site, the data will be evaluated for sufficiency to support a site-specific evaluation of risk. If the data are sufficient, a risk estimate for the analogous site will be calculated and then used to support the evaluation and selection of the appropriate remedial action for that waste site. If the data from a particular waste site are insufficient to support a risk estimate, the available data and information will be used to support the comparison and assignment to an appropriate representative site. In most cases, little or no characterization data are available from the analogous sites. In these instances, existing information from the WIDS database, discharge information, and general process information will be used to make assignments.

The characterization data from representative sites are intended to provide sufficient information to select remedies for the waste group. However, site-specific data also may be needed to verify that the selected remedial alternative is appropriate. Following the decision in the ROD, additional sampling would be conducted as needed to confirm the selected remedy for the analogous waste sites and to collect data to support remedial design. Following remedial action, an additional data collection activity would be conducted as needed to verify achievement of cleanup goals.

The risk analysis and data from the representative sites are used to support the risk evaluation and remedial decisions for those analogous sites without data to support a site-specific risk estimate. The use of the risk assessment from the representative sites presents some risk-management decisions for the decision makers. If an analogous site is well represented by the representative site (i.e., the evaluation criteria of waste stream, size and construction, geology, waste inventory, effluent volume received, etc. are similar or equal to the representative site), then the decision to apply the representative site risk and preferred alternative pose minimal risk and minimal consequences of an incorrect decision. Similarly, if the representative site bounds the contamination problem at an analogous site, the application of the representative site risk and remedial action pose minimal consequences from a human health and ecological risk standpoint, but may significantly impact costs through the potential application of an unnecessary remedy. In this situation, no confirmatory sampling or limited confirmatory sampling may be needed to confirm the nature of the contamination, the risk, and the appropriate remedial action. Design data may be needed depending on the preferred alternative. If an analogous site is not bound by the representative site because contamination may be greater at that analogous site, then application of the representative site risk estimate and preferred alternative poses the greatest decision risk and resulting consequences. In this case, mandatory confirmatory sampling would be conducted to ensure selection of the appropriate alternative based on a better understanding of the nature and risk of the analogous site. This last scenario is unlikely for most sites because the analogous site approach tends to target the worst case waste sites and the worst contamination locations in those sites in an effort to bound all the contamination circumstances associated with a waste group.

In some cases, the representative site may not appropriately represent a particular analogous site; however, a representative site from another OU may more closely align with the analogous site. In these instances, the representative sites from other OUs may be used to evaluate analogous sites. The analogous sites would be evaluated against the corresponding representative site using the process discussed above.

5.2.5.3.2 Ecological Risk Assessment

The screening-level ecological risk assessment in DOE/RL-2001-54 is meant to be a conservative evaluation of risk to ecological receptors 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. The following describes the information found in specific sections of DOE/RL-2001-54.

DOE/RL-2001-54, Chapter 2.0, 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 habitable location for wildlife and needs protection in this region because of encroachment and elimination of this habitat 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, and the protection status of these species has not yet been determined. More information is needed to help with this determination. Regarding the waste sites, 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 a distant location (e.g. borrow source sites).

The conceptual site model in DOE/RL-2001-54, Chapter 3.0, provides an understanding of 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 include the following:

- 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.

DOE/RL-2001-54, Chapter 4.0, discusses the toxicity values that are 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 then screened, primarily with respect to the likelihood to be present 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 that do not have toxicity values will be handled during the risk assessment for each OU.

DOE/RL-2001-54, Chapter 5.0, 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 will be body weight, and these data are 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 6.0, is the screening-level risk calculation for the Central Plateau. The state and DOE provide contaminant-specific numerical values (WAC 173-340-900, "Tables," and biota concentration guides [DOE-STD-1153-2002, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota*]) for potential risks. These are conservative numbers designed to address all possibilities without leaving potential risks out of consideration. 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. For radionuclides, Cs-137, Ra-226, Ra-228, and Sr-90 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 risk. 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 waste sites in the Central Plateau (see DOE/RL-2001-54, Appendix C). These data include soil from the waste site, vegetation, and soil invertebrates. As each OU quantifies their risk using the exposure models available, these data will be useful in verifying the mathematical estimates.

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 then better able to define the initial risks and determine direction for the DQO process, if needed. The DQO process will include the following activities:

- 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.

Ecological risk will be evaluated using the EPA eight-step process as outlined in DOE/RL-2001-54. DOE/RL-2001-54 serves as the screening-level assessment for the Central Plateau. DOE/RL-2001-54 provides the starting point for OU-specific ecological evaluations that will include a screening-level evaluation based on the data collected during the RI and on other existing data as available, which will be compared to screening-level concentrations protective of wildlife. Because the waste sites in these OUs are all within the core zone, only terrestrial wildlife risks will be evaluated. Consistent with this approach, WAC 173-340-7490(3)(b), "Terrestrial Ecological Evaluation Procedures," "Goals," specifies that for industrial or commercial properties, current or potential for exposure to soil contamination need only be evaluated for terrestrial wildlife protection. Plants and biota need not be considered unless the species is protected under the Federal *Endangered Species Act of 1973*. Currently, no Federally-listed threatened or endangered species are known to exist on the waste sites. Surveys taken before field activities are begun will confirm the presence of protected species.

For radionuclides, screening levels have been developed in DOE/STD-1153-2002. The international community has been involved for more than 20 years in evaluating the effects of ionizing radiation on plants and animals. The International Atomic Energy Agency (IAEA) issued a study in 1992, IAEA 332, endorsing the 1977 and 1990 International Commission on Radiological Protection (ICRP) reports, ICRP-26 and ICRP-60, both titled, *Recommendations of the International Commission on Radiological Protection*, and stating that chronic radiation dose rates below 0.1 rad/d will not harm plant and animal populations and that radiation standards for human protection will also protect populations of nonhuman biota. The report implies that dose limits of 0.1 rad/d for animals and 1 rad/d for plants will protect populations, but additional evaluation of effects may be needed if sensitive species are present.

ORNL/TM-13141, *Effects of Ionizing Radiation on Terrestrial Plants and Animals: A Workshop Report*, presents information from a DOE-sponsored workshop held in 1995. The workshop was attended by 12 experts in radioecology and ecological risk assessment. The goal of the workshop was to evaluate the adequacy of current approaches to radiological protection, as exemplified by the IAEA report. The attendees reviewed DOE's perspective and responsibilities, rationales underlying the IAEA conclusions, and a summary of ecological data from the former Soviet Union. The consensus of the workshop participants was that the 0.1 rad/d limit for animals and the 1.0 rad/d limit for plants recommended by the IAEA are adequately supported by the available scientific information. However, they concluded that guidance on implementing the limits is needed and that the existing data support application of the recommended limits for populations of terrestrial and aquatic organisms to representative rather than maximally exposed individuals.

In response to the workshop findings, DOE produced DOE/STD-1153-2002, which provides a graded approach to ecological risk assessment for radionuclides and screening level biota concentration guides. For radiological constituents, no promulgated screening or cleanup levels are available. The biota concentration guides from DOE/STD-1153-2002 will be used in the ecological evaluation of radiological constituents.

DOE/RL-2001-54 is foundational to the Central Plateau ecological evaluation DQO process to be conducted in fiscal year 2004. This DQO process will further develop data gaps identified in DOE/RL-2001-54 and will identify data needs for the Central Plateau to support remedial decision making. An ecological evaluation SAP will be prepared and implemented for the Central Plateau, either on an area-wide basis or by OU, depending on the actual data needs.

Based on the results of the DQO and the screening-level evaluation, additional risk assessment activities, including a baseline ecological risk assessment, may be conducted using the eight-step process. The evaluation will be conducted based on soil data collected during the RI, existing soil and ecological data, and, if identified during the Central Plateau ecological evaluation DQO, newly collected ecological data.

5.3 FEASIBILITY STUDY

After the RI is complete, remedial alternatives will be developed and evaluated against performance standards and evaluation criteria in an FS report. The FS process consists of the following steps:

1. Defining RAOs
2. Identifying general response actions (GRA) to satisfy RAOs
3. Identifying potential technologies and process options associated with each GRA
4. Screening process options and technologies based on their effectiveness, implementability, and cost
5. Assembling viable technologies or process options into alternatives representing a range of treatment and containment in addition to the no-action alternative
6. Evaluating alternatives and presenting information needed to support remedy selection.

Although some refinement is expected during the final FS, Appendix D of the Implementation Plan (DOE/RL-98-28) satisfies the requirements for the screening phase (steps 1 through 6) of the FS process. The preliminary RAOs, PRGs, and GRAs, and the screening-level analysis of alternatives, are incorporated by reference into this work plan. As a result of the work completed in the Implementation Plan, the FS report will focus on the final phase of the FS, consisting of refining and analyzing in detail a limited number of alternatives identified in the screening phase. Remedial action alternatives considered to be applicable to the 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 OUs include the following:

- No action
- Engineered surface barriers with or without vertical barriers
- Excavation and disposal with or without ex situ treatment
- In situ vitrification with or without removal of the vitrified material and with or without engineered surface barriers
- In situ grouting and stabilization
- Monitored natural attenuation (with institutional controls).

During the detailed analysis, each alternative will be evaluated against the following criteria:

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume
- Short-term effectiveness
- Implementability
- Cost
- State acceptance.

One additional modifying criterion, community acceptance, will be applied following the FS, at the proposed plan and ROD phase.

National Environmental Policy Act of 1969 (NEPA) values also will be evaluated as part of the DOE's responsibility under this authority. The NEPA values include impacts to natural, cultural, and historical resources; socioeconomic considerations; and irreversible and irretrievable commitments of resources.

The FS also will include supporting information needed to complete the detailed analysis, including the following:

- Summarize the RI, including the nature and extent of contamination, the contaminant distribution models, and an assessment of the risks to help establish the need for remediation and to estimate the volume of contaminated media
- Refine the conceptual exposure pathway model to identify pathways that might need to be addressed by remedial action

- Provide a detailed evaluation of ARARs, starting with potential ARARs identified in the Implementation Plan (Chapter 4.0, DOE/RL-98-28)
- Refine RAOs and PRGs based on the results of the RI, ARAR evaluation, and current land-use considerations
- Refine the list of remedial alternatives identified in the Implementation Plan (Appendix D, DOE/RL-98-28), based on the RI.

5.4 PROPOSED PLAN AND RECORD OF DECISION

The decision-making process for the 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 OUs will be based on the use of a proposed plan and an ROD. Following the completion of the FS, a proposed plan will be prepared that identifies the preferred remedial alternative for the OUs. In addition to identifying the preferred alternative, the proposed plan will accomplish the following:

- Provide a summary of the completed RI/FS
- Provide criteria by which analogous waste sites within the OUs not previously characterized will be evaluated after the ROD to confirm that the contaminant distribution model for the site is consistent with the preferred alternative
- Develop contingencies that allow for moving a waste site to a more appropriate waste group
- Identify performance standards and ARARs applicable to the OUs.

After the public review process is complete, the EPA, as the lead regulatory agency, will decide on the remedial action to be taken and will document that decision in an ROD.

5.5 POST-RECORD OF DECISION ACTIVITIES

After the ROD has been issued, a remedial design report/remedial action work plan will be prepared to detail the scope of the remedial action. As part of this activity, DQOs will be established and SAPs will be prepared to direct confirmatory and verification sampling and analysis efforts. Before remediation begins, confirmation sampling will be performed to ensure that sufficient characterization data are available to confirm that the selected remedy is appropriate for all waste sites within the OUs, to collect data necessary for the remedial design, and to support future risk assessments, if needed. Verification sampling will be performed after the remedial action is complete to determine if ROD requirements have been met and if the remedy was effective. Additional guidance for confirmatory and verification sampling is provided in Section 6.2 of the Implementation Plan (DOE/RL-98-28).

The remedial design report/remedial action work plan will include an integrated schedule of remediation activities for the OUs. Following the completion of the remediation effort, closeout activities will be performed as discussed in Section 2.4 of the Implementation Plan (DOE/RL-98-28).

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6.0 PROJECT SCHEDULE

The project schedule for activities discussed in this work plan is shown in Figure 6-1. This schedule is the baseline for the work planning process and will be used to measure the implementation of this work plan. The schedule for preparation, review, and issuance of the RI report, FS, and proposed plan also is shown in Figure 6-1. The schedule concludes with the preparation of a ROD.

Three of the Tri-Party Agreement milestones associated with this project have been met:

- "Complete Draft A of the Work Plan by December 31, 1999," (M-13-22)
- "Complete U Pond/Z-Ditches Cooling Water Group Field Work through Sample Collection and Analysis by September 30, 2002" (M-15-40A)
- "Submit Draft A U Pond/Z-Ditches Cooling Water Group Remedial Investigation Report by May 31, 2003" (M-15-40B)

The following are proposed project milestone completion dates for key activities:

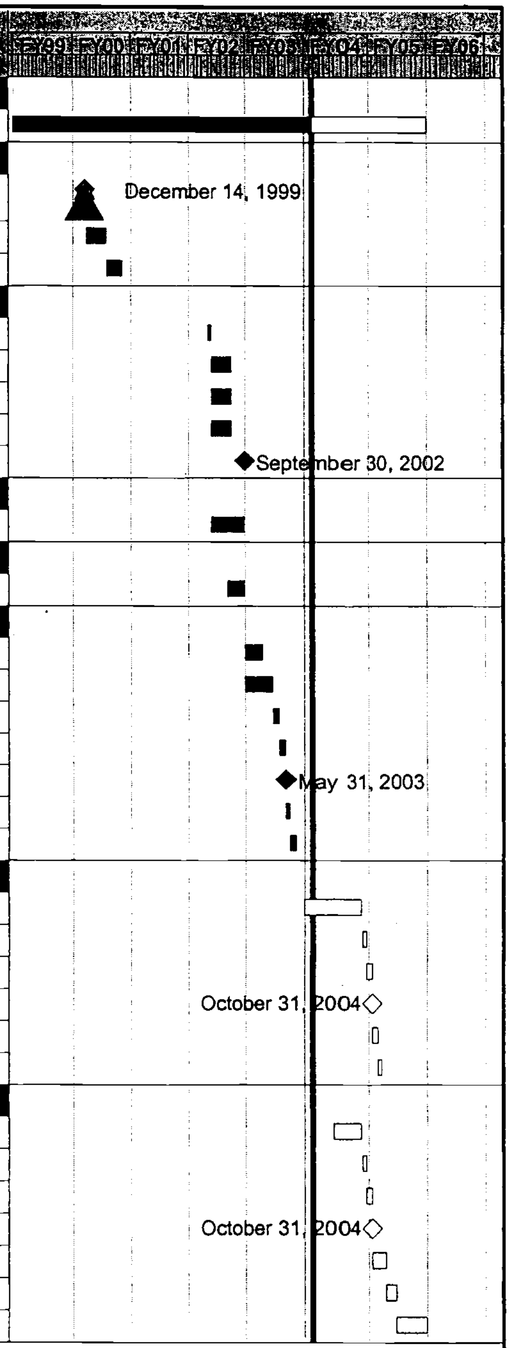
- Submit FS for regulator review, *October 1, 2004*[3]
- Submit proposed plan for regulator review, *October 1, 2004*[3].

Interim milestones to be designated under the Tri-Party Agreement will be established through negotiations between the parties. A Class II change form will be submitted to the EPA and Ecology to request the addition of any interim milestones. Any updates to the project schedule or associated milestones will be reflected in the annual work planning process.

[3] Target project milestones.

Figure 6-1. Project Schedule for the 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 Operable Units.

Activity ID	Activity Description
PROJECT MANAGEMENT	
0100	PROJECT MANAGEMENT
WORK PLAN	
0160	ISSUE DRAFT A OF WP - TPA MILESTONE M-13-22
0165	REGULATOR REVIEW OF DRAFT A WP
0180	FINALIZE WORK PLAN
FIELD INVESTIGATION	
0260	GEOPHYSICAL SURFACE SURVEY
0265	GEOPHYSICAL BOREHOLE LOGGING
0270	BOREHOLE DRILLING & SAMPLING
0273	PIPELINE CHARACTERIZATION
0275	COMPLETE FIELD WORK THROUGH SAMPLING/ANALYSIS
MANAGEMENT OF INVESTIGATION DERIVED WASTE	
0300	MANAGEMENT OF INVESTIGATION-DERIVED WASTE
LAB ANALYSIS & DATA VALIDATION	
0405	LAB ANALYSIS & DATA VALIDATION
REMEDIAL INVESTIGATION REPORT	
0410	DATA QUALITY ASSESSMENT
0425	COMPLETE & ISSUE DRAFT RI REPORT
0430	INTERNAL REVIEW/ISSUE DECISIONAL DRAFT RI RPT
0435	DOE REVIEW & REVISE DRAFT A RI REPORT
0437	ISSUE DRAFT A RI REPORT
0440	REGULATOR REVIEW DRAFT A RI REPORT
0445	FINALIZE RI REPORT
FEASIBILITY STUDY	
0450	PREPARE & ISSUE DRAFT FS REPORT
0455	FH REVIEW, REVISE/ISSUE DECISIONAL DRAFT FS
0460	DOE REVIEW & REVISE DRAFT A FS
0462	ISSUE DRAFT A FS
0465	REGULATOR REVIEW DRAFT A FS
0470	FINALIZE FS
PROPOSED PLAN	
0500	PREPARE & ISSUE DRAFT PP
0505	FH REVIEW & REVISE DECISIONAL DRAFT PP
0510	DOE REVIEW & REVISE DRAFT A PP
0515	ISSUE DRAFT A PP
0520	REGULATOR REVIEW & ISSUANCE OF REV 0 PP
0530	PUBLIC REVIEW PP
0700	ROD PROCESS

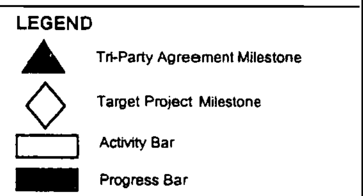


Start Date	01OCT98
Finish Date	28SEP05
Data Date	20NOV03
Run Date	23MAR04 13:35

200-CW-5

U-POND / Z-DITCHES

COOLING WATER OPERABLE UNIT



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APPENDIX A

200-CW-5, U POND/Z DITCHES COOLING WATER GROUP OPERABLE UNIT REMEDIAL INVESTIGATION SAMPLING AND ANALYSIS PLAN

NOTE: This appendix contains DOE/RL-2002-24, Revision 0, *200-CW-5 U Pond/Z Ditches Cooling Water Group Operable Unit Remedial Investigation Sampling and Analysis Plan*, as published in March 2002. The appendix contains the document in its entirety.

Beginning with the cover page, pagination for this appendix will follow the pagination of DOE/RL-2002-24. Normal pagination will resume with the first page of Appendix B.

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DOE/RL-2002-24

Rev. 0

200-CW-5 U Pond/Z Ditches Cooling Water Group Operable Unit Remedial Investigation Sampling and Analysis Plan

United States

Department of Energy

DOE/RL-2002-24
Rev. 0

200-CW-5 U Pond/Z Ditches Cooling Water Group Operable Unit Remedial Investigation Sampling and Analysis Plan

March 2002

United States Department of Energy

P.O. Box 550, Richland, Washington 99352

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ACRONYMS

ASTM	American Society for Testing and Materials
bgs	below ground surface
CFR	*Code of Federal Regulations*
COC	contaminant of concern
DOE	U.S. Department of Energy
dpm	disintegrations per minute
DQO	data quality objective
DS	decision statement
EMI	electromagnetic induction
EPA	U.S. Environmental Protection Agency
ERC	Environmental Restoration Contractor
GG/PN	gross gamma/passive neutron monitoring
GPR	ground penetrating radar
HEIS	Hanford Environmental Information System
HEPA	high-efficiency particulate air
IDW	investigation-derived waste
MTCA	*Model Toxics Control Act*
OU	operable unit
QAPjP	quality assurance project plan
QC	quality control
RCT	radiological control technician
RI	remedial investigation
SAF	sample authorization form
SAP	sampling and analysis plan
SGL	spectral gamma logging
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TRU (waste)	waste media contaminated with 100 nCi/g concentrations of transuranic materials having half-lives above 20 years
VCP	vitrified clay pipe
WAC	*Washington Administrative Code*

METRIC CONVERSION CHART

Into Metric Units			Out of Metric Units		
If You Know	*Multiply By*	*To Get*	*If You Know*	*Multiply By*	*To Get*
Length			**Length**		
inches	25.4	millimeters	millimeters	0.039	inches
inches	2.54	centimeters	centimeters	0.394	inches
feet	0.305	meters	meters	3.281	feet
yards	0.914	meters	meters	1.094	yards
miles	1.609	kilometers	kilometers	0.621	miles
Area			**Area**		
sq. inches	6.452	sq. centimeters	sq. centimeters	0.155	sq. inches
sq. feet	0.093	sq. meters	sq. meters	10.76	sq. feet
sq. yards	0.836	sq. meters	sq. meters	1.196	sq. yards
sq. miles	2.6	sq. kilometers	sq. kilometers	0.4	sq. miles
acres	0.405	hectares	hectares	2.47	acres
Mass (weight)			**Mass (weight)**		
ounces	28.35	grams	grams	0.035	ounces
pounds	0.454	kilograms	kilograms	2.205	pounds
ton	0.907	metric ton	metric ton	1.102	ton
Volume			**Volume**		
teaspoons	5	milliliters	milliliters	0.033	fluid ounces
tablespoons	15	milliliters	liters	2.1	pints
fluid ounces	30	milliliters	liters	1.057	quarts
cups	0.24	liters	liters	0.264	gallons
pints	0.47	liters	cubic meters	35.315	cubic feet
quarts	0.95	liters	cubic meters	1.308	cubic yards
gallons	3.8	liters			
cubic feet	0.028	cubic meters			
cubic yards	0.765	cubic meters			
Temperature			**Temperature**		
Fahrenheit	subtract 32, then multiply by 5/9	Celsius	Celsius	multiply by 9/5, then add 32	Fahrenheit
Radioactivity			**Radioactivity**		
picocuries	37	millibecquerel	millibecquerels	0.027	picocuries

1.0 INTRODUCTION

This sampling and analysis plan (SAP) directs sampling and analysis activities that will be performed to characterize the Hanford Site's 216-Z-11 Ditch, which is located in the 200-CW-5 U Pond/Z Ditches Cooling Water Group Operable Unit (OU). The sampling and analysis described in this document will be performed to provide soil/sediment/sludge data that may be used to refine and/or validate the site conceptual model, support an assessment of risk, and evaluate remedial alternatives for the 216-Z-11 Ditch and analogous waste sites. Characterization activities described in this SAP are based on the implementation of the data quality objectives (DQO) process, as documented in the *Data Quality Objectives Summary Report for the 200-CW-5 U Pond/Z Ditches System Waste Sites* (BHI 1999) and the *Data Quality Objectives Summary Report for the Designation of the 200-CW-5 Investigation Derived Wastes* (BHI 2001b).

The scope of activities described in this SAP involves a four-step characterization approach, which includes (1) surface geophysical surveys (ground-penetrating radar [GPR] and electromagnetic induction [EMI]), (2) geophysical logging of driven probes by use of gross gamma and passive neutron (GG/PN) logging methods, (3) the drilling of one deep borehole for soil sampling, and (4) radiological surveys of sludge/silt from accessible Z Plant discharge piping. Soil samples will be collected and analyzed for radiological and chemical contaminants of concern (COCs) and select physical properties. The borehole will be geophysically logged with spectral gamma and neutron moisture detectors to obtain additional information on the distribution of contamination and soil moisture. The GG/PN logging will also be performed in the borehole to establish a correlation with the spectral gamma logging (SGL) method.

1.1 BACKGROUND

The 200-CW-5 OU waste sites primarily received steam condensate and cooling water from several facilities in the 200 West Area. This effluent typically contained low concentrations of contaminants, but occasional failure in the process systems resulted in the release of significant amounts of radionuclides to the ponds and ditches in the OU. Some contamination may have penetrated the vadose zone and reached the aquifer beneath the waste sites. Pipelines carrying wastewater to the ditches and the 216-U-10 Pond may also have impacted the subsurface through leaks.

Three waste sites were chosen as representative sites in the *200 Areas Remedial Investigation/ Feasibility Study Implementation Plan – Environmental Restoration Program* (hereinafter referred to as the Implementation Plan) (DOE-RL 1999) to represent typical and worst-case conditions of contamination in the OU. These waste sites are the 216-U-10 Pond, 216-U-14 Ditch, and 216-Z-11 Ditch. During the DQO process, it was determined that sufficient vadose characterization data exist for the 216-U-10 Pond and the 216-U-14 Ditch. Because the characterization performed to date on the 216-Z-11 Ditch was considered insufficient, it is the focus of the characterization activities in this SAP. Knowledge gained from characterization of this site and existing data for the 216-U-10 and 216-U-14 sites will be used to refine the conceptual models and to support remedial action decision making for the OU.

1.2 200-CW-5 GROUP/WASTE SITE LOCATIONS

The 200-CW-5 waste sites are located in southeastern Washington State on the Hanford Site's 200 West Area. Figure 1-1 shows the specific locations of waste sites in the 200-CW-5 OU.

1.3 SITE DESCRIPTION AND HISTORY

The 216-Z-11 Ditch began operation in 1959 to dispose wastewater from the Z Plant to the 216-U-10 Pond (DOE-RL 1992), serving as a replacement for the 216-Z-1D Ditch. The 216-Z-11 Ditch was 797 m (2,615 ft) long and 0.6 m (2 ft) deep. The ditch was 1.2 m (4 ft) wide at the bottom and had side slopes of 2.5:1 with a 0.05% grade. The first 36.6 m (120 ft) of the ditch were in common with the 216-Z-1D Ditch, beginning at a point immediately east of the 241-Z Building. The middle section of the ditch ran parallel to the 216-Z-1D Ditch, then rejoined it for the last 203 m (665 ft), to the 216-U-10 Pond.

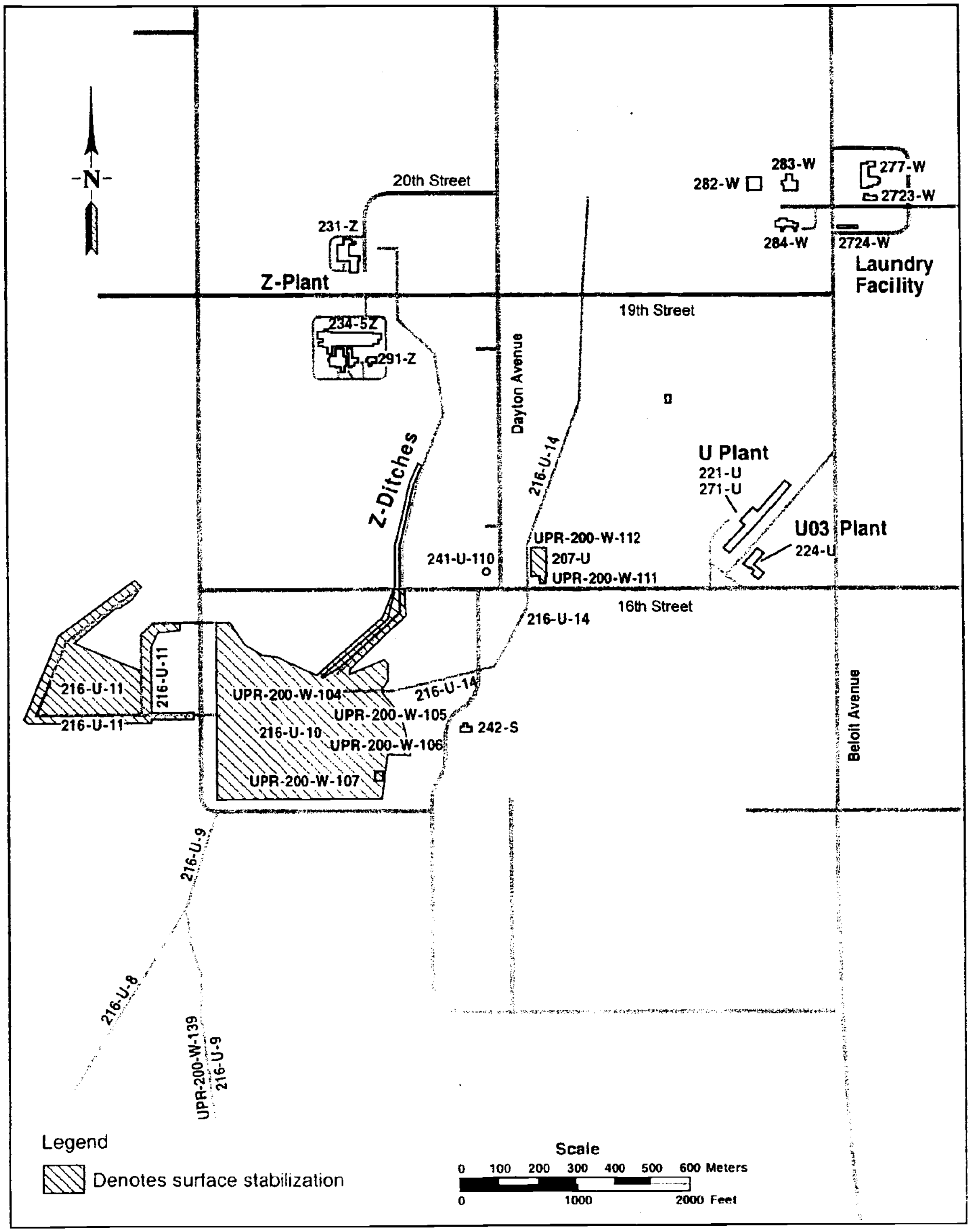
The 216-Z-11 Ditch received process cooling water and steam condensate from the 234-5Z Building, vacuum pump seal water and cooling water from the 291-Z Building, and laboratory waste and steam condensate from the 231-Z Building. The 216-Z-11 Ditch was deactivated in 1971 and replaced by the 216-Z-19 Ditch. The site was backfilled to grade when it was retired, and additional backfill material was added when the 216-Z-19 Ditch was deactivated in 1981. The 216-Z-11 Ditch has an estimated contamination burden of 137 Ci of plutonium-239 and 37 Ci of plutonium-240, and is reported as a transuranic-contaminated soil site (DOE-RL 1992).

Additional information on this waste site is provided in Section 2.2 of the *200-CW-5 U-Pond/ Z-Ditches Cooling Water Group Operable Unit RI/FS Work Plan* (DOE-RL 2000). Section 3.3 of the work plan contains information on the nature and extent of contamination and previous investigations.

1.4 CONTAMINANTS OF CONCERN

Step 1 of the DQO process identifies the need to develop a list of COCs for 200-CW-5 waste sites. Development of the list of COCs is an essential step toward refining the conceptual site model. From an initial list of more than 340 contaminants that potentially could have been discharged to 200-CW-5 waste sites, 66 COCs were retained as a result of the remedial investigation (RI) DQO process. Six additional COCs were added to the list through the investigation-derived waste (IDW) DQO process. Development of the COC lists is described in the DQO summary reports (BHI 1999, 2001b) and is summarized in Section 3.5 of the 200-CW-5 work plan (DOE-RL 2000).

Figure 1-1. Location of Waste Sites in the 200-CW-5 Operable Unit.



It is noted that the cleanup levels established by the *Model Toxics Control Act* (MTCA) (*Washington Administrative Code* [WAC] 173-340) have become less stringent for many chemical constituents since the 200-CW-5 RI DQO process was completed. Some of the constituents now carry action levels that are "not applicable" under the industrial land-use scenario. Of the affected constituents, four are also exempt from waste designation consideration, including chloride, cyclohexane, decane, and naphthylamine. Because there is no longer a basis for retaining these constituents as COCs, they are not included in this SAP. The RI COCs are identified in Table 1-1.

If contaminants not identified as COCs are detected during laboratory analysis, the data will be evaluated against regulatory standards, or risk-based levels if exposure data are available, and existing process knowledge in support of remedial action and waste designation decision making.

Table 1-1. Contaminants of Concern for 200-CW-5 Operable Unit. (2 Pages)

Radioactive Constituents		
Americium-241	Nickel-63[a]	Technetium-99[a]
Cesium-137	Niobium-94	Thorium-232
Cobalt-60	Plutonium-238	Tritium[a]
Curium-243	Plutonium-239/240	Uranium-234
Europium-152	Radium-226	Uranium-235
Europium-154	Radium-228	Uranium-236
Europium-155	Strontium-90	Uranium-238
Neptunium-237		
Chemical Constituents – Metals		
Arsenic	Copper	Nickel
Barium	Hexavalent chromium	Selenium
Beryllium	Lead	Silver
Cadmium	Mercury	Zinc
Chromium		
Chemical Constituents - Other Inorganics		
Fluoride	Sulfate	Sulfide
Nitrate		
Chemical Constituents - Volatile Organics		
Acetone	Chloroform (trichloromethane)	Tetrahydro furan
Acetonitrile	Dichloromethane	Toluene
2-butanone (MEK)	Hexane	Trichloroethene
Carbon tetrachloride	Perchloroethylene	Vinyl chloride
Chlorobenzene	Pseudo cumene (1,2,4 trimethyl benzene)	Xylenes

Table 1-1. Contaminants of Concern for 200-CW-5 Operable Unit. (2 Pages)

Semi-Volatile Organics		
Creosote	Normal paraffins	Tar
Cyclohexanone	Paint thinner	Tributyl phosphate
Kerosene[b]	Polychlorinated biphenyls (PCBs)	

[a] These COCs are deep-zone sensitive only. Analyses are not required for these COCs in the shallow zone (<7.6 m [25 ft] below ground surface) soils, as they are soft beta emitters in low abundance that have insignificant dose impact in the shallow zone.

[b] Analyzed as kerosene total petroleum hydrocarbons.

1.5 DATA QUALITY OBJECTIVES

The U.S. Environmental Protection Agency (EPA) document, *Guidance for the Data Quality Objectives Process* (EPA 1994), was used to support the development of this SAP. The DQO process is a strategic planning approach that provides a systematic process for defining the criteria that a data collection design should satisfy. Using the DQO process ensures that the type, quantity, and quality of environmental data used in decision making will be appropriate for the intended application.

This section summarizes the key outputs resulting from the implementation of the seven-step DQO process. Additional details are provided in the DQO summary reports (BHI 1999, 2001b).

1.5.1 Statement of the Problem

The primary objectives of the RI DQO process for the 200-CW-5 OU are to determine the environmental measurements necessary to refine the preliminary site conceptual model, support an evaluation of risk, and evaluate remedial alternatives. As identified in Section 5.3 of the 200-CW-5 work plan (DOE-RL 2000), possible remedial alternatives considered in the development of the DQO included the following:

- No-action alternative (no institutional controls)
- Capping
- Excavate and dispose of waste
- In situ vitrification
- In situ grouting and stabilization
- Monitored natural attenuation (with institutional controls).

The objective of the IDW DQO is to support the designation and disposal of the IDW from characterization activities in the 200-CW-5 OU. Therefore, data regarding radiological and chemical contamination are needed to determine the final disposition of the IDW.

1.5.2 Decision Rules

Decision rules (DRs) are developed from the combined results of DQO Steps 2, 3, and 4. These results include the principal study questions, decision statements, remedial action alternatives, data needs, COC action levels, analytical requirements, and the scale of the decisions. The DRs are generally structured as "IF…THEN" statements that indicate what action will be taken when a prescribed condition is met. The DRs incorporate the parameters of interest (e.g., COCs), the scale of the decision (e.g., location), the action level (e.g., COC concentration), and the actions that would result. The 200-CW-5 DRs are summarized in Table 1-2.

Table 1-2. Data Quality Objectives Decision Rules.[a] (2 Pages)

DR #	Decision Rule
1	If the 95% UCL of the mean or average (as applicable) detected SGL results and/or the maximum detected soil sampling results for the transuranic COCs in the 216-Z-11 Ditch sediment layer exceed the TRU definition of 100 nCi/g, then the chemical COCs will be evaluated in accordance with DR #4, and the need for special remedial alternatives will be evaluated in a FS. If the 95% UCL of the mean or average (as applicable) detected SGL results and/or the maximum detected soil sampling results for the transuranic COCs in the 216-Z-11 Ditch sediment layer do not exceed the TRU definition of 100 nCi/g, then the results will be evaluated by the RESRAD analytical model to determine if sediment layer exceeds the annual exposure limits for human health protection under the appropriate exposure scenario, the chemical COCs will be evaluated in accordance with DR #4, and the need for conventional remedial action[a] alternatives will be evaluated for the sediment layer in a FS.
2	If the RESRAD analysis of the 95% UCL of the mean or average (as applicable) detected SGL results and/or the maximum detected soil sampling results for the radiological COCs in the 216-Z-11 Ditch from the bottom of the sediment layer (about 3.6 m [12 ft] bgs) to 4.6 m (15 ft) bgs exceed or do not exceed the annual exposure limits for human health protection (under the appropriate scenario), then the chemical COCs will be evaluated in accordance with DR #5, and a FS will be performed to evaluate the need for remedial action[a] alternatives, or a streamlined approach to site closure will be applied administratively via an existing ROD.
3	If the RESRAD analysis of the 95% UCL of the mean or average (as applicable) detected SGL results and/or the maximum detected soil sampling results for the radiological COCs in the 216-Z-11 Ditch from 4.6 m (15 ft) bgs to 7.6 m (25 ft) bgs exceed or do not exceed the annual exposure limits for human health protection (under the appropriate scenario), then the chemical COCs will be evaluated in accordance with DR #6, and a FS will be performed to evaluate the need for remedial action[a] alternatives, or a streamlined approach to site closure will be applied administratively via an existing ROD.
4	If the analytical results of the 216-Z-11 Ditch sediment layer samples indicate that the three-part MTCA criteria or average detected values (as applicable) have or have not been met for the respective chemical COC preliminary action levels, then a FS will be performed to evaluate the need for remedial action[a] alternatives, or a streamlined approach to site closure will be applied administratively via an existing ROD.
5	If the analytical results of the 216-Z-11 Ditch from the bottom of the sediment layer (about 3.6 m [12 ft] bgs) to 4.6 m (15 ft) indicate that the three-part MTCA criteria or average detected values (as applicable) have or have not been met for the respective chemical COC preliminary action levels, then a FS will be performed to evaluate the need for remedial action[a] alternatives, or a streamlined approach to site closure will be applied administratively via an existing ROD.

Table 1-2. Data Quality Objectives Decision Rules.[a] (2 Pages)

DR #	Decision Rule
6	If the analytical results of the 216-Z-11 Ditch from 4.6 m (15 ft) bgs to 7.6 m (25 ft) indicate that the 95% UCL of the mean or average detected values (as applicable) have or have not been met for the respective chemical COC preliminary action levels, then a FS will be performed to evaluate the need for remedial action[a] alternatives, or a streamlined approach to site closure will be applied administratively via an existing ROD.
7	If the detected values indicate that the contamination distribution in the 0- to 7.6-m (0- to 25-ft) elevation and from 7.6 m (25 ft) to groundwater for the 216-Z-11 Ditch does not differ significantly from the preliminary contaminant distribution model, then the preliminary model will not be revised prior to use for remedial decision making or remedial action[a] planning. If the detected values indicate that the contamination distribution in the 0- to 7.6-m (0- to 25-ft) elevation and from –7.6 m (-25 ft) to groundwater for the 216-Z-11 Ditch differs significantly from the preliminary contaminant distribution model, then the preliminary model will be revised prior to use for remedial decision making or remedial action[a] planning.

Source: BHI 1999, Table 5-5.
[a] The use of the term "remedial action" is used collectively to refer to one of the alternatives described in the project objectives discussion.
bgs = below ground surface
FS = feasibility study
RESRAD = RESidual RADioactivity
ROD = Record of Decision
UCL = upper confidence limit

1.5.3 Error Tolerance and Decision Consequences

The consequence of selecting an inadequate nonstatistical sampling design is not considered severe. According to the guidance in Table 4-5a in the DQO summary report (BHI 1999), the sampling design rigor requirements are not significant because of the combination of low severity and continued accessibility of the 216-Z-11 Ditch for further sampling after RI sampling. If the sampling design is determined to be inadequate, additional sampling may be performed. Section 5.2 of the 200-CW-5 work plan (DOE-RL 2000) summarizes the sampling activities that are planned, as described in this SAP.

1.5.4 Sample Design Summary

A nonstatistical sampling design (i.e., professional judgment, biased) was used to determine sampling requirements for the 216-Z-11 Ditch. A biased sampling approach was developed from process knowledge, the expected behavior of COCs, the observed distribution of contamination in the other Z Ditches, and the preliminary conceptual site model developed for this waste group. To overcome the lack of historical data for the 216-Z-11 Ditch and the presence of a 1.8-m (6-ft)-thick blanket of stabilizing soil, a four-step characterization approach was developed to cost effectively locate and sample transuranic material "hot spots" and assess the nature and extent of other contaminants. Using this approach, sample locations are selected that increase the likelihood of encountering the worst-case conditions/maximum contaminant concentrations.

The preliminary site conceptual model suggests that highest contaminant concentrations should be detected near the bottom of the ditch and decrease with depth below the ditch bottom. Therefore, the sampling design focuses on sampling in the ditch sediment layer at the bottom of the 216-Z-11 Ditch. Sample frequency will decrease with depth below the ditch sediment layer based on the expected distribution of contamination. Additional samples may be collected at the discretion of the site geologist based on lithologic strata encountered and the field screening data. The sample design for this characterization is presented in Section 3.0 of this SAP.

The sample design developed for this SAP has several potential limitations that may affect the sampling results. Some of the factors that could affect the outcome of this sampling effort and an assessment of the possible contingencies are discussed in Section 3.3.6.

2.0 QUALITY ASSURANCE PROJECT PLAN

The quality assurance project plan (QAPjP) establishes the quality requirements for environmental data collection, including sampling, field measurements, and laboratory analysis. The overall QAPjP for environmental restoration waste sites in the 200 Areas is included in Appendix A of the Implementation Plan (DOE-RL 1999). The QAPjP complies with the requirements of the following:

- U.S. Department of Energy (DOE) O 414.1A, *Quality Assurance*
- 40 *Code of Federal Regulations* (CFR) 830.120, "Quality Assurance Requirements"
- *EPA Requirements for Quality Assurance Project Plans* (EPA 2001)
- *Hanford Analytical Services Quality Assurance Requirements Document* (DOE-RL 1998).

The Implementation Plan provides the general framework of technical and administrative requirements that apply to 200-CW-5 and other OUs in the 200 Areas.

The following sections describe the supplemental waste group quality requirements and the procedural controls applicable to this investigation. The 200 Areas QAPjP (Appendix A of the Implementation Plan [DOE-RL 1999]) and Section 2.0 of this SAP will serve as the QAPjP for the 200-CW-5 RI.

2.1 FIELD QUALITY CONTROL

Field quality control (QC) samples will be collected to evaluate the potential for cross-contamination and laboratory performance. Field QC for sampling in the 200-CW-5 OU will require the collection of field duplicates, field splits, equipment rinsate blanks, and trip blank samples. The QC samples and the required frequency for collection are described in this section.

The QC samples will not be collected from the ditch sediment layer (which is expected to contain TRU-contaminated soils) because of the extreme cost and handling requirements associated with TRU-contaminated materials; however, QC samples should be collected from the contaminated zone. Therefore, the QC sampling will begin at the first sampling interval that will be shipped to an offsite laboratory. The field duplicate and field split sample shall be retrieved from the same sample interval as the selected primary sample using the same equipment (collected from one split-spoon) and sampling technique.

Because of potential sample volume limitations, not all analytes need to be associated with the same split-spoon sample. For example, radiological QC samples may be collected from one split-spoon sample, and chemical constituent QC samples may be collected from the next interval. Reduced volumes may be used to ensure that a sufficient amount of QC material is available.

2.1.1 Field Duplicates

Field duplicates will be collected from a minimum frequency of 5% of total collected samples, or 1 field duplicate for every 20 samples (whichever is greater). The duplicate sample shall be retrieved from the same sample interval as the selected primary sample using the same equipment (collected from one split-spoon) and sampling technique. The sample media shall be homogenized, split into two separate aliquots in the field, and sent to the same laboratory. Field duplicates are used to evaluate the precision of field sampling methods.

2.1.2 Field Splits

One soil split sample shall be collected during soil sampling in the 216-Z-11 Ditch. The sample media shall be homogenized, split into two separate aliquots in the field, and sent to two independent laboratories. The split will be used to verify the performance of the primary laboratory.

The split sample will be obtained from sample media suitable for analysis in an offsite laboratory and shall be analyzed for all of the analytes listed in Table 2-1.

2.1.3 Equipment Rinsate Blanks

Equipment blanks shall be collected from a minimum of 5% of the total collected soil samples, or 1 equipment blank for every 20 samples (whichever is greater) and will be used to verify the adequacy of sampling equipment decontamination procedures. The field geologist may request that additional equipment blanks be taken. Equipment blanks shall consist of pure deionized water washed through decontaminated sampling equipment and placed in containers, as identified on the project sample authorization form (SAF). Note that the bottle and preservation requirements for water may differ from the requirements for soil.

Equipment rinsate blanks shall be analyzed for the following:

- Gross alpha
- Gross beta
- Metals (excluding hexavalent chromium and mercury)
- Anions (except cyanide)
- Semi-volatile organic analyte
- Volatile organic analytes.

These analytes are considered to be the best indicators of decontamination effectiveness.

2.1.4 Trip Blanks

The volatile organic trip blanks will constitute approximately 5% of all samples, which equates to approximately every sixth batch (cooler) of sample containers shipped. The trip blank shall consist of pure deionized water added to clean sample containers in the 3728 Sample Shipping

Facility. These containers will be transported to the field with the bottle set(s) and will be returned unopened to the laboratory. Trip blanks are prepared as a check for possible contamination originating from container preparation methods, shipment, handling, storage, or site conditions. The trip blank shall be analyzed only for volatile organic compounds.

Table 2-1. Analytical Performance Requirements. (4 Pages)

Analytical Method	Analyte	Preliminary Action Level	Detection Limit Requirements[a]	Accuracy Required	Precision Required
		RI/FS			
Radiological Constituents (pCi/g)					
AmAEA[b]	Americium-241	c	1	65-135	±35
HPGe/GeLi	Cesium-137	c	0.1	65-135	±35
HPGe/GeLi	Cobalt-60	c	0.1	65-135	±35
AmAEA[b]	Curium-243	c	1	65-135	±35
HPGe/GeLi	Europium-152	c	0.2	65-135	±35
HPGe/GeLi	Europium-154	c	0.2	65-135	±35
HPGe/GeLi	Europium-155	c	0.2	65-135	±35
NpAEA[b]	Neptunium-237	c	1	65-135	±35
Liquid scintillation	Nickel-63	c	30	65-135	±35
HPGe/GeLi	Niobium-94	c	1	65-135	±35
PuAEA[b]	Plutonium-238	c	1	65-135	±35
PuAEA[b]	Plutonium-239/240	c	1	65-135	±35
HPGe/GeLi	Radium-226	c	0.2	65-135	±35
HPGe/GeLi	Radium-228	c	0.2	65-135	±35
RADSr	Radiogenic strontium	c	1	65-135	±35
Liquid scintillation	Technetium-99	c	15	65-135	±35
ThAEA[b]	Thorium-232	c	1	65-135	±35
Liquid separation	Tritium	c	400	65-135	±35
UAEA[b]	Uranium-234	c	1	65-135	±35
	Uranium-235/236	c	1	65-135	±35
	Uranium-238	c	1	65-135	±35

Table 2-1. Analytical Performance Requirements. (4 Pages)

Analytical Method	Analyte	Preliminary Action Level		Detection Limit Requirements[a]	Accuracy Required	Precision Required
		Method C[d]	Groundwater Protection	RDL		
Inorganic Chemical Constituents[e] (mg/kg, or as noted)						
EPA 6010	Arsenic	87.5	1[f]	10/1[g]	h	h
EPA 6010	Barium	245,000	923	20	h	h
EPA 6010	Beryllium	7,000	63	0.5	h	h
EPA 6010	Cadmium	139[i]	0.7	0.5	h	h
EPA 6010	Chromium (III)	Unlimited	2,000	1	h	h
EPA 6010	Copper	130,000	263	2.5	h	h
EPA 7196	Hexavalent chromium	21[i]	18.4	0.5	h	h
Inorganic Chemical Constituents[e] (mg/kg)						
EPA 6010	Lead	1,000[j]	3,000	10	h	h
EPA 7471	Mercury	1,050	2.1	0.2	h	h
EPA 6010	Nickel	70,000[k]	130	4	h	h
EPA 6010	Selenium	17,500	5.2	10/1	h	h
EPA 6010	Silver	17,500	13.6	2	h	h
EPA 6010	Zinc	Unlimited	6,000	2	h	h
EPA 300.0	Fluoride	N/A	16	5	h	h
IC 300 modified and 353.1[l]	Nitrate/nitrite	350,000	4	2.5	h	h
EPA 300.0	Sulfate	N/A	1,000	5	h	h
EPA 9030	Sulfide	N/A	N/A	5	h	h
Organic Chemical Constituents (mg/kg)						
EPA 8260	Acetone	350,000	3.2	0.02	h	h
EPA 8260	Acetonitrile	N/A	N/A	0.1	h	h
EPA 8260	2-butanone (MEK)	Unlimited	N/A	0.01	h	h
EPA 8260	Carbon tetrachloride	1,010	0.005[f]	0.005	h	h
EPA 8260	Chlorobenzene	70,000	0.87	0.05	h	h
EPA 8260	Chloroform (trichloromethane)	21,500	0.038	0.005	h	h
EPA 8260/ 8270	Creosote/tar	N/A[m]	N/A[m]	m	h	h
EPA 8270 as TIC	Cyclohexanone	Unlimited	N/A	N/A	h	h
EPA 8260	Dichloromethane (methylene chloride)	17,500	0.022	0.005	h	h

Table 2-1. Analytical Performance Requirements. (4 Pages)

Analytical Method	Analyte	Preliminary Action Level		Detection Limit Requirements[a]	Accuracy Required	Precision Required
		Method C[d]	Groundwater Protection	RDL		
EPA 8260 as TIC	Hexane	210,000	N/A	N/A	h	h
EPA 8260	Perchloroethylene	100	0.0091	0.005	h	h
EPA 8080/ 8082	PCBs	10[j]	0.1[f]	0.1	h	h
EPA 8260 as TIC	Pseudo cumene (1,2,4 trimethyl benzene)	N/A	N/A	N/A	h	h
EPA 8260	Tetrahydro furan	N/A	N/A	0.05	h	h
EPA 8260	Toluene	700,000	73	0.005	h	h
EPA 8270	Tributyl phosphate	N/A	N/A	4	h	h
EPA 8260	Trichloroethene	11,900	0.025	0.005	h	h
EPA 8260	Vinyl chloride	87.5	0.01[f]	0.01	h	h
EPA 8260	Xylenes	Unlimited	91	0.01	h	h
NWTPH-Dx (modified for kerosene range)	Kerosene, normal paraffins, paint thinner	N/A	100	5	h	h
Soil Physical Properties						
D2216	Moisture content	N/A	N/A	wt%	N/A	N/A
D422	Particle size distributio	N/A	N/A	wt%	N/A	N/A
BHI-EE-01, Procedure 7.0	Lithology	N/A	N/A	Descriptive	N/A	N/A

[a] Detection limits are based on optimal conditions in a standard fixed laboratory. Interferences and matrix effects may degrade the values shown. If soil samples are determined to contain radiological contaminants in high concentrations, they will need to be analyzed in an onsite laboratory because of offsite laboratory acceptance criteria limits. In this case, expected impacts include high analytical costs, degradation of detection limits (i.e., four order-of-magnitude impact for the gamma isotopes), reduced analyte lists, and long turnaround times.

[b] AmAEA, PuAEA, UAEA, NpAEA, ThAEA – chemical separation, electro/microprecipitation deposition, alpha energy analysis via Si barrier detector.

[c] There are no preliminary action levels for radionuclides at this time; they will be developed during the RI/FS process.

[d] MTCA Method C industrial soil values for direct exposure form the CLARC Version 3.1 tables, updated November 2001 (Ecology 2001).

[e] Waste disposition for this project will comply with the Phase IV *Resource Conservation and Recovery Act of 1976* implementation requirements in accordance with 40 CFR 261.24 and 40 CFR 268.40. This applies to the toxicity characteristic metals, and require performance of toxicity characteristic leaching procedure (TCLP) analyses for sample results that exceed the land disposal restriction threshold values (determined by applying the 20 times totals values). If TCLP analyses are performed, the analyte list will be expanded to include antimony and thallium as potential underlying hazardous constituents.

[f] The calculated groundwater protection action level is less than the RDL. Therefore, the value shown is the RDL.

[g] First value shown is via routine inductively coupled plasma (ICP); the second value shown is via "trace" ICP or graphite furnace atomic absorption.

[h] Precision and accuracy requirements as identified and defined in the referenced EPA procedures as implemented through the *Hanford Analytical Services Quality Assurance Requirements Document* specifications (DOE-RL 1998).

[i] Calculated using MTCA air cleanup standards from WAC 173-303-750(3)(a)(ii)(B), page 210, equation 750-2, with Washington State Department of Health mass loading of particulates in air of 10^{-4} g/m^3.

[j] MTCA Method A values from Tables 740-1 and 745-1 of WAC 173-340-900, amended February 12, 2001.

[k] Based on nickel or uranium soluble salts value.

Table 2-1. Analytical Performance Requirements. (4 Pages)

Analytical Method	Analyte	Preliminary Action Level		Detection Limit Requirements[a]	Accuracy Required	Precision Required
		Method C[d]	Groundwater Protection	RDL		

[l] Nitrate/nitrite analysis yields total nitrogen.
[m] Creosote and tar are mixtures of volatile and semi-volatile constituents. The principle constituents found in creosote and tar will be detected and reported by the EPA 8260 and EPA 8270 suite analyses. If present, these constituents will be evaluated against the appropriate action levels in the same manner as the other COCs listed in this table.
GeLi = lithium drifted germanium
HPGe = high-purity germanium
N/A = not applicable
RDL = required detection limit
TIC = tentatively identified compound

2.1.5 Prevention of Cross-Contamination

Special care should be taken to prevent cross-contamination of soil samples. Particular care will be exercised to avoid the following common ways in which cross-contamination or background contamination may compromise the samples:

- Improperly storing or transporting sampling equipment and sample containers
- Contaminating the equipment or sample bottles by setting the equipment/sample bottle on or near potential contamination sources (e.g., uncovered ground)
- Handling bottles or equipment with dirty hands
- Improperly decontaminating equipment before sampling or between sampling events.

2.2 QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

Quality objectives and criteria for soil measurement data are presented in Table 2-1 for chemical and radiological analytes, as well as physical properties of interest. Table 2-2 provides the analytical performance requirements for SGL. Analysis of soil physical properties will be performed according to American Society for Testing and Materials (ASTM) procedures, if applicable.

2.3 SAMPLE PRESERVATION, CONTAINERS, AND HOLDING TIMES

Soil sample preservation, containers, and holding times for chemical and radiological analytes of interest and physical property test are presented in Table 2-3. Final sample collection requirements will be identified on the SAF.

Table 2-2. Analytical Performance Requirements for Spectral Gamma Logging.

Data Type	Analytical Method	Analyte	Preliminary Action Level	Detection Limit Requirements[a]		Accuracy Required	Precision Required
				MDL	RDL		
Rad, γ	HPGe	Americium-241	100 nCi/g	~25 nCi/g	--	70-130	±30
Rad, γ	HPGe	Cesium-137	a	0.3 pCi/g	--	70-130	±30
Rad, γ	HPGe	Cobalt-60	a	0.2 pCi/g	--	70-130	±30
Rad, γ	HPGe	Europium-152	a	2 pCi/g	--	70-130	±30
Rad, γ	HPGe	Europium-154	a	2 pCi/g	--	70-130	±30
Rad, γ	HPGe	Europium-155	a	5 pCi/g	--	70-130	±30
Rad, γ	HPGe	Neptunium-237	100 nCi/g	~100 pCi/g	--	70-130	±30
Rad, γ	HPGe	Plutonium-239/240	100 nCi/g	~50 nCi/g	--	70-130	±30

[a] There are no preliminary action levels for these radionuclides at this time; they will be developed during the RI/FS process.
γ = gamma analysis
MDL = method detection limit
RDL = required detection limit

Table 2-3. Sample Preservation, Container, and Holding Time Guidelines. (2 Pages)

Analytes	Analytical Priority	Matrix	Bottle		Volume[a]	Preservation	Packing Requirements	Holding Time
			Number	Type				
Radionuclides								
Americium AEA	2	Soil	1	G/P	10 g	None	None	6 months
Gamma spectroscopy	4	Soil	1	G/P	1,500 g	None	None	6 months
Carbon-14	10[b]	Soil	1	G/P	10g	None	None	6 months
Isotopic plutonium	1	Soil	1	G/P	10 g	None	None	6 months
Isotopic thorium	8	Soil	1	G/P	6 g	None	None	6 months
Isotopic uranium	7	Soil	1	G/P	10 g	None	None	6 months
Neptunium-237	4	Soil	1	G/P	10 g	None	None	6 months
Nickel-63	10[b]	Soil	1	G/P	6 g	None	None	6 months
Radiogenic strontium	6	Soil	1	G/P	10 g	None	None	6 months
Technetium-99	10[b]	Soil	1	G/P	6 g	None	None	6 months
Tritium – H-3	15	Soil	1	G	100 g	None	None	6 months
Chemicals								
Alcohols, glycols, and ketones – 8015	11	Soil	3	G	40 mL	None	Cool 4°C	14 days
IC anions – 300.0	17	Soil	1	G/P	250 g	None	Cool 4°C	28 days/ 48 hours
ICP metals – 6010A (TAL + add-on)	3	Soil	1	G/P	125 g	None	None	6 months
Hexavalent chromium – 7196	13	Soil	1	G/P	60 g	None	Cool 4°C	30 days
Mercury – 7471 – (CV)	12	Soil	1	G	125 g	None	None	28 days
PCBs – 8082	5	Soil	1	G	250 g	None	Cool 4°C	14/40 days
SVOA – 8270A (TCL)	10	Soil	1	G	250 g	None	Cool 4°C	14/40 days

Table 2-3. Sample Preservation, Container, and Holding Time Guidelines. (2 Pages)

Analytes	Analytical Priority	Matrix	Bottle		Volume[a]	Preservation	Packing Requirements	Holding Time
			Number	Type				
Sulfides – 9030	14	Soil	1	G	40 g	None	Cool 4°C	7 days
Total petroleum hydrocarbons – kerosene range	9	Soil	1	G	200 g	None	Cool 4°C	14 days
Hydrazine – ASTM-D1385	19	Soil	1	G	50 g	None	Cool 4°C	14 days
Methanol – VOA-8015	19	Soil	1	G	50 g	None	Cool 4°C	14 days
VOA – 8260A (TCL)	16	Soil	1	G	50 g	None	Cool 4°C	14 days
Physical Properties								
Moisture content – ASTM D2216	18	Soil	1	M	Moisture tin	None	None	None
Particle size distribution – ASTM D422	18	Soil	1	G/P	1,000g	None	None	None
Lithology – BHI-EE-01, Procedure 7.0	18	Soil	Descriptive					

[a] Optimal volumes, which may be adjusted downward to accommodate the possibility of small sample recoveries. Minimum sample size will be defined in the SAF.
[b] These radionuclides are COCs in the deep zone only and will only be analyzed for in the deeper borehole samples (7.6 m [>25 ft]).
AEA = alpha energy analysis
aG = amber glass
ASAP = as soon as possible
CV = cold vapor
G = glass
IC = ion chromatography
M = metal
P = plastic
SVOA = semi-volatile organic analyte
TAL = target analytical list
TCL = target compound list
VOA = volatile organic analyte

2.4 ONSITE MEASUREMENTS QUALITY CONTROL

The collection of QC samples for onsite measurements QC is not applicable to field screening techniques described in this SAP. Field screening instrumentation will be calibrated and controlled according to the procedures identified in Section 2.7.

2.5 DATA MANAGEMENT

Data resulting from the implementation of this QAPjP shall be managed and stored by the Environmental Restoration Contractor (ERC) organization responsible for sampling and characterization, in accordance with BHI-EE-01, *Environmental Investigations Procedures*, Section 2.0, "Sample Management." At the direction of the task lead, all analytical data packages shall be subject to final technical review by qualified personnel before their submittal to the regulatory agencies or before inclusion in reports. Electronic data access, when appropriate, shall be via a database (e.g., Hanford Environmental Information System [HEIS] or a project-specific database). Where electronic data are not available, hard copies shall be provided in accordance with Section 9.6 of the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1998).

2.6 VALIDATION AND VERIFICATION REQUIREMENT

Validation shall be performed on completed data packages by qualified ERC Sample Management personnel or by a qualified independent contractor. Validation shall consist of verifying required deliverables, requested versus reported analyses, and transcription errors. Validation shall also include the evaluation and qualification of results based on holding time, method blanks, matrix spikes, laboratory control samples, laboratory duplicates, and chemical and tracer recoveries, as appropriate to the methods used. No other validation or calculation checks will be performed. At least 5% of all data shall be validated. Validation requirements identified in this section are consistent with Level C validation, as defined in data validation procedures (BHI 2000a, 2000b). No validation will be performed for physical data.

2.7 TECHNICAL PROCEDURES AND SPECIFICATIONS

Soil sampling and onsite environmental measurements shall be performed according to approved procedures. Sampling and field measurements will be conducted in accordance with BHI-EE-01; BHI-EE-05, *Field Screening Procedures*; and the other approved procedures listed below. Individual procedures that may be used during performance of this SAP include the following:

- BHI-EE-01, Environmental Investigations Procedures

  <u>Section 1.0, General Information</u>

  - Procedure 1.5, "Field Logbooks"
  - Procedure 1.6, "Survey Requirements and Techniques"

  <u>Section 2.0, Sample Management</u>

  - Procedure 2.0, "Sample Event Coordination"
  - Procedure 2.1, "Sampling Documentation Processing"

  <u>Section 3.0, General Sampling</u>

  - Procedure 3.0, "Chain of Custody"
  - Procedure 3.1, "Sample Packaging and Shipping"
  - Procedure 3.2, "Field Decontamination of Sampling Equipment"

  <u>Section 4.0, Soil, Groundwater, and Biotic Sampling</u>

  - Procedure 4.0, "Soil and Sediment Sampling"

  - Procedure 4.2, "Sample Storage and Shipping Facility"

  Section 6.0, Drilling

  - Procedure 6.2, "Field Cleaning and/or Decontamination of Geoprobe Drilling Equipment"

  Section 7.0, Geologic and Hydrologic Data Collection

  - Procedure 7.0, "Geologic Logging"
  - Procedure 7.2, "Geophysical Survey Work"

- BHI-EE-05, Field Screening Procedures
  - Procedure 1.0, "Routine Field Screening"
  - Procedure 2.5, "Operation of Mobile Surface Contaminant Monitor II"

Work shall also be performed in accordance with the following manuals:

- BHI-EE-02, *Environmental Requirements*, Section 11.0, "Solid Waste System Operations"
- BHI-QA-01, *ERC Quality Program*
- BHI-QA-03, *ERC Quality Assurance Program Plans*
  - Plan No. 5.1, "Field Sampling Quality Assurance Program Plan"
  - Plan No. 5.2, "Onsite Measurements Quality Assurance Program Plan"
  - Plan No. 5.3, "Environmental Radiological Measurements Quality Assurance"
- BHI-MA-02, ERC Project Procedures
- BHI-SH-01, ERC Safety and Health Program
- BHI-SH-05, Industrial Hygiene Work Instructions
- BHI-SH-02, Vols. 1, 3, and 4, Safety and Health Procedures
- BHI-EE-10, Waste Management Plan
- BHI-RC-04, Radiological Control Work Instructions, Instruction 4.2, "Radiological Surveys"
- Specification for environmental drilling services specific to 200-CW-5
- Sampling Services Procedures Manual, ES-SSPM-001, Procedure 2.5, "Laboratory Cleaning of Sampling Equipment" (WMNW 1998).

2.7.1 Sample Location

Sample locations (e.g., geophysical surveys and the borehole) shall be staked and labeled prior to starting the activity. The locations shall be staked by the technical lead or the field team leader assigned by the project manager. After the sample locations have been staked, minor adjustments to the location may be made to mitigate unsafe conditions, avoid structural interferences, or bypass utilities. Sample locations shall be identified during or after sampling in accordance with BHI-EE-01, Procedure 1.6, "Survey Requirements and Techniques." Changes in sample locations that do not impact the DQOs will require approval of the project manager; however, changes to sample locations that result in impacts to the DQOs will require EPA concurrence.

2.7.2 Sample Identification

The ERC Sample and Data Tracking database will be used to track the samples from the point of collection and through the laboratory analysis process. The HEIS database is the repository for the laboratory analytical results. The HEIS sample numbers will be issued to the sampling organization for this project in accordance with BHI-EE-01, Procedure 2.0, "Sample Event Coordination." Each chemical/radiological and physical properties sample will be identified and labeled with a unique HEIS sample number. The sample location, depth, and corresponding HEIS numbers will be documented in the sampler's field logbook.

Each sample container will be labeled with the following information using a waterproof marker on firmly affixed, water-resistant labels:

- HEIS number
- Sample collection date/time
- Name of person collecting the sample
- Analysis required
- Preservation method (if applicable).

2.7.3 Field Sampling Log

All information pertinent to field sampling and analysis will be recorded in bound logbooks in accordance with BHI-EE-01, Procedure 1.5, "Field Logbooks." The sampling team will be responsible for recording all relevant sampling information including, but not limited to, the information listed in Appendix A of BHI-EE-01, Procedure 1.5. Entries made in the logbook will be dated and signed by the individual who made the entry.

2.7.4 Sample Custody

A chain-of-custody record will be initiated in the field at the time of sampling and will accompany each set of samples shipped to the laboratory(ies) in accordance with BHI-EE-01, Procedure 3.0, "Chain of Custody." The analyses requested for each sample will be indicated on the accompanying chain-of-custody form. Chain-of-custody procedures will be followed throughout sample collection, transfer, analysis, and disposal to ensure that sample integrity is maintained. Each time responsibility for custody of the sample changes, the new and previous custodians will sign the record and note the date and time. The sampler will make a copy of the signed record before sample shipment and transmit it to ERC Sample Management within 24 hours of shipping, as detailed in BHI-EE-01, Procedure 2.1, "Sampling Documentation Processing."

A custody seal (i.e., evidence tape) shall be used for each sample jar to demonstrate that tampering has not occurred. The container seal will be inscribed with the sampler's initials and the date sealed. For any sample jars collected inside the glovebag or glovebox and "bagged out," the evidence tape may be affixed to the seal of the bag to demonstrate that tampering has not occurred. This will eliminate problems associated with contaminated soils adhering to the custody tape while inside the glovebox.

2.7.5 Sample Containers and Preservatives

Level I EPA pre-cleaned sample containers will be used for soil samples collected for chemical and radiological analysis. Container sizes may vary depending on laboratory-specific volumes/requirements for meeting analytical detection limits. If, however, the dose rate on the outside of a sample jar or the curie content exceeds levels acceptable by an offsite laboratory, the sampling lead and task lead can send smaller volumes to the laboratory after consultation with ERC Sample Management to determine acceptable volumes. Preliminary container types and volumes are identified in Table 2-3. The final types and volumes will be indicated on the SAF.

2.7.6 Sample Shipping

The outside of each sample jar will be surveyed by the radiological control technician (RCT) to verify that the container is free of smearable surface contamination. The RCT shall also measure the radiological activity on the outside of the sample container (through the container) and will mark the container with the highest contact radiological reading in either disintegrations per minute (dpm) or mrem/hr, as applicable. Unless pre-qualified, all samples will have total activity analysis performed before shipment by the Radiological Counting Facility, the 222-S Laboratory, or other suitable onsite laboratory. This information and other data that may pre-qualify the samples will be used to select proper packaging, marking, labeling, and shipping paperwork in accordance with U.S. Department of Transportation regulations (49 CFR) and to verify that the sample can be received by the offsite analytical laboratory in accordance with the laboratory's acceptance criteria.

As a general rule, samples with activities less than 1 mR/hr will be shipped to an offsite laboratory. Samples with activities between 1 mR/hr and 10 mR/hr may be shipped to an offsite laboratory; samples with activities in this range will be evaluated on a case-by-case basis by ERC Sample Management. Samples with activities greater than 10 mR/hr will be sent to an onsite laboratory as arranged by ERC Sample Management. Potential impacts of onsite laboratory measurements are discussed in footnote "a" of Table 2-1.

3.0 FIELD SAMPLING PLAN

3.1 SAMPLING OBJECTIVES

The DQO summary report for 200-CW-5 (BHI 1999) concluded that the historical characterization data available for the 216-U-10 Pond and 216-U-14 Ditch met the needs of the DQO for remedial action decision making, but the lack of data available for the 216-Z-11 Ditch imposes the need for additional characterization. The following characterization goals exist for this project:

- Determine the probable locations of transuranic material hot spots based on ditch hydraulics and physical features.
- Determine the maximum concentrations of transuranic materials present in the identified hot spots.
- Obtain characterization data for the chemical constituents in the 216-Z-11 Ditch.

Based on the preliminary conceptual site model, the majority of the contamination is expected to be present in the ditch sediment layer. Because the Z Ditches were stabilized with approximately 1.8 m (6 ft) of cover soils, intrusive techniques must be employed to obtain samples for laboratory analysis. The presence of the stabilizing fill material and the lack of ditch location coordinates indicated that a multi-step sampling approach would be needed to minimize cost and to focus the sampling in the most highly contaminated locations. Therefore, a characterization approach was developed that includes the following four steps: (1) surface geophysical surveys, (2) GG/PN logging in driven soil probes, (3) soil sample collection via borehole, and (4) discharge pipeline sludge characterization. These four steps are discussed in the following text and are summarized in Table 3-1.

Additional vapor sampling has been included in this SAP to support the dispersed carbon tetrachloride vadose zone plume investigation for the 200-PW-1 OU RI characterization. The borehole planned for soil sampling to groundwater may also be completed as a groundwater well, and not abandoned in place. The decision to perform additional sampling and/or convert the borehole for groundwater monitoring will be made by the DOE and EPA project managers.

3.2 SURFACE RADIATION SURVEYS

Surface radiation surveys are a project baseline activity that will be performed over the 216-Z-11 Ditch. The surveys will identify existing surface contamination and support preparation of supporting health and safety documents. Surface radiation surveys shall be conducted by qualified RCTs in accordance with BHI-EE-05, Procedure 2.5, “Operation of the Mobile Surface Contamination Monitor II,” or other applicable approved procedures, as necessary. A post-sampling survey will also be performed to document changes to the surface contamination levels as a result of sampling activities.

Table 3-1. Key Features of the Sampling Design for the 216-Z-11 Ditch. (3 Pages)

Sample Collection Methodology	Key Features of Design	Basis for Sampling Design
Step 1 Vadose Zone Characterization		
Surface geophysical surveys (GPR and EMI)	Perform GPR/EMI over the width of the Z Ditches in series of transects at up to seven locations shown in Figure 3-1. The GPR/EMI surveys will begin over the ditch headwall and the first few feet of the ditches to provide a baseline definition of the ditch profile that supports interpretation of results from later transect surveys. Each of the survey transects will be closely spaced parallel lines to maximize the coverage over the survey areas.	GPR/EMI are expected to distinctly identify the 216-Z-11 Ditch relative to the other Z Ditches. It is the first step in a three-step vadose zone characterization sequence. It will identify the parallel Z Ditches in the "X-Y" plane and the depth bgs. The results of the GPR will be evaluated to locate the soil probes for geophysical logging.
Step 2 Vadose Zone Characterization		
GG/PN logging of driven soil probes	Install soil probes to a depth of 4.9 m (16 ft) bgs for GG/PN logging. Nominally, three probes will be installed at each of up to five transects across the 216-Z-11 Ditch. The locations will be based on interpretation of the geophysical surveys. Soil probe material will be 0.636-cm (2.5-in.) -diameter, 0.0762-cm- (0.3-in.)-thick steel.	GG/PN is expected to effectively locate the areas of high Am-241, Pu-239/240, and Np-237 (Pa-233) on the basis of gross activity. Americium and plutonium are expected to coincide in the vertical strata due to similar chemical behavior. These are the target isotopes for gamma detection because of characteristic gamma emissions and the absence of interfering gamma isotopes. Passive neutron detection is effective in TRU-contaminated soils because the α-η reaction greatly multiplies the neutron flux in the soil environment. The results of the GG/PN readings will be evaluated to identify the preferred location and depths for borehole soil sampling.

Table 3-1. Key Features of the Sampling Design for the 216-Z-11 Ditch. (3 Pages)

Sample Collection Methodology	Key Features of Design	Basis for Sampling Design
Step 3 Vadose Zone Characterization		
Borehole drilling and soil sampling	***Sampling from Surface to 7.6 m (25 ft) bgs***	
	One deep borehole (to groundwater) will be installed based on the highest readings from the GG/PN data. The borehole casing size will be reduced (at approximately 2.1 m [7 ft] bgs) to prevent "drag-down" of contaminants from the high contaminant concentration (sediment) layer into the moderate contaminant concentration zone. Collect samples at 15-cm (6-in.) intervals within the first 0.6 m (2 ft) of the ditch sediment layer. Collect samples at 0.6-m (2-ft) intervals at 0.8-, 1.5-, and 2.3-m (2.5-, 5-, and 7.5-ft) depths below the ditch bottom, then at 4 to 4.7 m (13 to 15.5 ft) and 7 to 7.7 m (23 to 25.5 ft) bgs. Critical sampling depths are the top 0.6 m (2 ft) of the ditch sediment layer, 4 to 4.7 m (13 to 15.5 ft) bgs and 7 to 7.7 m (23 to 25.5 ft) bgs.	Soil samples are required to determine the transuranic concentrations in the ditch sediment layer and in the underlying soils. Sampling to 7.6 m (25 ft) bgs provides COC data at depths significant to remedial action decision making and to confirm the preliminary conceptual vertical contaminant distribution model.
	Sampling from 7.6 m (25 ft) bgs to Groundwater	
	At a depth of 7.6 m (25 ft) bgs, the borehole casing size will be reduced to prevent "drag-down" of contaminants into the deeper vadose zone. Collect samples at 15-m (50-ft) intervals from 15 m (50 ft) bgs to groundwater (15, 30, 46, 61, and 73 m [50, 100, 150, 200, and 238 ft] bgs).	Soil samples are required in the deeper vadose zone (to groundwater) to confirm the preliminary conceptual vertical contaminant distribution model. The sample collected at the 73-m (238-ft) depth bgs is set just above the current water table.
	Borehole Spectral, Moisture, and GG/PN Logging	
	Perform borehole spectral logging in the borehole installed for soil sampling. Perform neutron moisture monitoring (requires proper calibration for the borehole environment) and GG/PN geophysical logging as well.	The SGL will be performed in borehole to expand the SGL database and to compare the SGL data with the sample analytical results. Neutron moisture logging provides a vertical vadose zone moisture profile. The GG/PN results will be used to provide an approximate correlation to the GG/PN results obtained in the driven soil probes.
	Perform borehole spectral logging in accessible boreholes and groundwater wells near the Z Ditches. The ERC's well status records indicate that well 299-W18-15 is accessible.	These data will be collected to expand the Z Ditches SGL database. Table 3-5 provides location information for well 299-W18-15.

Table 3-1. Key Features of the Sampling Design for the 216-Z-11 Ditch. (3 Pages)

Sample Collection Methodology	Key Features of Design	Basis for Sampling Design
Discharge Pipeline Characterization		
Z Ditch discharge pipe characterization	Open one of the manhole access ports in the 46-cm (18-in.)–diameter VCP Z Ditch discharge pipe from the 231-Z Plant (Figures 3-2 and 3-3) for remote video inspection and spectral gamma assay using NaI and/or HPGe detectors.	The manhole ports will be characterized to assess impacts on remedial decision making and for health and safety purposes.
	Open one of the manhole access ports in the 38-cm (15-in.)-diameter VCP Z Ditch discharge pipe from the 234-5Z/291-Z Plants (Figures 3-2 and 3-3) for remote video inspection and spectral gamma assay using NaI and/or HPGe detectors.	

NaI = sodium iodide
VCP = vitrified clay pipe

3.3 216-Z-11 DITCH CHARACTERIZATION

The logic used to develop the characterization approach for the 216-Z-11 Ditch is based on the physical constraints present at the site. The use of the characterization techniques identified in this SAP is expected to yield meaningful radiological and chemical characterization data. The sampling design includes three vadose zone characterization steps and one discharge pipe characterization activity:

- Surface geophysical surveys over the 216-Z-11 Ditch
- GG/PN logging in driven soil probes in selected locations over the 216-Z-11 Ditch
- Borehole soil sampling of the 216-Z-11 Ditch
- Characterization of the sludge through manhole access ports in the Z Ditch discharge piping between the Z Plant and the 216-Z-11 Ditch.

The first three vadose zone characterization steps listed above will be performed in sequence to effectively locate and sample the soils within the ditch. The pipeline characterization activity may be performed at any time because it is remote from the ditch and is not dependent on ditch characterization activities. The individual characterization techniques are described further in the following subsections.

Figure 3-1. Location of Planned Surface Geophysical Surveys at 216-Z Ditches (with 216-Z-19 Ditch Shown as Open).

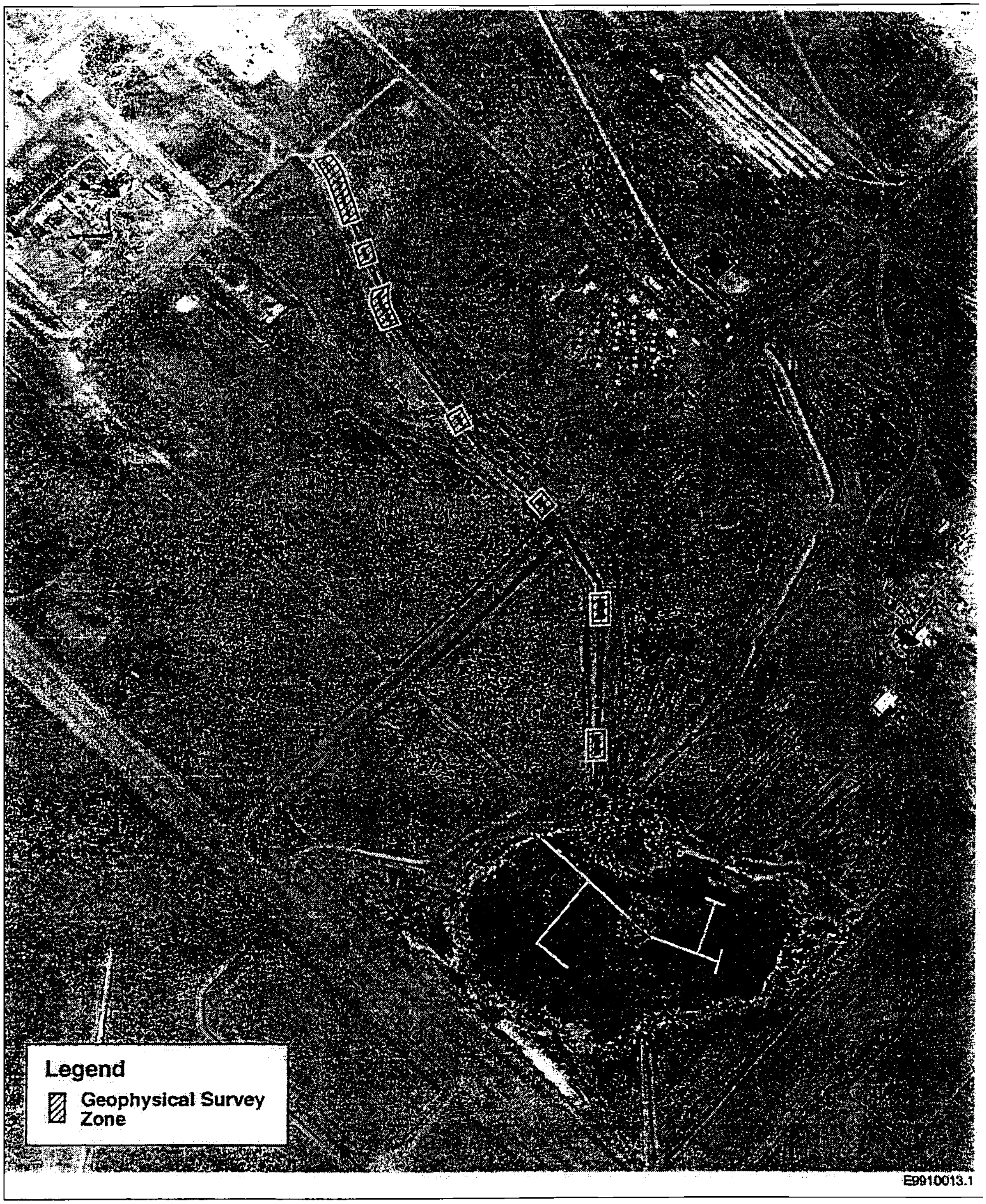


Figure 3-2. Z Ditch Discharge Pipeline Area and Manhole Locations.

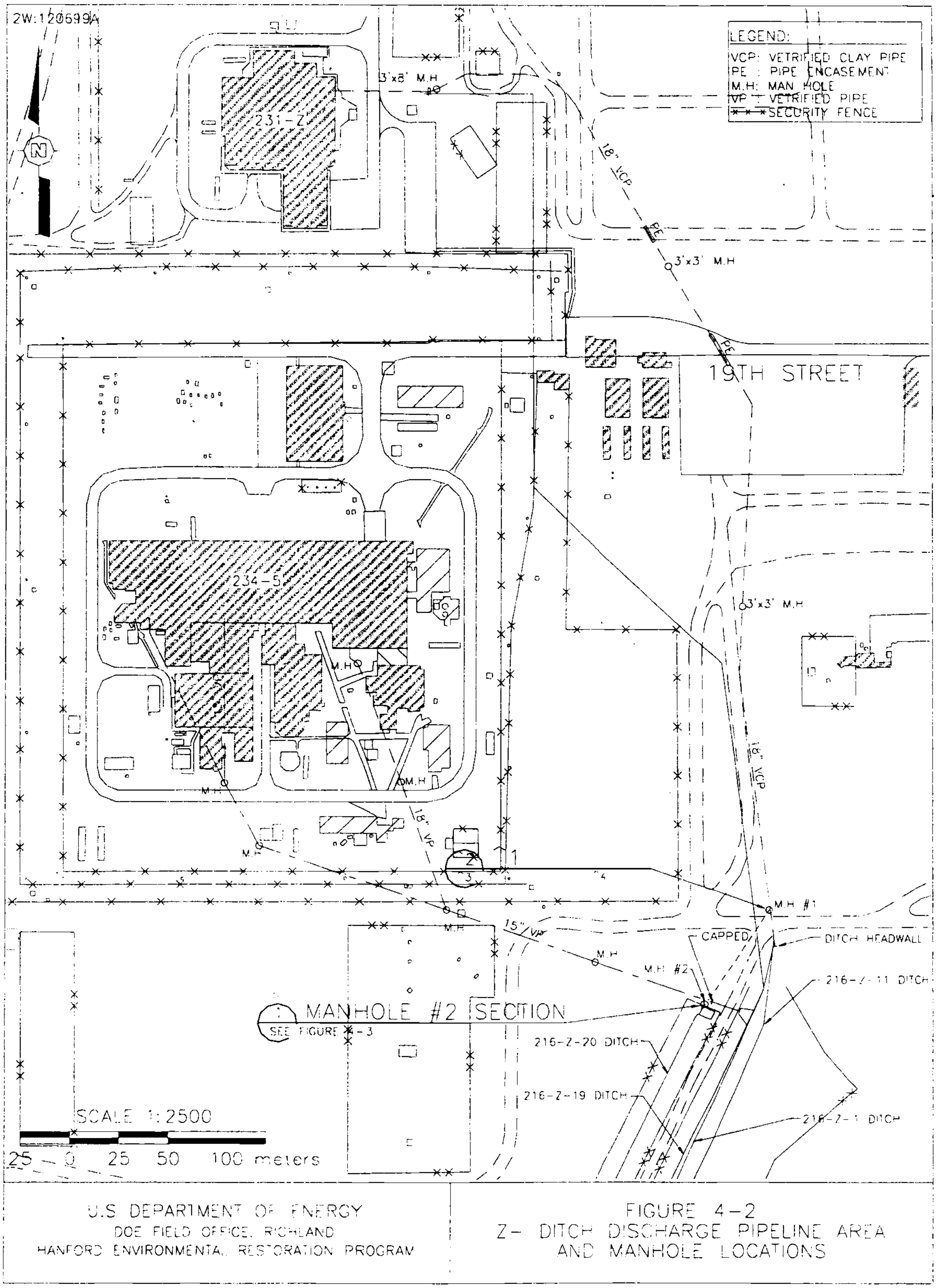
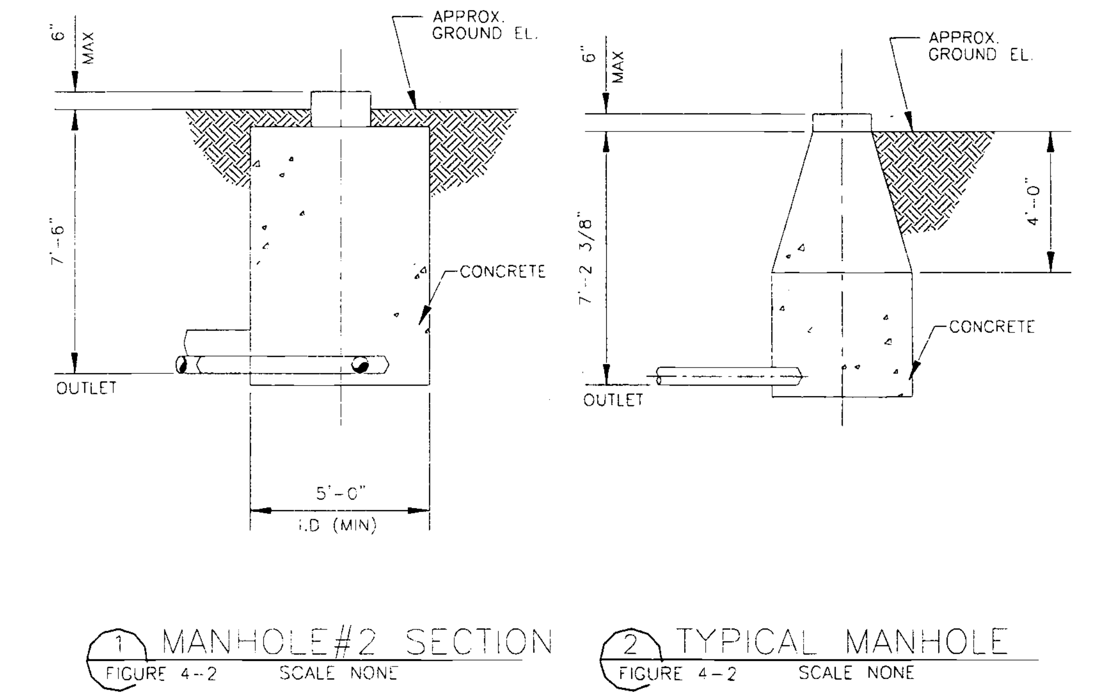


Figure 3-4. Typical Section Views of Manholes in Z Ditch Pipelines.

2W:1206998



NOTES.
1. ALL DIMENSION SHOWN ARE REFERENCED IN FEET AND INCHES

U.S DEPARTMENT OF ENERGY DOE FIELD OFFICE, RICHLAND HANFORD ENVIRONMENTAL RESTORATION PROGRAM	FIGURE 4-3 TYPICAL SECTION VIEWS OF MANHOLES IN Z-DITCH PIPELINES

CH_11ERC.DWG

3.3.1 Surface Geophysical Surveys

One of the primary objectives of the soil sampling in the 216-Z-11 Ditch is to locate and sample the radiological hot spot areas for laboratory analysis. However, the stabilizing fill placed on the site for contamination control purposes rendered the site unrecognizable from the surrounding features. The unrecognizable location of the site combined with a lack of accurate site photographs or coordinates defined the first challenge of the characterization: to locate the site. Historical records indicate that the stabilizing fill is shallow (nominally 1.8 m [6 ft] thick) and the ditch bottom is covered with a fine-grained layer of sediment. The configuration of the ditch is expected to work well with surface geophysical survey techniques, because the depth of stabilizing fill material is within the range of the current surface scanning technologies, and the fine-grained sediment layer should act as a reflecting media for survey signals. Therefore, surface geophysical survey techniques were chosen as the first vadose zone characterization activity.

Two geophysical survey techniques will be used to locate the 216-Z-11 Ditch, including GPR and EMI. Historical sampling data from the other Z Ditches indicate that fluid velocity changes likely caused sediments to deposit, thus creating radiological hot spots. Historical aerial photographs and site maps were studied in an effort to select locations where fluid velocity changes were likely. As a result, seven locations were identified over the presumed location of the 216-Z-11 Ditch for surface geophysical surveys, which included areas between the head-end of the discharge pipe and the 216-U-10 Pond. Figure 3-1 shows the planned locations for performance of surface geophysical surveys.

3.3.1.1 Ground-Penetrating Radar. GPR uses a transducer to transmit FM frequency electromagnetic energy into the ground. Interfaces in the ground, defined by contrasts in dielectric constants, magnetic susceptibility, and to some extent, electrical conductivity, reflect the transmitted energy. The GPR system then measures the travel time between transmitted pulses and arrival of reflected energy. Geologic features (i.e., cross-bedding, lateral and vertical changes in soil properties, and rock interfaces) can cause reflections of a portion of the electromagnetic energy.

The reflected energy provides the means for mapping the subsurface features of interest, whether synthetic or geologic. Display and interpretation of GPR data are similar to that of seismic reflection data. When numerous adjacent profiles are collected, often in two orthogonal directions, a plan view map showing the location and depth of features can be generated.

3.3.1.2 Electromagnetic Induction. EMI is a noninvasive method of detecting, locating, and/or mapping shallow subsurface features, and it is a good complementary tool for use with GPR because of its response to subsurface anomalies and ability to quickly obtain reconnaissance-level information over large areas to help focus GPR efforts. The EMI techniques are used to determine the electrical conductivity of the subsurface soil, rock, and groundwater. They are generally used for shallow investigations. The method is based on a transmitting coil radiating an electromagnetic field that induces eddy currents in the earth. A resulting secondary electromagnetic field is measured at a receiving coil as a voltage that is linearly related to the subsurface conductivity.

3.3.2 Gross Gamma and Passive Neutron Logging of Driven Soil Probes

Characterization data provided by Last et al. (1994) indicate that contamination concentrations varied significantly across the ditch bottom. This led to the conclusion that a screening technique was needed to optimize the selection of a borehole location based on indications of radiological activity. Because the ditch sediment layer is buried, the screening technique would need to be intrusive. Therefore, a geophysical logging technique for use in small-diameter driven soil probes was identified as the second characterization activity for the 216-Z-11 Ditch.

The 216-Z-11 Ditch will be logged with a small-diameter GG/PN logging system to determine the distribution and gross concentrations of the americium-241, plutonium-239, and neptunium-237 (via their gamma and neutron emissions) along the length of the ditch and vertically. The results will be used to locate the transuranic material hot spots for subsequent borehole soil sampling and laboratory analysis. These methods are described in Section 4.3 of the 200-CW-5 work plan (DOE-RL 2000).

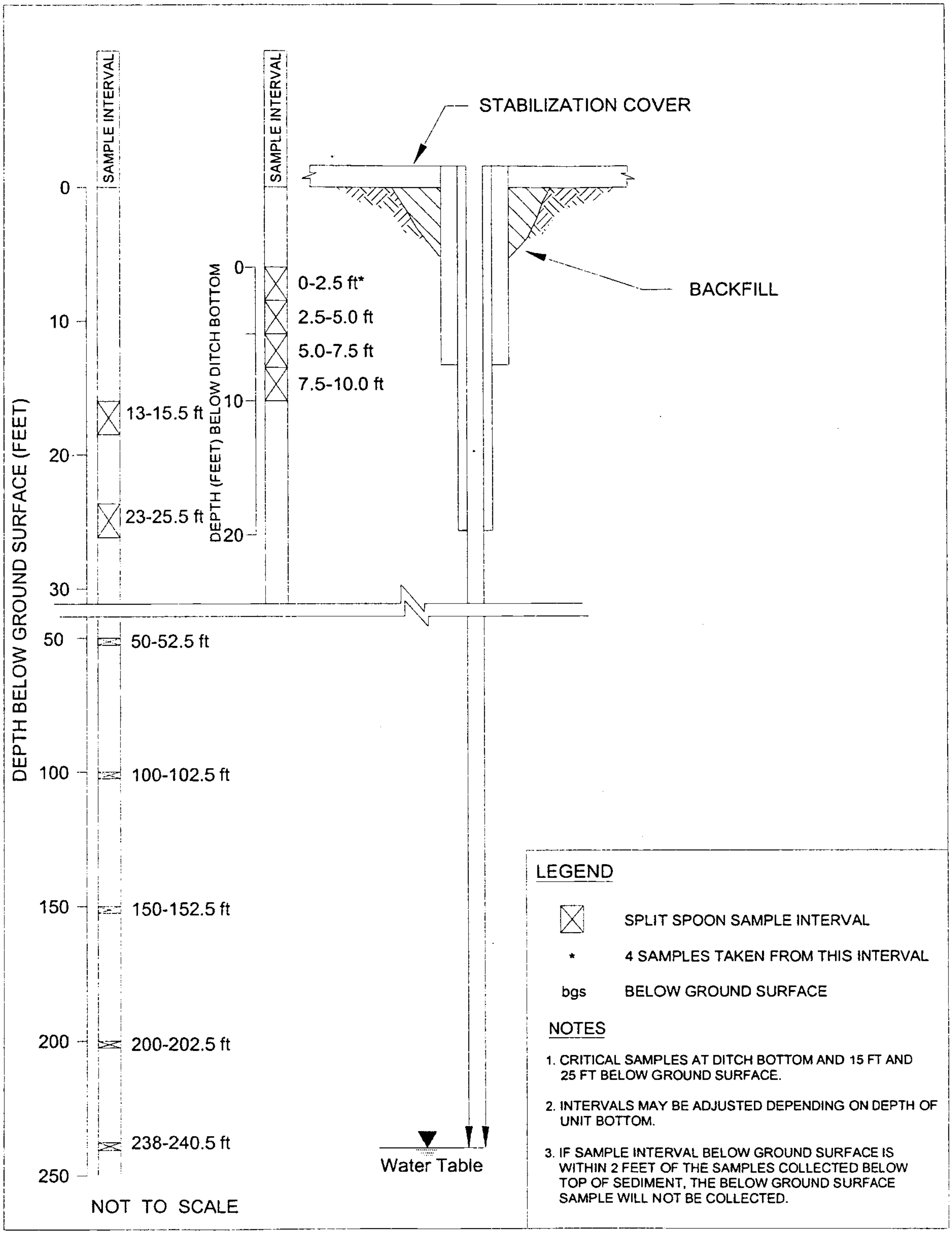
Driven soil probes will be installed vertically to 4.9 m (16 ft) below the ground surface at the 216-Z-11 Ditch in a series of transects perpendicular to the ditch axis. At least three probes will be installed and logged per transect. Up to five transects will be logged along the ditch at locations indicated by the surface geophysical surveys. The GG/PN detectors will be lowered the full depth of the probes, retrieved, and then moved to the next driven probe, until all of the probes have been surveyed. The starting point for logging will be recorded, usually ground surface or the top of the probe. Additional geophysical logging associated with the soil sampling borehole is discussed in Section 3.3.3 of this SAP.

3.3.3 Borehole Sampling and Analysis

The third characterization step involves interpreting the GG/PN logging data, selecting the most highly contaminated locations, and installing a borehole for soil sampling. Soil samples will be collected using a split-spoon-type sampler.

One borehole will be installed in the 216-Z-11 Ditch to collect soil samples for chemical, radiological, and physical properties analyses. The borehole will be drilled at the location that corresponds to the worst-case transuranic material hot spot, based on interpretation of the GG/PN logging data. The final sampling intervals may vary somewhat depending on the thickness of the strata observed in the GG/PN logging data and field instrument readings. The intent of the sampling design is to begin sample collection at the ditch sediment layer. As the split-spoon samples are removed, the ditch sediment layer will be identified by use of field screening methods and geologic observations in the drill cuttings. Potential screening instruments are listed in Table 3-2. Figure 3-4 illustrates the planned borehole sampling intervals.

Figure 3-4. Example Illustration of Borehole Sampling Intervals to the Groundwater in 216-Z-11 Ditch.



2E:032602A

Sampling will be initiated at the ditch sediment layer. It is a critical sample point because the highest transuranic material concentrations are expected at this horizon. Samples from 4.6 m (15 ft) below ground surface (bgs) and 7.6 m (25 ft) bgs are also considered critical sampling points for remedial alternative decision making. Sampling from depths greater than 7.6 m (25 ft) bgs will be used to verify the site conceptual model and to evaluate potential groundwater impacts. Drilling and sampling will stop when the water table is encountered.

Sampling will be performed using a split-spoon sampler in accordance with WAC 173-160 and BHI-EE-01, Procedure 4.0, "Soil and Sediment Sampling." The split-spoon samplers will be equipped with four separate stainless-steel liners. Site personnel will not overdrive the sampling device. With the exception of samples for volatile organic analysis, soil shall be transferred to a pre-cleaned, stainless-steel mixing bowl; homogenized; and then containerized in accordance with the sampling procedure. Samples collected for volatile organic analysis shall be transferred directly from the liners to an appropriate container without mixing the sample. The analytes associated with the various sampling intervals are summarized in Table 3-3 (for 216-Z-11 Ditch soil sampling) and Table 3-4 (for Hanford Groundwater Project ditch soil sampling). If sample volume requirements cannot be met due to poor split-spoon recovery, samples will be collected according to the priority presented in Table 2-3. Analytical priorities are based on expected contaminant inventories and associated potential level of risk. Contaminants with the largest inventory that are expected to be the greatest risk drivers have the highest priority. Radiological and chemical samples will always take precedence over physical property samples.

Physical soil properties of interest are moisture content, grain-size distribution, and lithology. Samples will be analyzed in accordance with ASTM methods, listed in Table 2-1 (ASTM 1993), if applicable. A minimum of three soil samples will be collected for analysis of physical properties. The samples will be collected to coincide with chemical and radiological split-spoon sample intervals. Additional samples may be obtained as determined by the field geologist. Requirements for the collection of physical property samples are listed in Table 3-3.

Geologic materials removed from the borehole will be logged by the site geologist on a borehole log, as specified in BHI-EE-01, Procedure 7.0, "Geologic Logging." The logbook includes, but is not limited to, the lithologic description, including potential caliche and silt horizons, sample depths, HEIS database sample numbers for each sample interval, field screening results, relevant and/or pertinent events, and general information about the borehole.

The IDW waste generated during this activity will be handled according to applicable procedures in Section 2.0 of this SAP and in the *Waste Control Plan for the 200-CW-5 Operable Unit* (BHI 2002).

3.3.3.1 Soil Screening. All samples and cuttings from the borehole will be field screened for evidence of radioactive contamination by the RCT. Surveys of these materials will be conducted with field instruments. Potential screening instruments are listed in Table 3-2 with their respective detection limits. The RCT will record all field measurements, noting the depth of the sample and the instrument reading.

Table 3-2. Field Screening Methods.

Measurement Type	Emission Type	Method/Instrument	Detection Limit
Exposure/dose rate	Beta/gamma	RO-20/RO-03 portable ionization chamber	0.5 mR/hr
Contamination level	Alpha/beta-gamma	E-600 rate meter with SHP380-A/B scintillation probe	100 dpm α 1,921 dpm[a] $\beta-\gamma$
	Volatile organic compounds	Photo ionization detector	2 ppm (may be higher for some compounds)
SGL	Gamma isotopic emissions	HPGe	~25 nCi/g for Am-241 and Pu-239. ~100 pCi/g for Np-237
Gross gamma logging	Gamma emissions	BGO	~25 nCi/g for Am-241 and Pu-239
Passive neutron logging	Neutron emissions	He-3	~ 100 nCi/g for Am-241 and Pu-239
Vapor analysis	Carbon tetrachloride, chloroform	B&K vapor analyzer	~ 1 ppmv for CCl_4 TBD for chloroform

[a] Detection limit rating is for 100 cm^2 at a scan rate of 2 in./sec.
B&K = Brüel and Kjær
BGO = bismuth-germanium detector
He-3 = helium-3 detector
ppmv = parts per million by volume
TBD = to be determined

Before excavation, a local area background reading will be taken with the field screening instruments at a background site to be selected in the field. Field screening of drill cuttings and visual observations of the soil (i.e., sediment/clay layer, organic debris) will be used to optimize sample selection, assist in determining sample shipping requirements, and support worker health and safety monitoring. The field geologist will use GG/PN logging results, professional judgment, screening data, and the information provided in this field sampling plan to finalize sampling decisions.

Samples exceeding 0.5 mrem/hr may be stored at a temporary onsite radioactive material storage area until shipment to the laboratory. If soil samples contain significant concentrations of radiological constituents, they may be analyzed in an onsite laboratory. Because the analytical costs for highly contaminated soils are extreme, Table 3-3 identifies a reduced analyte list for samples analyzed in onsite laboratories.

Field screening instruments will be used, maintained, and calibrated in accordance with the manufacturer's specifications and other approved procedures. The field geologist will record field screening results in the borehole log.

Table 3-3. 216-Z-11 Ditch Soil Sampling Plan.

Sample Collection Methodology	Sample Location	Maximum Depth of Investigation	Sample Interval Depth (ft)		Onsite Laboratory Analyte List	Offsite Laboratory Analyte List[b]	Physical Properties	
			Below Ditch Bottom	bgs[a]			Sample Interval (bgs)	Parameters
Split-spoon borehole soil sampling	Borehole C3808	Just above the groundwater table	0 to 6 in, 6 to 12 in., 12 to 18 in., 18 to 24 in. 2.5 to 5, 5.0 to 7.5, 7.5 to 10	13 to 15.5, 23 to 25.5 50 to 52.5, 100 to 102.5, 150 to 152.5, 200 to 202.5, 238 to 240.5	Isotopic Am/Pu, gamma spectroscopy, ICP metals, and PCBs. The four discrete samples from the 0 to 2.5-ft below ditch bottom interval will be analyzed for isotopic Am/Pu. Split samples from the above discrete samples will be composited into one sample for gamma spectroscopy, ICP metals, and PCBs).[c]	All COCs in Table 1-1 in accordance with footnotes a and d.	1 sample from Hanford formation, Unit 1 1 sample from Hanford formation, Unit 2 1 sample from Plio-Pleistocene Unit	Moisture content, particle size distribution, lithology

Maximum number of samples	14
Approximate number of field QC samples	4[e]
Approximate total number of physical samples	3
Approximate total number of samples	21

[a] If sample interval below the ditch bottom intersects with interval bgs, the below ditch bottom sample interval will not be collected.
[b] See Table 2-1 for detection limits and other analytical parameters.
[c] If this composite sample is analyzed in an offsite laboratory, analyze for all COCs except for americium and plutonium isotopes.
[d] Antimony-125, C-14, Cs-134, hydrazine, freon-11, and methanol analyses will only be performed from the second sample (2.5 to 5 ft below ditch bottom). C-14, Ni-63, and Tc-99 are COCs in the deep zone only and will only be analyzed for in the deeper borehole samples (7.6 m [>25 ft]).
[e] See Table 3-6 for QC sampling details.

Table 3-4. Groundwater Project 216-Z-11 Ditch Soil Sampling Plan.

Sample Collection Methodology	Sample Location	Maximum Depth of Investigation	Sample Interval Depth (ft bgs)	Field Screening Analyte List[a]	Physical Properties	
					Sample Interval (bgs)	Parameters
Borehole vapor sampling	C3808	238 to 240.5 ft bgs	25-30; 50; 75; 100; 125; 132; 138; 160; 180; 200; 220	Carbon tetrachloride, chloroform	N/A	N/A
Maximum number of samples			12			
Approximate number of field QC samples			N/A			
Approximate total number of physical samples			N/A			
Approximate total number of samples			12			

[a] See Table 3-2 for field screening detection limits.
N/A = not applicable

3.3.3.2 Borehole Spectral Logging. As the soil sampling borehole is installed, it will be geophysically logged using a high-resolution SGL detector, as well as the neutron moisture detector and the GG/PN detectors. The spectral gamma data will be used to expand the Z Ditches SGL database and may be evaluated for possible correlation with the soil analytical data. The GG/PN logging results will be compared with the SGL data to approximate a correlation with the GG/PN data from the driven soil probes. Multiple drilling and logging steps may be required to assess the potential for "drag-down" as the casing is driven into the soil.

3.3.3.3 Logging in Existing Wells. Existing boreholes and groundwater wells sufficiently near the Z Ditches that are properly configured for SGL (i.e., single casing in contact with the formation) will also be logged with the spectral gamma detector to expand the Z Ditches SGL database. Table 3-1 identifies one existing well that may be suitable for SGL. Table 3-5 shows further information on the existing well considered for SGL.

Table 3-5. Existing Well Considered for Spectral Gamma Logging.

Borehole Number	Approximate Location	Coordinates (Wash. State Plane, NAD83[91])	
		Northing	Easting
299-W18-15[a]	At the junction of Z Ditch delta and U-10 Pond	134733.478	566380.033

[a] Planned borehole.
NOTE: A single casing in contact with the formation is the preferred configuration for logging. The as-built diagrams indicate that this well may be logged above and below the 41.1- to 44.2-m (135- to 145-ft) interval due to the presence of an external concrete plug in that depth range that would adversely affect gamma logging results. A field inspection of the well configuration will be performed as a final determination that the borehole is suitable for logging.

3.3.4 Z Ditches Discharge Pipe Characterization

Particulates that may have settled in the bottom of the manhole access vaults could represent the "worst-case" contaminated media associated with the Z Ditches. Therefore, the manhole ports will be characterized to assess impacts on remedial decision making and for health and safety purposes.

The 216-Z-11 and 216-Z-19 Ditches received liquid effluents from the 231-Z Building through a vitrified clay pipe (VCP) pipe. As shown in Figure 3-2, four manholes are upstream of the 216-Z-11 Ditch along the length of this 45-cm (18-in.)-diameter discharge pipe. The 234-5Z and 291-Z Buildings' effluents were discharged to the 216-Z-11 Ditch through a 38-cm (15-in.)-diameter VCP. This pipeline has six manholes that are being considered for characterization. Figure 3-3 shows typical section views of the manholes in the Z Ditch pipelines.

The Z Ditches discharge piping will be visually inspected through the manhole access ports by remote video camera, followed by in situ radiological measurements. Sodium iodide and/or high purity germanium detectors may be employed for this purpose.

3.3.5 Summary of Sampling Activities

A summary of the number and types of samples to be collected is presented in Table 3-6.

Table 3-6. Summary of Projected Sample Collection Requirements.

Parameters	216-Z-11 Ditch	Groundwater Project	Project Total
Chemical Parameters			
Maximum number of characterization samples	14	N/A	14
Maximum number of vapor samples	N/A	12	12
Detail of QC Samples			
Field duplicates	1	N/A	1
Field splits	1	N/A	1
Equipment blanks	1	N/A	1
Trip blanks	1	N/A	1
Approximate number of field QC samples	4	N/A	4
Approximate total number of samples	18	12	30
Physical Properties			
Bulk density, moisture content, and particle size distribution	3	N/A	3
Totals	21	12	33

N/A = not applicable

3.3.6 Potential Sample Design Limitations

The sample design developed for this SAP has several potential limitations that may affect the sampling results. Some of the factors that have the potential to affect the outcome of this sampling effort include the following:

1. The geophysical survey locations were based on the assumption that the transuranic COCs would preferentially be deposited where the wastewater velocities decreased. It is possible that transuranic deposition was influenced by other factors. The historical data for the 216-Z Ditches show significant spatial variability in both axial and longitudinal orientations in the ditch bottoms, with measured concentrations varying by several orders of magnitude over minor distances. Last et al. (1994) reported that the transuranics may have preferentially collected on mats of decayed organic plant matter, which would be impossible to locate under a blanket of stabilizing fill.

2. The effectiveness of the geophysical survey techniques in identifying the 216-Z-11 Ditch bottom under the stabilizing fill soil has not been determined. Certain factors could degrade the survey results sufficiently to preclude positive identification of the subsurface ditch profile.

3. The use of the driven soil probes for geophysical logging is a proven technology, but the weak gamma emissions from the target isotopes could yield disappointing results if the soil probes are not driven in close proximity to the contaminated ditch sediment layer.

4. The sampling design is based on the use of multiple interdependent technologies to locate and characterize the 216-Z-11 Ditch. The overall success of this sampling effort depends on the effective use of the individual technologies.

5. Drilling impediments (e.g., boulders) may be encountered, and/or insufficient sample volumes may be retrieved from the split-spoon samplers.

6. The sample design is based on a limited number of samples that could limit the ability to identify TRU hot spot locations.

7. The discharge pipeline manholes may not be accessible for in situ measurements, or safety/radiological concerns may prohibit access.

8. Because the soil samples retrieved from the ditch sediment layer are expected to contain significant concentrations of radiological COCs, it is likely that they will be analyzed in an onsite laboratory. In this case, expected impacts include high analytical costs, degradation of detection limits, reduced analyte lists, and long turnaround times.

3.3.6.1 Sampling Contingencies. This SAP includes an assessment of the possible contingency considerations to offset the possible limitations encountered during sampling in the 216-Z-11 Ditch. The ERC project engineer will evaluate the need to implement these contingencies on a case-by-case basis.

3.3.6.1.1 Surface Geophysical Surveys. If the results of the surface geophysical surveys do not clearly indicate the presence of a ditch, or if the results are difficult to interpret, it is possible to employ three-dimensional interpretation techniques to enhance the results.

It may be necessary to select locations for installation of the soil probes and perform geophysical logging with little or no surface geophysical survey data. In this case, ditch coordinates would be based on best judgment, using historical data, maps, photographs, and/or global positioning instruments. Under this circumstance, it may be advantageous to install more shallow casings than originally planned to increase the likelihood of locating the highly contaminated ditch sediment layer.

3.3.6.1.2 Gross Gamma and Passive Neutron Logging of Driven Soil Probes. If the geophysical logging of soil probes does not locate the ditch sediment layer, or if only low concentration areas within the sediment layer are encountered, the GG/PN measurements may not meet sampling objectives. This may be overcome by driving additional probes and by repeating the geophysical logging for extended count times. If the GG/PN is not successful in identifying an appropriate borehole location, sampling activities in the 216-Z-11 Ditch will cease, and existing analytical data from the 216-Z-1D Ditch may be used as the "worst-case analogous information" for the 216-Z-11 Ditch.

3.3.6.1.3 Borehole Soil Sampling. If sample volume recoveries from the split-spoon samplers are not sufficient to meet analytical needs, then analyses will be performed in accordance with the priorities established in Table 2-3. Higher detection limits and reduced analyte lists associated with onsite laboratories are considered acceptable because only soil with high contaminant concentrations will be sent to the onsite laboratories, and the primary risk drivers will be analyzed.

3.3.6.1.4 Pipeline Characterization. If manholes are not accessible for in situ measurements or safety/radiological concerns prohibit access, pipeline characterization will be eliminated, and the sampling effort will focus on ditch soil sampling.

3.4 RADIOLOGICAL CONTROLS DURING CHARACTERIZATION ACTIVITIES

The high levels of alpha contamination associated with 216-Z-11 Ditch soils represent significant radiological control challenges because previous Z Ditch sample data indicate significant plutonium and americium activity levels. The RI relies heavily on nonintrusive measurement techniques. However, soil sampling will be required. Borehole drilling and associated split-spoon soil sampling could potentially result in airborne exposure and contamination spread if not properly planned and controlled. Detailed pre-job planning and preparation may require the use of mockup staging. Typical precautions when drilling through the highly contaminated vadose zone will include the following:

- Drilling equipment may use windscreens to prevent contamination spread. Operators may require respiratory protection.
- Opening split spoons, sample preparation, sample packaging, and equipment decontamination will likely need to be performed inside glovebags with high-efficiency particulate air (HEPA) ventilation exhaust. Drill casings will likely be sleeved with HEPA evacuation during removal.

Special precautions expected during characterization of the discharge pipelines include the following:

- The alpha contamination in the discharge pipeline is likely to be present in fine-grained particulates that may be more transferable and more likely to become airborne than that found in the soil. Consequently, opening manway covers and installing and removing equipment will likely require glovebags or tents for containment with HEPA exhaust ventilation.
- Special handling and disposal considerations are required for TRU-contaminated IDW wastes.
- Additional RCT support will likely be needed when performing borehole and pipeline work.

3.5 BOREHOLE ABANDONMENT SURVEYING

The borehole will be surveyed after the sampling and abandonment activities are completed. Surveys shall be performed according to BHI-EE-01, Procedure 1.6. Data will be recorded in the North American Vertical Datum of 1988 (NAVD 1988) and the Washington State Plane (South Zone) North American Datum of 1983 (NAD 1983), with the 1991 adjustment for horizontal coordinates. All survey data will be recorded in meters and in feet.

3.6 WASTE MANAGEMENT SAMPLING

A DQO process was conducted to identify additional sampling that may be required to support waste management of the IDW generated from the field sampling activities. The DQO process included review of the contaminants of potential concern identified for the 200-CW-5 OU and an analysis of any additional constituents that should be evaluated to complete the waste designation and profile. Based on the results of the waste management DQO (BHI 2001b), additional samples are required as listed in Table 3-7. Table 3-8 details the additional samples identified and the corresponding analytical requirements. Bottle requirements are identified in Table 2-3.

Table 3-7. Investigation Derived Waste Contaminants of Concern.

Sample Collection Methodology	Key Features of Design	Basis for Sampling Design
Antimony-125, carbon-14, and cesium-134		
Borehole characterization at 216-Z-11 Ditch	Collect one soil sample from the moderate contamination zone beneath the ditch bottom.	Analysis for these constituents will be performed from moderate concentration zone samples to avoid the extreme costs associated with the TRU-contaminated soils in onsite laboratories.
Hydrazine, freon-11, and methanol		
Borehole characterization at 216-Z-11 Ditch	Collect one soil sample from the moderate contamination zone beneath the ditch bottom.	Analysis for these constituents will be performed from moderate concentration zone samples to avoid the extreme costs associated with the TRU-contaminated soils in onsite laboratories.

TRU = waste materials contaminated with 100 nCi/g of transuranic materials having half-lives longer than 20 years

Table 3-8. Waste Management Sample Requirements.

CAS #	COCs	Survey or Analytical Method	Action Level (pCi/g or mg/kg)	RDL (pCi/g or mg/kg)	Precision Required	Accuracy Required
14234-35-6	Antimony-125	GEA	1	0.3	±35%	65-135%
14762-75-5	Carbon-14	Carbon-14 - liquid scintillation	1[a]	50[a]	±35%	65-135%
13967-70-9	Cesium-134	GEA	1	0.1	±35%	65-135%
25-69-4	Freon-11	EPA Method 8260	c	0.01	b	b
302-01-2	Hydrazine	ASTM D1385	c	5	b	b
67-56-1	Methanol	EPA Method 8015	d	TBD	b	b

[a] When the RDL does not meet the action level and the laboratory results indicate nondetection, Waste Management designates the waste with an assigned value equal to the RDL.

[b] Precision and accuracy requirements as identified and defined in the referenced EPA procedures as implemented through the *Hanford Analytical Services Quality Assurance Requirements Document* specifications (DOE-RL 1998).

[c] There is no action level for this constituent in this case; it contributes to the Washington State equivalent concentration calculation.

[d] Methanol could be regulated by the flammability limit (140°F), or by the treatment standard value of 0.75 mg/L (TCLP).

CAS = Chemical Abstract Service
GEA = gamma energy analysis
TBD = to be determined

3.7 SUPPLEMENTAL SAMPLING FOR CORE PROJECTS

Supplemental sampling requirements identified by other core projects are described in the following subsections.

3.7.1 Science and Technology Program

Supplemental sampling needs have not been conveyed to the project by the science and technology program.

3.7.2 Groundwater Project

Interim efforts to address contaminant impacts associated with carbon tetrachloride in the subsurface beneath the 200 West Area involve soil vapor extraction and groundwater pump-and-treat. These current efforts to mitigate impacts are being implemented by the Hanford Groundwater Project. To maximize the return on available resources, the Groundwater Project has identified supplemental samples to be added to this 200-CW-5 OU SAP. These supplemental samples are needed to fill data gaps associated with distribution of carbon tetrachloride in the 200 West Area. Supplemental samples will be used mainly to identify sources of carbon tetrachloride and expand the vadose zone database within the 200 West Area. The Groundwater Project has proposed the collection of 12 vapor samples from the borehole at the 216-Z-11 Ditch during borehole drilling. Supplementary sampling is presented in Tables 3-4 and 3-6. All samples will be collected, handled, and controlled according to procedures identified in Section 2.7 of this SAP. Sample collection and analysis are contingent on availability of Groundwater Project funding to support sample collection and analysis.

3.7.2.1 General Vapor Sampling Requirements. Vapor sampling will be performed from the open borehole. Sampling will be performed in accordance with the applicable portions of BHI-EE-05, Procedure 3.2, "Field Screening Tedlar Bag Sampling." Analysis shall be performed in accordance with the applicable portions of BHI-EE-05, Procedure 1.6, "Analysis of Volatile Organic Compounds in Soil Gas." Vapor samples will be collected in tedlar® bags through teflon® tubing. The tedlar bag will be plumbed with a "T-fitting" that allows venting of one volume of air from the gas probe and tubing prior to collecting the sample. The venting time is based on the length of the tubing. After venting, the valves are aligned to fill the tedlar bag. Sampling is complete when bags reach approximately 75% of their capacity.

Borehole soil vapor sampling at each location will use the following steps:

® Tedlar is a registered trademark of E. I. du Pont de Nemours and Company, Wilmington, Delaware.

® Teflon is a registered trademark of E. I. du Pont de Nemours and Company, Wilmington, Delaware.

Advance the borehole to approximately 0.06 m (2 ft) beyond the bottom of the temporary casing if no split-spoon sample is collected. Otherwise, use the access provided by the split-spoon sample interval after sample collection.

1. Remove drilling tool(s) or split-spoon sampler from the borehole.
2. Insert an inflatable rubber packer or test plug with the vapor sampling tube attached.
3. Inflate the packer/test plug to seal off the casing and leave the end of the sampling tube exposed to the soil vapor in or near the open portion of the borehole.
4. Use an air-sealing pump to withdraw vapor from the vapor sampling tube into a tedlar bag.
5. Measure the carbon tetrachloride concentration in the tedlar bag using a Brüel & Kjær vapor analyzer.
6. Measure the chloroform concentration using a Brüel & Kjær vapor analyzer.
7. Record the measurements.
8. Deflate and move the packer/test plug and continue drilling.

The IDW generated during these activities will be handled according to the *Waste Control Plan for the 200-CW-5 Operable Unit* (BHI 2002).

3.7.3 System Assessment Capabilities

Supplemental sampling needs have not been conveyed to the project by system assessment capabilities.

3.7.4 River Protection Project

Supplemental sampling needs have not been conveyed to the project by the River Protection Project.

4.0 HEALTH AND SAFETY

All field operations will be performed in accordance with Bechtel Hanford, Inc. health and safety requirements outlined in BHI-SH-01, *ERC Safety and Health Program*, and BHI-RC-01, *Radiation Protection Program Manual.* In addition, a work control package will be prepared in accordance with BHI-MA-02, *ERC Project Procedures*, which will further control site operations. This package will include an activity hazard analysis, site-specific health and safety plan, and applicable radiological work permits.

The sampling procedures and associated activities will take into consideration exposure reduction and contamination control techniques that will minimize the radiation exposure to the sampling team, as required by BHI-QA-01, *ERC Quality Program*, and BHI-RC-01.

As noted in Section 3.4 of this SAP, the Z Ditch discharge pipelines and the 216-Z-11 Ditch soils represent significant radiological control challenges because the pipelines are expected to contain significant concentrations of plutonium and americium. For this reason, characterization efforts in the discharge pipeline manhole access ports and borehole drilling and soil sampling activities will likely require detailed pre-job planning and preparation that includes the use of mockup staging. In addition, the work will likely be aided by the use of tent enclosures and glovebags ith HEPA ventilation exhaust.

5.0 MANAGEMENT OF INVESTIGATION-DERIVED WASTE

The IDW generated by characterization activities will be managed in accordance with the *Strategy for Management of Investigation Derived Waste* (Ecology et al. 1995) and as directed in BHI-EE-10, *Waste Management Plan*, which identifies the requirements and responsibilities for containment, labeling, and tracking of IDW. Management of IDW, minimization practices, and waste types applicable to 200-CW-5 waste control is described in the waste control plan (BHI 2002).

Unused samples and associated laboratory waste for the analysis will be dispositioned in accordance with the laboratory contract, which in most cases will require the laboratory to dispose this material. Transuranic-contaminated soil will be returned to the project for disposition. The approval of the remedial project manager is required before returning unused samples or waste from offsite laboratories.

Investigation-derived waste is defined as potentially contaminated waste materials that result from field investigation and characterization activities and may pose a risk to human health and the environment. This waste may include drilling mud, cuttings, and purgewater from the installation of test pits and wells; purgewater, soil, and other materials from the collection of samples; residues from the testing of treatment technologies and pump-and-treat systems; contaminated personal protective equipment; decontamination fluids (aqueous or otherwise); and disposable sampling equipment (EPA 1992).

All IDW and remediation wastes generated in the 216-Z-11 and 216-Z-19 Ditches, the 216-U-10 Pond, and the 216-U-9 and 216-U-11 Ditches will be designated with an "F001" listed waste code because of the carbon tetrachloride discharges associated with the 231-Z Laboratory waste streams. The other 200-CW-5 OU waste sites did not receive the 231-Z Laboratory discharges and will not be assigned the "F001" listed waste code.

5.1 CHARACTERIZATION AND DESIGNATION OF DRIVEN SOIL PROBE RODS

After geophysical logging is complete, the driven soil probe rods will be left in place for disposition during remediation, or they will be extracted during the RI field characterization. If the rod assemblies are left in place, they will be filled with bentonite crumbles, closed with a threaded plug, and capped with cement grout and a brass identification marker. If the rod assemblies are removed during RI characterization, they will be extracted with conventional construction equipment. The rest of the information in this section presents the characterization and designation requirements that pertain to rod extraction during RI characterization.

If the probe rods are removed during RI characterization, they will be extracted from the ground in one piece. Each rod will be pulled into a plastic sleeve for contamination control. Characterization will be performed on the two probe rods in the highest soil contamination zones to determine if the rods represent TRU-contaminated waste or low-level radioactively contaminated waste. The GG/PN detector results will be used to identify the two rods that will be characterized.

The extracted rods will be characterized by manually wiping their outer surface area with a cloth. After wipe down, the cloth will be removed from the plastic sleeve and shipped to a laboratory for alpha energy analyses. It will be conservatively assumed that the cloths remove only 50% of the contamination present on the surface of each rod. The activity reported by the laboratory for the wipe (in pCi/g) will be multiplied by the mass of the wipe. This yields a total inventory value, which will be doubled (to account for the assumed fixed contamination) and applied to the mass of each rod, yielding the TRU activity in nanocuries per gram for each rod. The contamination concentrations determined for the rods from the two worst-case locations will be used to determine the TRU/non-TRU waste status for all of the extracted rods.

Prior to disposal, the driven soil probe rods will be designated for chemical constituents in accordance with the worst-case borehole soil samples from the surface to 4.9 m (16 ft) bgs. The isotopic distribution for waste designation will also be derived from the soil sampling analytical results.

If the two probe rods in the highest contamination regions are determined to exceed the TRU-contamination limit of 100 nCi/g, additional rods may be characterized.

5.2 CHARACTERIZATION AND DESIGNATION OF MISCELLANEOUS SOFT WASTES

Radiological characterization of miscellaneous soft wastes for waste designation will be performed by radiological surveys, using hand-held instruments in accordance with BHI-RC-04, *Radiological Control Work Instructions*, Instruction 4.2, "Radiological Surveys"; and BHI-RC-05, *Radiological Instrumentation Instructions*, Instruction 2.1, "Operating Portable Instruments." The surveys will be used to identify total and removable contamination levels and provide dose-rate information and data/information for making waste management decisions. Additionally, radiological surveys may be performed prior to sample collection to identify areas of "worst-case" radiological contamination of the waste stream matrices. The amount of removable material per 100 cm^2 of surface area should be determined by wiping an area of that size with a dry filter or soft absorbent paper, applying moderate pressure, and then measuring the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of surface area less than 100 cm^2 is necessary, the activity per unit area should be based on the actual area, and the entire surface area should be wiped.

The amount of total contamination (removable plus fixed) should be determined by using an appropriate instrument of known efficiency and placing the probe of the instrument adjacent to the surface being surveyed. Care should be used when checking uneven surfaces.

Dose-rate surveys should be determined by using an appropriate instrument of known efficiency and taking readings on contact and at 30 cm from the item being surveyed. Information annotated on survey forms should indicate the highest reading.

Survey data in the form of direct-reading survey measurements, smear surveys, and dose-rate surveys will be used to verify process knowledge that the radioactive waste is low-level waste and is within the approved waste profile. The information obtained from the surveys will be recorded on a Bechtel Hanford, Inc. Radiological Survey Record. For conservatism, the highest levels (contamination and dose-rate information) indicated on the survey record will be used for waste verification purposes. This information will then be converted from the reported units (e.g., dose rate, disintegrations per minute) to an activity per unit mass. The basis for the conversion will be documented in a calculation performed in accordance with BHI-DE-01, *Design Engineering Procedures Manual*, Engineering Department Project Instruction (EDPI) 4.37-01, "Project Calculations." An example of this conversion can be found in the calculation used for the *233-S Determination of Step-Off Pad Waste Alpha Activity Concentration* (BHI 2001a).

All radiological instruments used will be calibrated within the frequency specified in the instrument operating procedures. Daily instrument response checks for portable instruments will be performed in accordance with BHI-RC-05, Instruction 2.1.

The isotopic distribution for waste designation will be derived from the soil sampling analytical results. Chemical waste designation for miscellaneous soft waste will be based on the borehole soil samples from the corresponding depth intervals.

5.3 CHARACTERIZATION AND DESIGNATION OF VADOSE ZONE DRILL CUTTINGS

The second-step characterization GG/PN logging performed in driven soil probe rods will be used to identify the worst-case contamination concentration area for subsequent borehole drilling. The geophysical logs obtained by the GG/PN detectors will provide preliminary indications of the soil subsurface contamination profile. This information, combined with radiological screening of drill cuttings by field instruments, will be used to direct the loading of drill cuttings into non-TRU and potentially TRU waste drums. All cuttings will be containerized in mid-performance coated drums with 10-mil reinforced plastic liners as required for potentially mixed waste. Potentially TRU-contaminated drill cuttings will be loaded into containers with HEPA-filtered vented lids. The waste containers will be staged at the designated storage area pending designation based on the soil sample analytical results.

Figure 3-4 shows a section view of the 216-Z-11 Ditch that depicts the characterization borehole. As shown, a zone of native backfill soil (approximately 1.8 m [6 ft] thick) is present above the ditch bottom. This zone is assumed to contain near-background levels of radioactivity. The backfill is underlain by a sediment layer at the ditch bottom that is assumed to contain TRU contamination. Below the sediment layer, the transuranic contaminant concentrations are expected to generally decrease to near-background levels over an interval of approximately 2.1 m (7 ft).

Sorting the drill cuttings is the most important aspect of the IDW waste handling operations, because the TRU-contaminated materials cannot be disposed in the Environmental Restoration Disposal Facility and non-TRU-contaminated material cannot be disposed of as TRU waste. The drill cuttings will be sorted in accordance with the radiological data collected during the GG/PN geophysical logging, and field instrument readings.

Drill cuttings will be loaded into 208-L (55-gal) drums as materials are removed from the borehole. Cuttings identified as potentially TRU-contaminated soils will be placed in a separate drum(s). Soil collected in the HEPA filter "drop-out drum" during sampling of the potentially TRU-contaminated soils will be loaded into the drum(s) used to collect potentially TRU-contaminated soil cuttings. Waste drums will be numbered and correlated with sample identification numbers. This information will be recorded in the field logbook to ensure proper waste designation of each drum.

Because of the known contamination in the groundwater beneath the 200 West Area, all drill cuttings that come in contact with the groundwater will be labeled "F001," "F002," "F003," "F004," "F005" waste (Borghese 2000). The waste designation of drill cuttings that come into contact with groundwater will also include a review of the groundwater monitoring wells in the vicinity of this site.

5.3.1 Characterization Sampling and Waste Designation

All drill cuttings will be characterized via borehole soil sampling and laboratory analytical results. The sampling intervals, sampling requirements, and bases for waste designation for the potentially TRU-contaminated materials are presented in Table 5-1. The logic for sampling and waste designation of the non-TRU-contaminated materials is summarized in the table.

As drill cuttings are removed from the drill casing, they will be loaded into 208-L (55-gal) drums. The backfill soils atop the ditch will be designated in the same manner as the drum containing the low-level radiologically contaminated soils immediately beneath the potentially TRU-contaminated soils.

Containerized non-TRU drill cuttings will be linked with specific borehole depths and laboratory samples. In some cases, several samples may be associated with the contents of a single drum. In those cases, waste designation will be based on the average activity/concentrations reported for that drum. When one sample is associated with a given drum, the waste designation will be based on the single sample results. If no samples are associated with a drum, the waste designation will be based on the most conservative sampling results from the soils in the depth interval immediately above that drum. Samples taken from non-TRU drill cuttings will be analyzed for all of the COCs identified in the SAP.

Table 5-1. Waste Characterization and Designation of Potentially TRU-Contaminated Soil.

<table>
<tr><th>Sampling Depth Interval (below ditch bottom)</th><th>Waste Characterization Sampling</th><th>Waste Designation Basis</th></tr>
<tr><td>0 to 2.5 ft</td><td>Collect four discrete samples (at 0.5-ft intervals) within this depth interval for isotopic Am/Pu analysis.
Split samples from the above discrete samples will be composited into one sample for gamma spectroscopy, ICP metals, and PCBs.[a]</td><td rowspan="3">TRU determination – calculate the average activity of the four discrete samples in the 0 to 2.5-ft interval, and then average that value with the two samples from the 2.5 to 5-ft and 5 to 7.5-ft sample intervals.
Radiological designation – use the TRU determination averaging method. The beta emitter contribution for the 0 to 2.5-ft interval will be estimated using the concentrations and isotopic ratios from the 2.5- to 7.5-ft below ditch bottom interval.[b]
Chemical designation – calculate the average concentrations from the 0 to 7.5-ft sample intervals.</td></tr>
<tr><td>2.5 to 5 ft</td><td>Collect one sample from this interval. Analyze for all COCs.</td></tr>
<tr><td>5 to 7.5 ft</td><td>Collect one sample from this interval. Analyze for all COCs.</td></tr>
</table>

[a] If this composite sample is analyzed in an offsite laboratory, analyze for all COCs except for americium and plutonium isotopes.
[b] If the sample from the 0 to 2.5-ft interval is analyzed in an offsite lab, there is no need to estimate the beta inventory, as all COCs will be analyzed.

5.4 CHARACTERIZATION AND DESIGNATION OF BOREHOLE CASING

Borehole casing will be dispositioned according to its contact with contaminated soils. The large diameter casing that was in contact with backfill soils may be surveyed for reuse. The portions of the large and medium diameter borehole casing in contact with contaminated soil will not be decontaminated for reuse. The medium diameter casing in contact with soil will be designated for disposal in the same manner as the soils in its associated depth intervals.

The borehole casing in the potentially TRU-contaminated soil zone will be characterized and designated in a similar manner as the probe rods to determine the TRU/non-TRU waste status (see Section 5.1). The exterior surface of the casing that was in contact with the potentially TRU-contaminated soil will be wiped down with a cloth for alpha-energy analysis. The total inventory reported by the laboratory will be doubled and applied proportionately to the mass of the casing that corresponds to the wiped area.

The isotopic distribution used for waste designation will be derived from the soil sampling analytical results. The casing will be designated for chemical constituents in accordance with the borehole soil samples from the corresponding depth intervals.

The portion of the 15.2-cm (6-in.)-diameter borehole casing that was in contact with the saturated zone will be decontaminated by pressure washing for reuse.

6.0 REFERENCES

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40 CFR 268, "Land Disposal Restrictions," *Code of Federal Regulations*, as amended.

40 CFR 830.120, "Quality Assurance Requirements," *Code of Federal Regulations*, as amended.

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APPENDIX B

ECOLOGICAL SAMPLING DATA FROM THE 200-CW-5, 200-CW-2, 200-CW-4, AND 200-SC-1 OPERABLE UNIT WASTE SITES

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APPENDIX B

ECOLOGICAL SAMPLING DATA FROM THE 200-CW-5, 200-CW-2, 200-CW-4, AND 200-SC-1 OPERABLE UNIT WASTE SITES

Table B-1 provides the biological sampling results from the 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 Operable Unit Waste Sites, which were originally reported in WHC-MR-0418, Rev. 0, *Historical Records of Radioactive Contamination in Biota at the 200 Areas of the Hanford Site*. Table B-2 provides 1998 sampling data for surface soils and vegetation originally reported in PNNL-12088, Appendix 2, *Hanford Site Near-Facility Environmental Monitoring Data Report for Calendar Year 1998.*

REFERENCES

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Table B-1. Biological Sampling Results from the 200-CW-5, 200-CW-2, 200-CW-4, 200-SC-1 Operable Unit Waste Sites (Summarized From WHC-MR-0418). (28 Pages)

Year	Ref[a]	Operable Unit	Location	Group: Species	Field Instrument Levels	Cs-137 (pCi/g)	Sr-90 (pCi/g)	Pu-239 (pCi/g)	Uranium (pCi/g)
1978	80a	200-RO-02	2W Basin: 207-S	Mammal: Coyote Feces	100,000 c/min	1.9E+05	1.9E+05	8.4E+01	
1986	87a	200-RO-02	2W Basin: 207-S	Vegetation: Rabbitbrush		1.2E+03	8.5E+01	<det	
1981	82a	200-RO-02	2W Basin: 207-S	Vegetation: Russian Thistle	Unrecorded Levels of Contamination				
1982	83a	200-RO-02	2W Basin: 207-S	Vegetation: Russian Thistle	Unrecorded Levels of Contamination				
1983	84a	200-RO-02	2W Basin: 207-S	Vegetation: Russian Thistle	Up to 2,500 c/min (multiple)				
1978	80a	200-RO-01	2W Grid Site 31: 216-S-16 northwest	Mammal: Rabbit Feces		8.5E+00			
1979	80b	200-RO-01	2W Grid Site 31: 216-S-16 northwest	Mammal: Rabbit Feces		1.5E+01	2.4E+01	1.0E-01	
1981	82a	200-RO-01	2W Grid Site 31: 216-S-16 northwest	Mammal: Rabbit Feces		<det			
1982	83a	200-RO-01	2W Grid Site 31: 216-S-16 northwest	Mammal: Rabbit Feces		1.9E+00			
1983	84a	200-RO-01	2W Grid Site 31: 216-S-16 northwest	Mammal: Rabbit Feces		7.8E-01			
1980	81d	200-RO-01	2W Grid Site 31: 216-S-16 northwest	Vegetation: Big Sagebrush		9.8E-01			
1980	81d	200-RO-01	2W Grid Site 31: 216-S-16 northwest	Vegetation: Cheatgrass		<det			
1979	80b	200-RO-01	2W Grid Site 31: 216-S-16 northwest	Vegetation: Terrestrial Composite		1.6E-01	3.0E-02	1.7E-02	
1981	82a	200-RO-01	2W Grid Site 31: 216-S-16 northwest	Vegetation: Terrestrial Composite		<det			
1982	83a	200-RO-01	2W Grid Site 31: 216-S-16 northwest	Vegetation: Terrestrial Composite		<det			
1983	84a	200-RO-01	2W Grid Site 31: 216-S-16 northwest	Vegetation: Terrestrial Composite		2.6E-01			
1985	86a	200-RO-01	2W Grid Site 31: 216-S-16 northwest	Vegetation: Terrestrial Composite		<det	<det	<det	

Table B-1. Biological Sampling Results from the 200-CW-5, 200-CW-2, 200-CW-4, 200-SC-1 Operable Unit Waste Sites (Summarized From WHC-MR-0418). (28 Pages)

Year	Ref [a]	Operable Unit	Location	Group: Species	Field Instrument Levels	Cs-137 (pCi/g)	Sr-90 (pCi/g)	Pu-239 (pCi/g)	Uranium (pCi/g)
1987	88a	200-RO-01	2W Grid Site 31: 216-S-16 northwest	Vegetation: Terrestrial Composite		1.5E-01			
1987	88a	200-RO-01	2W Grid Site 31: 216-S-16 northwest	Vegetation: Terrestrial Composite		1.3E-01			
1988	89a	200-RO-01	2W Grid Site 31: 216-S-16 northwest	Vegetation: Terrestrial Composite		1.7E-01			
1976	77c	200-RO-01	2W Pond (dry): 216-S-16 (Pond 4)	Vegetation: Balsam Root		1.5E+01	1.6E+02		
1976	77c	200-RO-01	2W Pond (dry): 216-S-16 (Pond 4)	Vegetation: Big Sagebrush		3.0E+00	4.9E+01		
1976	77c	200-RO-01	2W Pond (dry): 216-S-16 (Pond 4)	Vegetation: Cheatgrass		7.7E+01	1.4E+02		
1976	77c	200-RO-01	2W Pond (dry): 216-S-16 (Pond 4)	Vegetation: Desert Parsley		6.4E+01	4.3E+02		
1976	77c	200-RO-01	2W Pond (dry): 216-S-16 (Pond 4)	Vegetation: Rabbitbrush (Gray)		6.0E+00	2.4E+02		
1976	77c	200-RO-01	2W Pond (dry): 216-S-16 (Pond 4)	Vegetation: Sandberg's Bluegrass		3.5E+02	2.7E+02		
1976	77c	200-RO-01	2W Pond (dry): 216-S-16 (Pond 4)	Vegetation: Terrestrial Composite		6.2E+01	1.1E+02		
1975	76a	200-RO-01	2W Pond: 216-S-16	Mammal: Rabbit (Black-tailed Jack) (2)		3.0E+00 (m) avg	2.0E+00 (b) avg	3.0E-03 (li) avg	
1982	83a	200-RO-01	2W Pond: 216-S-16	Vegetation: Russian Thistle	Up to 4,000 c/min (multiple)				
1983	84a	200-RO-01	2W Pond: 216-S-16	Vegetation: Russian Thistle	Up to 4,000 c/min (multiple)				
1990	92c	200-RO-01	2W Pond: 216-S-16 (Site 105)	Vegetation: Terrestrial Composite		5.1E-02	1.3E-01	8.6E-02	2.8E-02
1991	92d	200-RO-01	2W Pond: 216-S-16 (Site 105)	Vegetation: Terrestrial Composite		9.9E-02	1.1E-02	8.5E-03	6.5E-02
1992	93b	200-RO-01	2W Pond: 216-S-16 (Site 105)	Vegetation: Terrestrial Composite		6.8E-02		5.1E-02	

Table B-1. Biological Sampling Results from the 200-CW-5, 200-CW-2, 200-CW-4, 200-SC-1 Operable Unit Waste Sites (Summarized From WHC-MR-0418). (28 Pages)

Year	Ref[a]	Operable Unit	Location	Group: Species	Field Instrument Levels	Cs-137 (pCi/g)	Sr-90 (pCi/g)	Pu-239 (pCi/g)	Uranium (pCi/g)
1965	66a	200-RO-01	2W Pond: 216-S-16	Waterfowl: American Coot		2.0E+02 (m)			
1965	66a	200-RO-01	2W Pond: 216-S-16	Waterfowl: American Coot		2.0E+02 (m)			
1965	66a	200-RO-01	2W Pond: 216-S-16	Waterfowl: American Coot		2.0E+02 (m)			
1965	66a	200-RO-01	2W Pond: 216-S-16	Waterfowl: Bufflehead		2.9E+01 (m) 1.4E+01 (h)			
1965	66a	200-RO-01	2W Pond: 216-S-16	Waterfowl: Bufflehead		1.9E+01 (m) 9.0E+00 (h)			
1965	66a	200-RO-01	2W Pond: 216-S-16	Waterfowl: Bufflehead		7.8E+01 (m) 2.7E+01 (h)			
1966	67a	200-RO-01	2W Pond: 216-S-16	Waterfowl: Bufflehead		1.5E+01 (m)			
1966	67a	200-RO-01	2W Pond: 216-S-16	Waterfowl: Bufflehead		2.4E+01 (m)			
1966	67a	200-RO-01	2W Pond: 216-S-16	Waterfowl: Bufflehead		1.2E+01 (m)			
1966	67a	200-RO-01	2W Pond: 216-S-16	Waterfowl: Bufflehead		4.1E+00 (m)			
1973	75a	200-RO-01	2W Pond: 216-S-16	Waterfowl: Ducks (3)		3.8E+00 (m)	1.0E-02 (m)		
1974	75b	200-RO-01	2W Pond: 216-S-16	Waterfowl: Ducks (1)		1.2E+02	7.0E-04		
1965	66a	200-RO-01	2W Pond: 216-S-16	Waterfowl: Goldeneye		1.0E-01 (m)			
1966	67a	200-RO-01	2W Pond: 216-S-16	Waterfowl: Goldeneye		4.5E+00 (m)			
1966	67a	200-RO-01	2W Pond: 216-S-16	Waterfowl: Mallard		7.4E+01 (m)			
1966	67a	200-RO-01	2W Pond: 216-S-16	Waterfowl: Mallard		3.1E+00 (m)			
1966	67a	200-RO-01	2W Pond: 216-S-16	Waterfowl: Mallard		1.4E+01 (m)			
1966	67a	200-RO-01	2W Pond: 216-S-16	Waterfowl: Mallard		3.7E+01 (m)			
1966	67a	200-RO-01	2W Pond: 216-S-16	Waterfowl: Mallard		2.0E+01 (m)			
1966	67a	200-RO-01	2W Pond: 216-S-16	Waterfowl: Mallard		1.2E+02 (m)			
1967	68a	200-RO-01	2W Pond: 216-S-16	Waterfowl: Mallard		6.8E+01 (m)			
1967	68a	200-RO-01	2W Pond: 216-S-16	Waterfowl: Mallard		6.3E+01 (m)			
1965	66a	200-RO-01	2W Pond: 216-S-16	Waterfowl: Ruddy Duck		1.2E+02 (m)			
1965	66a	200-RO-01	2W Pond: 216-S-16	Waterfowl: Ruddy Duck		1.0E-01 (m)			
1965	66a	200-RO-01	2W Pond: 216-S-16	Waterfowl: Ruddy Duck		6.0E-01 (m)			

Table B-1. Biological Sampling Results from the 200-CW-5, 200-CW-2, 200-CW-4, 200-SC-1 Operable Unit Waste Sites (Summarized From WHC-MR-0418). (28 Pages)

Year	Ref[a]	Operable Unit	Location	Group: Species	Field Instrument Levels	Cs-137 (pCi/g)	Sr-90 (pCi/g)	Pu-239 (pCi/g)	Uranium (pCi/g)
1965	66a	200-RO-01	2W Pond: 216-S-16	Waterfowl: Ruddy Duck		5.0E-01 (m)			
1965	66a	200-RO-01	2W Pond: 216-S-16	Waterfowl: Ruddy Duck		9.0E-01 (m)			
1969	70a	200-RO-01	2W Pond: 216-S-16	Waterfowl: Ruddy Duck		1.6E+02 (h) 3.9E+02 (m)			
1969	70a	200-RO-01	2W Pond: 216-S-16	Waterfowl: Ruddy Duck		1.1E+02 (h) 7.0E+01 (m)			
1967	68a	200-RO-01	2W Pond: 216-S-16	Waterfowl: Scaup (Lesser)		<det			
1967	68a	200-RO-01	2W Pond: 216-S-16	Waterfowl: Shoveler		1.6E+02 (m)			
1966	67a	200-RO-01	2W Pond: 216-S-16	Waterfowl: Teal (Green-winged)		1.2E+01 (m)			
1976	77a	200-RO-01	2W Pond: 216-S-17	Mammal: Mouse (Deer)		5.8E+00	5.8E+00	1.4E+00	
1976	77a	200-RO-01	2W Pond: 216-S-17	Mammal: Mouse (Deer)		5.4E-01	4.6E-01	5.0E-02	
1976	77a	200-RO-01	2W Pond: 216-S-17	Mammal: Mouse (Deer)		4.6E+01	2.9E+00		
1976	77a	200-RO-01	2W Pond: 216-S-17	Mammal: Mouse (House)		9.6E-01	4.2E+00	2.0E-02	
1976	77a	200-RO-01	2W Pond: 216-S-17	Mammal: Mouse (Deer)		5.6E-01	2.0E+00		
1978	79e	200-RO-01	2W Pond: 216-S-17	Mammal: Mouse (27)		1.9E+00			
1976	77b	200-RO-01	2W Pond: 216-S-17	Vegetation: Russian Thistle			7.4E-01		
1976	77b	200-RO-01	2W Pond: 216-S-17	Vegetation: Russian Thistle			2.5E-01		
1976	77b	200-RO-01	2W Pond: 216-S-17	Vegetation: Russian Thistle			3.3E-01		
1976	77b	200-RO-01	2W Pond: 216-S-17	Vegetation: Russian Thistle			5.0E+00		
1976	77b	200-RO-01	2W Pond: 216-S-17	Vegetation: Russian Thistle			2.1E-01		
1976	77b	200-RO-01	2W Pond: 216-S-17	Vegetation: Russian Thistle			3.8E-01		
1976	77b	200-RO-01	2W Pond: 216-S-17	Vegetation: Russian Thistle			1.6E+01		
1976	77b	200-RO-01	2W Pond: 216-S-17	Vegetation: Russian Thistle			1.5E-01		
1976	77b	200-RO-01	2W Pond: 216-S-17	Vegetation: Russian Thistle			3.9E-01		
1976	77b	200-RO-01	2W Pond: 216-S-17	Vegetation: Russian Thistle			1.2E+00		
1976	77b	200-RO-01	2W Pond: 216-S-17	Vegetation: Russian Thistle			2.0E-01		
1976	77b	200-RO-01	2W Pond: 216-S-17	Vegetation: Russian Thistle			5.8E-01		

Table B-1. Biological Sampling Results from the 200-CW-5, 200-CW-2, 200-CW-4, 200-SC-1 Operable Unit Waste Sites (Summarized From WHC-MR-0418). (28 Pages)

Year	Ref [a]	Operable Unit	Location	Group: Species	Field Instrument Levels	Cs-137 (pCi/g)	Sr-90 (pCi/g)	Pu-239 (pCi/g)	Uranium (pCi/g)
1976	77b	200-RO-01	2W Pond: 216-S-17	Vegetation: Russian Thistle			4.5E-01		
1976	77b	200-RO-01	2W Pond: 216-S-17	Vegetation: Russian Thistle			5.0E-02		
1976	77b	200-RO-01	2W Pond: 216-S-17	Vegetation: Russian Thistle			9.0E-02		
1976	77b	200-RO-01	2W Pond: 216-S-17	Vegetation: Russian Thistle			1.7E+01		
1976	77b	200-RO-01	2W Pond: 216-S-17	Vegetation: Russian Thistle			1.5E-01		
1976	77b	200-RO-01	2W Pond: 216-S-17	Vegetation: Russian Thistle			2.4E-01		
1976	77b	200-RO-01	2W Pond: 216-S-17	Vegetation: Russian Thistle			3.8E-01		
1976	77b	200-RO-01	2W Pond: 216-S-17	Vegetation: Russian Thistle			3.9E-01		
1981	82a	200-RO-01	2W Pond: 216-S-17	Vegetation: Russian Thistle	1,000 c/min - 4,000 c/min (multiple)				
1982	83a	200-RO-01	2W Pond: 216-S-17	Vegetation: Russian Thistle	Unrecorded Levels of Contamination				
1983	84a	200-RO-01	2W Pond: 216-S-17	Vegetation: Russian Thistle	Unrecorded Levels of Contamination				
1978	79c	200-RO-01	2W Pond: 216-S-17	Vegetation: Terrestrial Composite (165)		4.7E+00			
1990	92c	200-RO-01	2W Pond: 216-S-17 (Site 106)	Vegetation: Terrestrial Composite		1.8E-02	2.5E-02	4.4E-03	1.3E-02
1991	92d	200-RO-01	2W Pond: 216-S-17 (Site 106)	Vegetation: Terrestrial Composite		1.6E-03	6.0E-03	2.1E-03	2.8E-03
1992	93b	200-RO-01	2W Pond: 216-S-17 (Site 106)	Vegetation: Terrestrial Composite		1.5E-02		4.1E-03	
1971	72a	200-RO-01	2W Pond: 216-S-17	Waterfowl: Ducks (4)		5.1E+01 (m) avg			
1972	73a	200-RO-01	2W Pond: 216-S-17	Waterfowl: Ducks (2)		3.1E+00 (m) avg			
1982	83a	200-TP-03	2W Basin: 207-T	Vegetation: Russian Thistle	Unrecorded Levels of Contamination				
1983	84a	200-TP-03	2W Basin: 207-T	Vegetation: Russian Thistle	Unrecorded Levels of Contamination				
1986	87a	200-TP-03	2W Basin: 207-T	Vegetation: Russian Thistle		3.3E+03	2.0E+01	<det	

Table B-1. Biological Sampling Results from the 200-CW-5, 200-CW-2, 200-CW-4, 200-SC-1 Operable Unit Waste Sites (Summarized From WHC-MR-0418). (28 Pages)

Year	Ref [a]	Operable Unit	Location	Group: Species	Field Instrument Levels	Cs-137 (pCi/g)	Sr-90 (pCi/g)	Pu-239 (pCi/g)	Uranium (pCi/g)
1992	93b	200-TP-03	2W Basin: 207-T	Vegetation: Russian Thistle	2,000 c/min				
1990	92c	200-TP-04	2W Ditch: 216-T-01 Inlet (Site 25)	Vegetation: Terrestrial Composite		1.7E-01	7.6E-02	1.0E-02	1.5E-02
1991	92d	200-TP-04	2W Ditch: 216-T-01 Inlet (Site 25)	Vegetation: Terrestrial Composite		1.8E-01	5.9E-02	7.3E-03	2.5E-02
1992	93b	200-TP-04	2W Ditch: 216-T-01 Inlet (Site 25)	Vegetation: Terrestrial Composite		6.1E-02		1.9E-03	
1972	73a	200-TP-03	2W Pond: 216-T-01	Waterfowl: Ducks (1)		7.0E+01 (m)			
1986	87a	200-TP-03	2W Ditch: 216-T-04-2	Vegetation: Aquatic Composite		<3.0E+00	6.1E+00	2.0E-01	2.1E-07
1982	83a	200-UP-02	2W Basin: 207-U	Vegetation: Russian Thistle	Unrecorded Levels of Contamination				
1983	84a	200-UP-02	2W Basin: 207-U	Vegetation: Russian Thistle	Unrecorded Levels of Contamination				
1990	92c	200-UP-02	2W Basin: 207-U	Vegetation: Russian Thistle	1,000 c/min	5.0E+02	3.3E+00	5.0E-01	8.5E-01
1990	92c	200-UP-02	2W Basin: 207-U	Vegetation: Russian Thistle	1,000 c/min	1.8E+03	3.9E+00	5.0E-01	2.4E-01
1981	82a	200-UP-02	2W Grid Site 23: 207-U east	Mammal: Rabbit Feces		3.3E+01			
1982	83a	200-UP-02	2W Grid Site 23: 207-U east	Mammal: Rabbit Feces		1.6E+01			
1980	81d	200-UP-02	2W Grid Site 23: 207-U east	Vegetation: Cheatgrass		5.5E-01			
1978	80a	200-UP-02	2W Grid Site 23: 207-U east	Vegetation: Terrestrial Composite		1.7E+00	3.6E-01	6.0E-02	
1979	80b	200-UP-02	2W Grid Site 23: 207-U east	Vegetation: Terrestrial Composite		1.6E+00	<det	7.0E-02	
1981	82a	200-UP-02	2W Grid Site 23: 207-U east	Vegetation: Terrestrial Composite		2.2E+00			
1982	83a	200-UP-02	2W Grid Site 23: 207-U east	Vegetation: Terrestrial Composite		<det			
1982	83a	200-UP-02	2W Grid Site 23: 207-U east	Vegetation: Terrestrial Composite		<det			

Table B-1. Biological Sampling Results from the 200-CW-5, 200-CW-2, 200-CW-4, 200-SC-1 Operable Unit Waste Sites (Summarized From WHC-MR-0418). (28 Pages)

Year	Ref[a]	Operable Unit	Location	Group: Species	Field Instrument Levels	Cs-137 (pCi/g)	Sr-90 (pCi/g)	Pu-239 (pCi/g)	Uranium (pCi/g)
1983	84a	200-UP-02	2W Grid Site 23: 207-U east	Vegetation: Terrestrial Composite		1.1E+00			
1983	84a	200-UP-02	2W Grid Site 23: 207-U east	Vegetation: Terrestrial Composite		8.1E-01			
1984	85a	200-UP-02	2W Grid Site 23: 207-U east	Vegetation: Terrestrial Composite		8.0E+00			
1984	85a	200-UP-02	2W Grid Site 23: 207-U east	Vegetation: Terrestrial Composite		6.5E+00			
1985	86a	200-UP-02	2W Grid Site 23: 207-U east	Vegetation: Terrestrial Composite		1.9E+00	<det	<det	
1986	87a	200-UP-02	2W Grid Site 23: 207-U east	Vegetation: Terrestrial Composite		8.4E-01	<det	<det	
1986	87a	200-UP-02	2W Grid Site 23: 207-U east	Vegetation: Terrestrial Composite		1.2E+00	3.8E-01	<det	
1987	88a	200-UP-02	2W Grid Site 23: 207-U east	Vegetation: Terrestrial Composite		5.2E+00			
1988	89a	200-UP-02	2W Grid Site 23: 207-U east	Vegetation: Terrestrial Composite		1.9E+00			
1989	90b	200-UP-02	2W Grid Site 23: 207-U east	Vegetation: Terrestrial Composite		2.2E+00	2.3E-01	5.9E-02	
1990	92c	200-UP-02	2W Retention Basin: 207-U north (Site 34)	Vegetation: Terrestrial Composite		7.9E-01	3.3E-01	7.4E-02	1.3E-02
1991	92d	200-UP-02	2W Retention Basin: 207-U north (Site 34)	Vegetation: Terrestrial Composite		3.0E+00	3.2E+00	2.3E-02	4.1E-02
1992	93b	200-UP-02	2W Retention Basin: 207-U north (Site 34)	Vegetation: Terrestrial Composite		4.2E-02		4.2E-02	
1975-78	80a	200-UP-02	2W Crib: 216-U-09	Vegetation: Russian Thistle	3,000 c/min (multiple)				
1979	80b	200-UP-02	2W Crib: 216-U-09	Vegetation: Russian Thistle	3,000 c/min (multiple)				

Table B-1. Biological Sampling Results from the 200-CW-5, 200-CW-2, 200-CW-4, 200-SC-1 Operable Unit Waste Sites (Summarized From WHC-MR-0418). (28 Pages)

Year	Ref [a]	Operable Unit	Location	Group: Species	Field Instrument Levels	Cs-137 (pCi/g)	Sr-90 (pCi/g)	Pu-239 (pCi/g)	Uranium (pCi/g)
1981	82a	200-UP-02	2W Grid Site 27: 216-U-10 southeast	Mammal: Rabbit Feces		8.6E+00			
1982	83a	200-UP-02	2W Grid Site 27: 216-U-10 southeast	Mammal: Rabbit Feces		9.0E+00			
1983	84a	200-UP-02	2W Grid Site 27: 216-U-10 southeast	Mammal: Rabbit Feces		1.6E+01			
1980	81d	200-UP-02	2W Grid Site 27: 216-U-10 southeast	Vegetation: Cheatgrass		<det			
1978	80a	200-UP-02	2W Grid Site 27: 216-U-10 southeast	Vegetation: Terrestrial Composite		2.7E+00	1.3E+00	8.0E-03	
1979	80b	200-UP-02	2W Grid Site 27: 216-U-10 southeast	Vegetation: Terrestrial Composite		3.0E-01	8.0E-02	1.9E-02	
1981	82a	200-UP-02	2W Grid Site 27: 216-U-10 southeast	Vegetation: Terrestrial Composite		<det			
1982	83a	200-UP-02	2W Grid Site 27: 216-U-10 southeast	Vegetation: Terrestrial Composite		1.2E+00			
1983	84a	200-UP-02	2W Grid Site 27: 216-U-10 southeast	Vegetation: Terrestrial Composite		1.0E+00			
1984	85a	200-UP-02	2W Grid Site 27: 216-U-10 southeast	Vegetation: Terrestrial Composite		4.9E-01		7.4E+01	
1986	87a	200-UP-02	2W Grid Site 27: 216-U-10 southeast	Vegetation: Terrestrial Composite		2.9E-01	<det	<det	
1988	89a	200-UP-02	2W Grid Site 27: 216-U-10 southeast	Vegetation: Terrestrial Composite		2.0E-01	1.3E-01		
1979	80b	200-UP-02	2W Grid Site 21: 216-U-11 north	Mammal: Coyote Feces		1.1E+01	1.9E+00	7.0E-02	
1974	75b	200-UP-02	2W Pond: 216-U-10	Mammal: Mouse		2.9E+00	9.7E-01	<det	<det
1974	75b	200-UP-02	2W Pond: 216-U-10	Mammal: Mouse		1.6E+02	4.1E+00	1.1E-01	1.0E-02
1976	77a	200-UP-02	2W Pond: 216-U-10	Mammal: Mouse (Deer)		2.0E+00	3.3E+00	1.1E-01	1.3E-01
1976	77a	200-UP-02	2W Pond: 216-U-10	Mammal: Mouse (Deer)		3.5E+01	1.1E+01	1.6E+00	6.0E-02
1977	78a	200-UP-02	2W Pond: 216-U-10	Mammal: Mouse (Deer)		2.6E+01	1.1E+00	2.9E-01	

Table B-1. Biological Sampling Results from the 200-CW-5, 200-CW-2, 200-CW-4, 200-SC-1 Operable Unit Waste Sites (Summarized From WHC-MR-0418). (28 Pages)

Year	Ref [a]	Operable Unit	Location	Group: Species	Field Instrument Levels	Cs-137 (pCi/g)	Sr-90 (pCi/g)	Pu-239 (pCi/g)	Uranium (pCi/g)
1975	79b	200-ZP-03	2W Pond: 216-U-10 north	Mammal: Mouse (Deer)		average: <det (f/li/k/lu/gi) 5.4E-01 (m/b)			
1976	79b	200-UP-02	2W Pond: 216-U-10	Mammal: Mouse (Deer):		2.5E+01			
1976	79b	200-UP-02	2W Pond: 216-U-10	Mammal: Mouse (Deer):		1.1E+02			
1975	79b	200-UP-02	2W Pond: 216-U-10	Mammal: Mouse (Deer)		average: 2.5E+01 (f) <det (li/k/lug) 6.5E+01 (gi) 4.4E+01 (m/b)			
1975	79b	200-UP-02	2W Pond: 216-U-10	Mammal: Mouse (Deer)		average: 3.3E+00 (f) 5.3E+00 (li) <det (k/lu) 1.5E+01 (gi) 1.5E+01 (m/b)			
1975	79b	200-UP-02	2W Pond: 216-U-10	Mammal: Mouse (Deer)		average: 4.2E+01 (f) 6.2E+01 (li) 8.1E+01 (k) 9.6E+01 (lu) 5.1E+01 (gi) 8.7E+01 (m/b)			
1976	79b	200-UP-02	2W Pond: 216-U-10	Mammal: Mouse (Deer):		6.9E+01			
1975	79b	200-UP-02	2W Pond: 216-U-10	Mammal: Mouse (House) (2)				average: 7.0E-02	
1975	79b	200-UP-02	2W Pond: 216-U-10	Mammal: Mouse (House)		average: 3.5E+01 (f) 7.9E+01 (li) 1.1E+02 (k) 2.6E+02 (lu) <det (gi) 1.6E+02 (m/b)			

Table B-1. Biological Sampling Results from the 200-CW-5, 200-CW-2, 200-CW-4, 200-SC-1 Operable Unit Waste Sites (Summarized From WHC-MR-0418). (28 Pages)

Year	Ref [a]	Operable Unit	Location	Group: Species	Field Instrument Levels	Cs-137 (pCi/g)	Sr-90 (pCi/g)	Pu-239 (pCi/g)	Uranium (pCi/g)
1975	79b	200-UP-02	2W Pond: 216-U-10	Mammal: Mouse (Western Harvest)		average: 1.6E+02 (f) 3.3E+02 (li) 5.0E+02 (k) 3.5E+02 (lu) 3.7E+02 (gi) 3.6E+02 (m/b)			
1975	79b	200-ZP-03	2W Pond: 216-U-10 north	Mammal: Mouse (House)				6.0E-02	
1975	79b	200-UP-02	2W Pond: 216-U-10	Mammal: Mouse (Western Harvest)		average: 3.2E+01 (f) 6.5E+01 (li) 2.9E+02 (k) <det (lu) 1.1E+02 (gi) 7.3E+01 (m/b)			
1975	79b	200-ZP-03	2W Pond: 216-U-10 north	Mammal: Mouse (Deer)		average: <det (f/li/k/gi/m/b) 1.2E+02 (lu)			
1976	79b	200-UP-02	2W Pond: 216-U-10	Mammal: Mouse (Deer):		3.0E+01			
1977	79b	200-UP-02	2W Pond: 216-U-10	Mammal: Mouse (Deer):		1.3E+01			
1977	79b	200-UP-02	2W Pond: 216-U-10	Mammal: Mouse (Great Basin Pocket)		1.4E+02			
1977	79b	200-ZP-03	2W Pond: 216-U-10 north	Mammal: Mouse (Great Basin Pocket)		<det			
1977	79b	200-ZP-03	2W Pond: 216-U-10 north	Mammal: Mouse (Great Basin Pocket)		<det			
1977	79b	200-UP-02	2W Pond: 216-U-10	Mammal: Mouse (Great Basin Pocket)		2.2E+02			
1977	79b	200-ZP-03	2W Pond: 216-U-10 north	Mammal: Mouse (Great Basin Pocket)		<det			
1977	79b	200-ZP-03	2W Pond: 216-U-10 north	Mammal: Mouse (Great Basin Pocket)		<det			

Table B-1. Biological Sampling Results from the 200-CW-5, 200-CW-2, 200-CW-4, 200-SC-1 Operable Unit Waste Sites (Summarized From WHC-MR-0418). (28 Pages)

Year	Ref [a]	Operable Unit	Location	Group: Species	Field Instrument Levels	Cs-137 (pCi/g)	Sr-90 (pCi/g)	Pu-239 (pCi/g)	Uranium (pCi/g)
1977	79b	200-UP-02	2W Pond: 216-U-10	Mammal: Mouse (Great Basin Pocket)		2.9E+02			
1977	79b	200-UP-02	2W Pond: 216-U-10	Mammal: Mouse (Deer):		5.6E+01			
1976	79b	200-UP-02	2W Pond: 216-U-10	Mammal: Mouse (Deer):		8.3E+01			
1976	79b	200-UP-02	2W Pond: 216-U-10	Mammal: Mouse (Great Basin Pocket)		1.6E+01			
1976	79b	200-UP-02	2W Pond: 216-U-10	Mammal: Mouse (Deer):		1.1E+02			
1976	79b	200-UP-02	2W Pond: 216-U-10	Mammal: Mouse (Great Basin Pocket)		2.1E+01			
1975	79b	200-ZP-03	2W Pond: 216-U-10 north	Mammal: Mouse (Deer)		average: 1.0E+01 (f) <det (li/k/gi/m/b) 4.5E+01 (lu)			
1977	79b	200-ZP-03	2W Pond: 216-U-10 north	Mammal: Mouse (Great Basin Pocket)		<det			
1976	79b	200-UP-02	2W Pond: 216-U-10	Mammal: Mouse (Deer):		4.5E+01			
1976	79b	200-UP-02	2W Pond: 216-U-10	Mammal: Mouse (Deer):		2.7E+02			
1975	79b	200-UP-02	2W Pond: 216-U-10	Mammal: Mouse (Deer)		average: 3.3E+00 (f) 1.3E+01 (li) 3.8E+01 (k) <det (lu) 1.7E+01 (gi) 2.8E+01 (m/b)	average: 4.6E+00 (m/b)		
1975	79b	200-UP-02	2W Pond: 216-U-10	Mammal: Mouse (House)		average: 2.1E+02 (f) 2.2E+02 (li) 5.0E+02 (k) 3.6E+02 (lu) 3.1E+02 (gi) 3.9E+02 (m/b)			

Table B-1. Biological Sampling Results from the 200-CW-5, 200-CW-2, 200-CW-4, 200-SC-1 Operable Unit Waste Sites (Summarized From WHC-MR-0418). (28 Pages)

Year	Ref [a]	Operable Unit	Location	Group: Species	Field Instrument Levels	Cs-137 (pCi/g)	Sr-90 (pCi/g)	Pu-239 (pCi/g)	Uranium (pCi/g)
1975	79b	200-UP-02	2W Pond: 216-U-10	Mammal: Mouse (House)		average: 1.5E+01 (f) 1.9E+01 (li) <det (k) 1.4E+01 (lu) 3.2E+01 (gi) 2.0E+01 (m/b)			
1975	79b	200-ZP-03	2W Pond: 216-U-10 north	Mammal: Mouse (Great Basin Pocket)		average: <det (f/k) 3.3E+00 (li) 1.5E+01 (lu) 1.8E+00 (gi) 6.7E-01 (m/b)			
1975	79b	200-ZP-03	2W Pond: 216-U-10 north	Mammal: Mouse (Great Basin Pocket)		average: 4.4E-01 (f) <det (li/lu) 9.5E+00 (k) 1.3E+00 (gi) 5.3E-01 (m/b)			
1975	79b	200-UP-02	2W Pond: 216-U-10	Mammal: Mouse (House)		average: 4.8E+01 (f) 5.7E+01 (li) 7.2E+01 (k) 6.2E+01 (lu) 7.5E+01 (gi) 6.1E+01 (m/b)			
1975	79b	200-ZP-03	2W Pond: 216-U-10 north	Mammal: Mouse (Deer)				1.2E-01	
1975	79b	200-ZP-03	2W Pond: 216-U-10 north	Mammal: Mouse (Great Basin Pocket)		average: <det (f/li/k/lu/gi/m/b)			

Table B-1. Biological Sampling Results from the 200-CW-5, 200-CW-2, 200-CW-4, 200-SC-1 Operable Unit Waste Sites (Summarized From WHC-MR-0418). (28 Pages)

Year	Ref[a]	Operable Unit	Location	Group: Species	Field Instrument Levels	Cs-137 (pCi/g)	Sr-90 (pCi/g)	Pu-239 (pCi/g)	Uranium (pCi/g)
1975	79b	200-UP-02	2W Pond: 216-U-10	Mammal: Mouse (Deer)		average: 5.9E+00 (f) 8.5E+00 (li) 8.4E+00 (k) <det (lu) 8.3E+00 (gi) 1.0E+01 (m/b)			
1975	79b	200-UP-02	2W Pond: 216-U-10	Mammal: Mouse (Deer)		average: 2.8E+01 (f) 3.8E+01 (li) 5.2E+01 (k) 7.0E+01 (lu) 4.0E+01 (gi) 6.7E+01 (m/b)			
1977	79b	200-UP-02	2W Pond: 216-U-10	Mammal: Mouse (Deer):		4.1E+00			
1977	79b	200-UP-02	2W Pond: 216-U-10	Mammal: Mouse (Deer):		7.3E+01			
1977	79b	200-UP-02	2W Pond: 216-U-10	Mammal: Mouse (Deer):		9.1E+00			
1977	79b	200-UP-02	2W Pond: 216-U-10	Mammal: Mouse (Deer):		8.5E+00			
1977	79b	200-UP-02	2W Pond: 216-U-10	Mammal: Mouse (Deer):		2.4E+01			
1977	79b	200-UP-02	2W Pond: 216-U-10	Mammal: Mouse (Deer):		2.3E+01			
1977	79b	200-UP-02	2W Pond: 216-U-10	Mammal: Mouse (Deer):		<det			
1977	79b	200-UP-02	2W Pond: 216-U-10	Mammal: Mouse (Great Basin Pocket)		3.3E+02			
1977	79b	200-UP-02	2W Pond: 216-U-10	Mammal: Mouse (Deer):		4.8E+00			
1977	79b	200-UP-02	2W Pond: 216-U-10	Mammal: Mouse (Deer):		2.2E+01			
1977	79b	200-ZP-03	2W Pond: 216-U-10 north	Mammal: Mouse (Great Basin Pocket)		<det			
1977	79b	200-ZP-03	2W Pond: 216-U-10 north	Mammal: Mouse (Great Basin Pocket)		<det			
1977	79b	200-UP-02	2W Pond: 216-U-10	Mammal: Mouse (Deer):		3.7E+00			
1977	79b	200-ZP-03	2W Pond: 216-U-10 north	Mammal: Mouse (Great Basin Pocket)		<det			

Table B-1. Biological Sampling Results from the 200-CW-5, 200-CW-2, 200-CW-4, 200-SC-1 Operable Unit Waste Sites (Summarized From WHC-MR-0418). (28 Pages)

Year	Ref [a]	Operable Unit	Location	Group: Species	Field Instrument Levels	Cs-137 (pCi/g)	Sr-90 (pCi/g)	Pu-239 (pCi/g)	Uranium (pCi/g)
1967	68a	200-UP-02	2W Pond: 216-U-10	Upland Game Bird: Ring-necked Pheasant		1.1E+02 (m)			
1975	76a	200-UP-02	2W Pond: 216-U-10 south	Vegetation: Aquatic Composite		1.0E+01	6.5E+01		
1975	76a	200-UP-02	2W Pond: 216-U-10 north	Vegetation: Aquatic Composite		7.5E+02	8.7E+02		
1976	77c	200-UP-02	2W Pond: 216-U-10 north	Vegetation: Aquatic Composite		8.7E+02	1.1E+03	1.6E+02	
1976	77c	200-UP-02	2W Pond: 216-U-10 south	Vegetation: Aquatic Composite		<det	5.4E+02	3.9E+01	
1977	78b	200-UP-01	2W Pond: 216-U-10 north	Vegetation: Aquatic Composite		3.5E+01	9.8E+00	5.0E-02	
1978	80a	200-UP-02	2W Pond: 216-U-10 north	Vegetation: Aquatic Composite		7.8E+01	2.2E+01	1.6E+01	
1978	80a	200-UP-02	2W Pond: 216-U-10 south	Vegetation: Aquatic Composite		1.1E+01	2.8E+01	9.8E+00	
1980	81d	200-UP-02	2W Pond: 216-U-10 north	Vegetation: Aquatic Composite		4.1E+01	9.3E+00	1.3E+00	
1981	82a	200-UP-02	2W Pond: 216-U-10	Vegetation: Aquatic Composite		2.0E+02	1.1E+01	5.0E-01	
1983	84a	200-UP-02	2W Pond: 216-U-10	Vegetation: Aquatic Composite		5.9E+01	1.6E+00	6.0E-01	
1984	85a	200-UP-02	2W Pond: 216-U-10	Vegetation: Aquatic Composite		2.0E+02	<1.0E+00	<1.0E+00	
1977	78b	200-UP-01	2W Pond: 216-U-10 south	Vegetation: Mushroom		1.2E+03	7.0E+01	2.5E+00	
1985	86b	200-UP-02	2W Pond: 216-U-10	Vegetation: Peachleaf Willow & Cottonwood Core		1.5E+02 max 1.5E+00 min 3.1E+01 avg (10 Samples)	1.4E+02 max 1.5E+00 min 7.3E+01 avg (9 Samples)	6.0E-02 max 1.0E-02 min 4.0E-02 avg 4 Samples)	

Table B-1. Biological Sampling Results from the 200-CW-5, 200-CW-2, 200-CW-4, 200-SC-1 Operable Unit Waste Sites (Summarized From WHC-MR-0418). (28 Pages)

Year	Ref [a]	Operable Unit	Location	Group: Species	Field Instrument Levels	Cs-137 (pCi/g)	Sr-90 (pCi/g)	Pu-239 (pCi/g)	Uranium (pCi/g)
1985	86b	200-UP-02	2W Pond: 216-U-10	Vegetation: Peachleaf Willow & Cottonwood Root		3.3E+02 max 2.6E+00 min 5.7E+01 avg (10 Samples)	1.5E+02 max 1.1E+00 min 2.7E+01 avg (9 Samples)	6.0E-02 max 1.0E-02 min 1.0E-02 avg (4 Samples)	
1985	86b	200-UP-02	2W Pond: 216-U-10	Vegetation: Peachleaf Willow & Cottonwood Leaf/Twig	1.3 m high	2.1E+02 max 7.0E-01 min 4.3E+01 avg (44 Samples)	5.5E+02 max 7.0E-01 min 4.2E+01 avg (34 Samples)	2.0E-01 max 1.0E-02 min 2.0E-02 avg (27 Samples)	
1985	86b	200-UP-02	2W Pond: 216-U-10	Vegetation: Peachleaf Willow & Cottonwood Leaf/Twig	4.5 m high	2.0E+02 max 8.0E-01 min 3.4E+01 avg (27 Samples)	4.1E+02 max 1.0E-01 min 5.9E+01 avg (18 Samples)	3.0E-01 max 1.0E-02 min 7.0E-02 avg (7 Samples)	
1986	87a	200-UP-02	2W Pond: 216-U-10	Vegetation: Peachleaf Willow		9.2E+00	1.0E+02	3.2E+00	
1988	89a	200-UP-02	2W Pond: 216-U-10	Vegetation: Peachleaf Willow	1,000 c/min				
1982	83a	200-UP-02	2W Pond: 216-U-10	Vegetation: Russian Thistle	Unrecorded Levels of Contamination				
1983	84a	200-UP-02	2W Pond: 216-U-10	Vegetation: Russian Thistle	Unrecorded Levels of Contamination				
1991	92d	200-UP-02	2W Pond: 216-U-10	Vegetation: Russian Thistle	Unspecified Levels of Contamination				
1991	92d	200-UP-02	2W Pond: 216-U-10	Vegetation: Russian Thistle	750 c/min	2.2E+01	1.7E+02		
1990	92c	200-UP-02	2W Pond: 216-U-10 north (Site 02)	Vegetation: Terrestrial Composite		1.4E-01	1.3E-01	4.7E-02	3.8E-02
1991	92d	200-UP-02	2W Pond: 216-U-10 north (Site 02)	Vegetation: Terrestrial Composite		1.3E-01	2.9E-01	4.7E-02	1.8E-02
1992	93b	200-UP-02	2W Pond: 216-U-10 north (Site 02)	Vegetation: Terrestrial Composite		7.7E-02		3.3E-02	
1965	66a	200-UP-02	2W Pond: 216-U-10	Waterfowl: American Coot		1.6E+02 (m)			

Table B-1. Biological Sampling Results from the 200-CW-5, 200-CW-2, 200-CW-4, 200-SC-1 Operable Unit Waste Sites (Summarized From WHC-MR-0418). (28 Pages)

Year	Ref [a]	Operable Unit	Location	Group: Species	Field Instrument Levels	Cs-137 (pCi/g)	Sr-90 (pCi/g)	Pu-239 (pCi/g)	Uranium (pCi/g)
1965	66a	200-UP-02	2W Pond: 216-U-10	Waterfowl: American Coot		2.0E+02 (m)			
1965	66a	200-UP-02	2W Pond: 216-U-10	Waterfowl: American Coot		1.4E+02 (m)			
1967	68a	200-UP-02	2W Pond: 216-U-10	Waterfowl: American Coot		2.4E+02 (m)			
1974-77	79a	200-UP-02	2W Pond: 216-U-10	Waterfowl: American Coot (18)		7.0E+01 (b) 2.2E+02 (li) 3.6E+02 (m) 1.3E+03 (gi)			
1966	67a	200-UP-02	2W Pond: 216-U-10	Waterfowl: Canada Goose (Lesser)		4.7E+01 (m)			
1976	77c	200-UP-02	2W Pond: 216-U-10	Waterfowl: Duck		6.5E+01 (m) 3.2E+01 (li)	<8.0E-03 (m) <3.0E-02 (li)		
1977	78a	200-UP-02	2W Pond: 216-U-10	Waterfowl: Duck (2)				2.0E-02 max (li) 1.0E-02 avg (li)	
1978	79c	200-UP-02	2W Pond: 216-U-10	Waterfowl: Duck (2)		1.6E+01 max 1.0E+01 avg	<det		
1979	80a	200-UP-02	2W Pond: 216-U-10	Waterfowl: Duck (1)		2.6E-01 (m)			
1980	81c	200-UP-02	2W Pond: 216-U-10	Waterfowl: Duck (1)		5.2E+01 (m)			
1971	72a	200-UP-02	2W Pond: 216-U-10	Waterfowl: Ducks (4)		7.8E+01 avg (m)			
1972	73a	200-UP-02	2W Pond: 216-U-10	Waterfowl: Ducks (2)		2.7E+01 avg (m)			
1973	75a	200-UP-02	2W Pond: 216-U-10	Waterfowl: Ducks (1)					1.0E-03 (li)
1973	75a	200-UP-02	2W Pond: 216-U-10	Waterfowl: Ducks (1)		2.2E+01 (m)	2.0E-02 (m)		
1974	75b	200-UP-02	2W Pond: 216-U-10	Waterfowl: Ducks (3)		4.3E+01 max 2.9E+01 avg	2.0E-02 max <7.0E-03 avg	2.2E-01 max (li) 1.2E-01 avg (li)	

Table B-1. Biological Sampling Results from the 200-CW-5, 200-CW-2, 200-CW-4, 200-SC-1 Operable Unit Waste Sites (Summarized From WHC-MR-0418). (28 Pages)

Year	Ref [a]	Operable Unit	Location	Group: Species	Field Instrument Levels	Cs-137 (pCi/g)	Sr-90 (pCi/g)	Pu-239 (pCi/g)	Uranium (pCi/g)
1977	78a	200-UP-02	2W Pond: 216-U-10	Waterfowl: Ducks (3)		7.0E+01 max (m) 5.6E+01 avg (m)	1.0E-02 max (m) <6.0E-03 avg (m)		
1981	82b	200-UP-02	2W Pond: 216-U-10	Waterfowl: Ducks (7)		2.8E+02 max (m) 1.1E+02 avg (m)			
1982	83b	200-UP-02	2W Pond: 216-U-10	Waterfowl: Ducks (7)		1.6E+02 max (m) 5.8E+01 avg (m)			
1967	68a	200-UP-02	2W Pond: 216-U-10	Waterfowl: Goldeneye		4.3E+01 (m)			
1965	66a	200-UP-02	2W Pond: 216-U-10	Waterfowl: Mallard		1.0E+02 (m) 3.6E+01 (h)			
1965	66a	200-UP-02	2W Pond: 216-U-10	Waterfowl: Mallard		2.9E+02 (m) 1.3E+02 (h)			
1965	66a	200-UP-02	2W Pond: 216-U-10	Waterfowl: Mallard		1.1E+02 (m) 8.5E+01 (h)			
1966	67a	200-UP-02	2W Pond: 216-U-10	Waterfowl: Mallard		7.7E+00 (m)			
1966	67a	200-UP-02	2W Pond: 216-U-10	Waterfowl: Mallard		1.3E+02 (m)			
1966	67a	200-UP-02	2W Pond: 216-U-10	Waterfowl: Mallard		1.7E+02 (m)			
1966	67a	200-UP-02	2W Pond: 216-U-10	Waterfowl: Mallard		6.2E+00 (m)			
1967	68a	200-UP-02	2W Pond: 216-U-10	Waterfowl: Mallard		2.0E+01 (m)			
1976	77a	200-UP-02	2W Pond: 216-U-10	Waterfowl: Mallard		1.0E+02 (m)	0.0E+00 (m)		
1976	77a	200-UP-02	2W Pond: 216-U-10	Waterfowl: Mallard		7.7E+01 (m) 2.4E+01 (li)	8.0E-03 (m) 0.0E+00 (li)		
1976	77a	200-UP-02	2W Pond: 216-U-10	Waterfowl: Mallard		2.9E+00 (m)	2.0E-02 (m)	6.0E-04 (li)	
1976	77a	200-UP-02	2W Pond: 216-U-10	Waterfowl: Mallard		1.4E+01 (m) 4.5E+00 (li)	2.0E-02 (m) 0.0E+00 (li)		
1976	77a	200-UP-02	2W Pond: 216-U-10	Waterfowl: Mallard		6.5E+01 (m) 3.2E+01 (li)	8.0E-03 (m) 3.0E-02 (li)		

Table B-1. Biological Sampling Results from the 200-CW-5, 200-CW-2, 200-CW-4, 200-SC-1 Operable Unit Waste Sites (Summarized From WHC-MR-0418). (28 Pages)

Year	Ref [a]	Operable Unit	Location	Group: Species	Field Instrument Levels	Cs-137 (pCi/g)	Sr-90 (pCi/g)	Pu-239 (pCi/g)	Uranium (pCi/g)
1976	77a	200-UP-02	2W Pond: 216-U-10	Waterfowl: Mallard		2.0E+01 (m)	5.0E-03 (m)	4.0E-02 (li)	
1976	77c	200-UP-02	2W Pond: 216-U-10	Waterfowl: Mallard		1.4E+01 (m) 4.5E+00 (li)	2.1E-02 (m) <6.5E-02 (li)		
1976	77c	200-UP-02	2W Pond: 216-U-10	Waterfowl: Mallard		7.7E+01 (m) 2.4E+01 (li)	8.0E-03 (m) <8.0E-02 (li)		
1984	85c	200-UP-02	2W Pond: 216-U-10	Waterfowl: Mallard		5.5E+00 (m)			
1984	85c	200-UP-02	2W Pond: 216-U-10	Waterfowl: Mallard		6.7E+01 (m)			
1966	67a	200-UP-02	2W Pond: 216-U-10	Waterfowl: Pintail		4.3E+02 (m)			
1965	66a	200-UP-02	2W Pond: 216-U-10	Waterfowl: Ruddy Duck		7.2E+01 (m)			
1976	77a	200-UP-02	2W Pond: 216-U-10	Waterfowl: Shoveler		3.9E+00 (m) 2.0E+01 (li)	6.0E-03 (m)		
1976	77a	200-UP-02	2W Pond: 216-U-10	Waterfowl: Teal (Blue-winged)		3.2E+00 (m) 7.1E+00 (li)	6.0E-03 (m) 0.0E+00 (li)		
1976	77a	200-UP-02	2W Pond: 216-U-10	Waterfowl: Teal (Winged-winged)		3.6E+00 (m) 7.1E+00 (li)	2.0E-02 (m) 2.7E-01 (li)		
1976	77c	200-UP-02	2W Pond: 216-U-10	Waterfowl: Teal (Green-winged)		3.6E+00 (m) 7.1E+00 (li)	1.7E-02 (m) 2.7E-01 (li)		
1976	77c	200-UP-02	2W Pond: 216-U-10	Waterfowl: Teal (Winged-winged)		3.2E+00 (m) 7.1E+00 (li)	6.0E-03 (m) ≤1.6E-01 (li)		
1967	68a	200-UP-02	2W Pond: 216-U-10	Waterfowl: Widgeon		1.7E+02 (m)			
1967	68a	200-UP-02	2W Pond: 216-U-10	Waterfowl: Widgeon		1.6E+02 (m)			
1979	80b	200-UP-02	2W Grid Site 21: 216-U-11 north	Mammal: Coyote Feces		1.1E+01	1.9E+00	7.0E-02	
1978	80a	200-UP-02	2W Grid Site 26: 216-U-11	Mammal: Rabbit Feces		2.3E+00			
1978	80a	200-UP-02	2W Grid Site 21: 216-U-11 north	Mammal: Rabbit Feces		3.1E+00			
1978	80a	200-UP-02	2W Grid Site 21: 216-U-11 north	Mammal: Rabbit Feces		3.1E+00			

Table B-1. Biological Sampling Results from the 200-CW-5, 200-CW-2, 200-CW-4, 200-SC-1 Operable Unit Waste Sites (Summarized From WHC-MR-0418). (28 Pages)

Year	Ref[a]	Operable Unit	Location	Group: Species	Field Instrument Levels	Cs-137 (pCi/g)	Sr-90 (pCi/g)	Pu-239 (pCi/g)	Uranium (pCi/g)
1979	80b	200-UP-02	2W Grid Site 26: 216-U-11	Mammal: Rabbit Feces		2.5E+00	9.5E+00	6.0E-02	
1979	80b	200-UP-02	2W Grid Site 21: 216-U-11 north	Mammal: Rabbit Feces		2.8E+00	5.0E+00	7.0E-02	
1981	82a	200-UP-02	2W Grid Site 26: 216-U-11	Mammal: Rabbit Feces		<det			
1981	82a	200-UP-02	2W Grid Site 21: 216-U-11 north	Mammal: Rabbit Feces		<det			
1982	83a	200-UP-02	2W Grid Site 21: 216-U-11 north	Mammal: Rabbit Feces		<det			
1982	83a	200-UP-02	2W Grid Site 26: 216-U-11	Mammal: Rabbit Feces		4.9E-01			
1983	84a	200-UP-02	2W Grid Site 21: 216-U-11 north	Mammal: Rabbit Feces		<det			
1983	84a	200-UP-02	2W Grid Site 26: 216-U-11	Mammal: Rabbit Feces		2.7E+00			
1980	81d	200-UP-02	2W Grid Site 21: 216-U-11 north	Vegetation: Big Sagebrush		<det			
1980	81d	200-UP-02	2W Grid Site 26: 216-U-11	Vegetation: Big Sagebrush		<det			
1980	81d	200-UP-02	2W Grid Site 26: 216-U-11	Vegetation: Cheatgrass		<det			
1980	81d	200-UP-02	2W Grid Site 21: 216-U-11 north	Vegetation: Cheatgrass		<det			
1979	80b	200-UP-02	2W Grid Site 26: 216-U-11	Vegetation: Terrestrial Composite		1.9E-01	7.0E-02	2.8E-02	
1979	80b	200-UP-02	2W Grid Site 21: 216-U-11 north	Vegetation: Terrestrial Composite		<det	1.0E-01	7.4E-02	
1981	82a	200-UP-02	2W Grid Site 21: 216-U-11 north	Vegetation: Terrestrial Composite		<det			
1981	82a	200-UP-02	2W Grid Site 26: 216-U-11	Vegetation: Terrestrial Composite		<det			

Table B-1. Biological Sampling Results from the 200-CW-5, 200-CW-2, 200-CW-4, 200-SC-1 Operable Unit Waste Sites (Summarized From WHC-MR-0418). (28 Pages)

Year	Ref [a]	Operable Unit	Location	Group: Species	Field Instrument Levels	Cs-137 (pCi/g)	Sr-90 (pCi/g)	Pu-239 (pCi/g)	Uranium (pCi/g)
1982	83a	200-UP-02	2W Grid Site 26: 216-U-11	Vegetation: Terrestrial Composite		2.5E-01			
1982	83a	200-UP-02	2W Grid Site 21: 216-U-11 north	Vegetation: Terrestrial Composite		<det			
1983	84a	200-UP-02	2W Grid Site 21: 216-U-11 north	Vegetation: Terrestrial Composite		<det			
1983	84a	200-UP-02	2W Grid Site 21: 216-U-11 north	Vegetation: Terrestrial Composite		<det			
1983	84a	200-UP-02	2W Grid Site 26: 216-U-11	Vegetation: Terrestrial Composite		<det			
1984	85a	200-UP-02	2W Grid Site 26: 216-U-11	Vegetation: Terrestrial Composite		5.2E-02			
1985	86a	200-UP-02	2W Grid Site 26: 216-U-11	Vegetation: Terrestrial Composite		<det	<det	<det	
1985	86a	200-UP-02	2W Grid Site 21: 216-U-11 north	Vegetation: Terrestrial Composite		6.4E-02	<det	<det	
1986	87a	200-UP-02	2W Grid Site 21: 216-U-11 north	Vegetation: Terrestrial Composite		2.3E-01	<det	<det	
1987	88a	200-UP-02	2W Grid Site 21: 216-U-11 north	Vegetation: Terrestrial Composite		1.3E-01			
1988	89a	200-UP-02	2W Grid Site 21: 216-U-11 north	Vegetation: Terrestrial Composite		1.5E-01			
1988	89a	200-UP-02	2W Grid Site 26: 216-U-11	Vegetation: Terrestrial Composite		1.5E-01			
DET	82a	200-UP-02	2W Grid Site 29: 216-U-12 southeast	Mammal: Rabbit Feces		<det			
1977	79b	200-UP-02	2W Ditch: 216-U-14	Mammal: Mouse (Great Basin Pocket)		<det			
1977	79b	200-UP-02	2W Ditch: 216-U-14	Mammal: Mouse (Great Basin Pocket)		<det			
1977	79b	200-UP-02	2W Ditch: 216-U-14	Mammal: Mouse (Great Basin Pocket)		7.2E+00			

Table B-1. Biological Sampling Results from the 200-CW-5, 200-CW-2, 200-CW-4, 200-SC-1 Operable Unit Waste Sites (Summarized From WHC-MR-0418). (28 Pages)

Year	Ref [a]	Operable Unit	Location	Group: Species	Field Instrument Levels	Cs-137 (pCi/g)	Sr-90 (pCi/g)	Pu-239 (pCi/g)	Uranium (pCi/g)
1977	79b	200-UP-02	2W Ditch: 216-U-14	Mammal: Mouse (House)		6.9E+00			
1977	79b	200-UP-02	2W Ditch: 216-U-14	Mammal: Mouse (House)		3.3E+00			
1977	79b	200-UP-02	2W Ditch: 216-U-14	Mammal: Mouse (Great Basin Pocket)		1.3E+00			
1977	79b	200-UP-02	2W Ditch: 216-U-14	Mammal: Mouse (Great Basin Pocket)		<det			
1975	79b	200-UP-02	2W Ditch: 216-U-14	Mammal: Mouse (Deer)		average: 3.3E+01 (f) 6.2E+01 (li) 5.0E+01 (k) 6.7E+01 (lu) 1.2E+02 (gi) 6.8E+01 (m/b)			
1977	79b	200-UP-02	2W Ditch: 216-U-14	Mammal: Mouse (Great Basin Pocket)		8.6E+00			
1975	79b	200-UP-02	2W Ditch: 216-U-14	Mammal: Mouse (Great Basin Pocket)		average: 3.1E+00 (f) 1.3E+01 (li) <det (k/lu) 8.4E+00 (gi) 8.2E+00 (m/b)			
1975	79b	200-UP-02	2W Ditch: 216-U-14	Mammal: Mouse (Great Basin Pocket)		average: 2.5E+00 (f) <det (li/k/lu) 7.1E+00 (gi) 5.2E+00 (m/b)			
1975	79b	200-UP-02	2W Ditch: 216-U-14	Mammal: Mouse (Great Basin Pocket)		average: 2.5E+00 (f) <det (li/lu/m/b) 5.4E+01 (k) 1.4E+01 (gi)			

Table B-1. Biological Sampling Results from the 200-CW-5, 200-CW-2, 200-CW-4, 200-SC-1 Operable Unit Waste Sites (Summarized From WHC-MR-0418). (28 Pages)

Year	Ref [a]	Operable Unit	Location	Group: Species	Field Instrument Levels	Cs-137 (pCi/g)	Sr-90 (pCi/g)	Pu-239 (pCi/g)	Uranium (pCi/g)
1980	82c	200-UP-02	2W Ditch: 216-U-14	Mammal: Mouse (Deer) (21)		3.8E+01 max 2.8E+00 avg	4.2E+01 max 3.7E+00 avg	9.0E-01 max 3.0E-01 avg	
1980	82c	200-UP-02	2W Ditch: 216-U-14	Mammal: Mouse (Great Basin Pocket) (11)		1.2E+00 max 7.0E-01 avg	6.0E-01 max 2.0E-01 avg		
1975	76a	200-UP-02	2W Ditch: 216-U-14	Vegetation: Aquatic Composite		5.5E+01	5.4E+02		
1978	80a	200-UP-02	2W Ditch: 216-U-14	Vegetation: Aquatic Composite		1.5E+01	1.7E+01	1.1E+01	
1979	80b	200-UP-02	2W Ditch: 216-U-14 (Inlet to Pond)	Vegetation: Aquatic Composite		3.0E+02	6.9E+00	1.5E+00	
1979	80b	200-UP-02	2W Ditch: 216-U-14	Vegetation: Aquatic Composite		2.0E+02	5.1E+01	<1.0E+00	
1980	81d	200-UP-02	2W Ditch: 216-U-14	Vegetation: Aquatic Composite		5.6E+01	1.8E+01	6.1E-01	
1981	82a	200-UP-02	2W Ditch: 216-U-14	Vegetation: Aquatic Composite		2.2E+01	2.8E+01	1.1E+00	
1982	83a	200-UP-02	2W Ditch: 216-U-14	Vegetation: Aquatic Composite		1.7E+02		9.1E+00	
1983	84a	200-UP-02	2W Ditch: 216-U-14	Vegetation: Aquatic Composite		2.7E+01	3.5E+00	1.0E+00	
1991	92d	200-UP-02	2W Ditch: 216-U-14	Vegetation: Aquatic Composite		<det	9.3E-01	1.2E+00	5.9E-08
1992	93b	200-UP-02	2W Ditch: 216-U-14	Vegetation: Aquatic Composite		9.7E-01	<7.3E-01	<4.8E-01	2.4E-07
1980	82c	200-UP-02	2W Ditch: 216-U-14	Vegetation: Cattail		3.4E+01 max 1.5E+01 avg	2.1E+01 max 4.2E+00 avg	2.6E+01 max 4.1E+00 avg 2.0E+01 max 4.0E+00 avg	

Table B-1. Biological Sampling Results from the 200-CW-5, 200-CW-2, 200-CW-4, 200-SC-1 Operable Unit Waste Sites (Summarized From WHC-MR-0418). (28 Pages)

Year	Ref [a]	Operable Unit	Location	Group: Species	Field Instrument Levels	Cs-137 (pCi/g)	Sr-90 (pCi/g)	Pu-239 (pCi/g)	Uranium (pCi/g)
1980	82c	200-UP-02	2W Ditch: 216-U-14	Vegetation: Horsetail		5.6E+00 max 3.7E+00 avg	3.0E-01 max 2.0E-01 avg		
1981	82c	200-UP-02	2W Ditch: 216-U-14	Vegetation: Russian Thistle (24)		2.0E-02 avg	5.6E+00 avg	6.0E-01	
1982	83a	200-UP-02	2W Ditch: 216-U-14	Vegetation: Russian Thistle	Unrecorded Levels of Contamination				
1983	84a	200-UP-02	2W Ditch: 216-U-14	Vegetation: Russian Thistle	Unrecorded Levels of Contamination				
1990	92c	200-UP-02	2W Ditch: 216-U-14	Vegetation: Russian Thistle	600 c/min - 13 mrads/h				
1991	92d	200-UP-02	2W Ditch: 216-U-14	Vegetation: Russian Thistle	<det		5.1E-01	<2.9E-01	5.6E-02
1991	92d	200-UP-02	2W Ditch: 216-U-14	Vegetation: Russian Thistle	<det		6.6E-01	<3.0E-01	9.2E-02
1991	92d	200-UP-02	2W Ditch: 216-U-14	Vegetation: Russian Thistle	<det		6.7E-01	<3.1E-01	9.0E-04
1991	92d	200-UP-02	2W Ditch: 216-U-14	Vegetation: Russian Thistle	<det		4.0E-01	<3.0E-01	8.0E-02
1991	92d	200-UP-02	2W Ditch: 216-U-14	Vegetation: Russian Thistle	<det		2.2E-01	<2.9E-01	1.2E-01
1991	92d	200-UP-02	2W Ditch: 216-U-14	Vegetation: Russian Thistle	<det		1.4E+02	6.6E-01	3.2E-01
1991	92d	200-UP-02	2W Ditch: 216-U-14	Vegetation: Russian Thistle	<det		1.3E-02	<2.9E-01	2.2E-01
1991	92d	200-UP-02	2W Ditch: 216-U-14	Vegetation: Russian Thistle	<det		4.1E-01	<3.0E-01	2.8E-02
1991	92d	200-UP-02	2W Ditch: 216-U-14	Vegetation: Russian Thistle	<det		4.5E-01	<2.9E-01	6.2E-01
1991	92d	200-UP-02	2W Ditch: 216-U-14	Vegetation: Russian Thistle	Unspecified Levels of Contamination				

Table B-1. Biological Sampling Results from the 200-CW-5, 200-CW-2, 200-CW-4, 200-SC-1 Operable Unit Waste Sites (Summarized From WHC-MR-0418). (28 Pages)

Year	Ref [a]	Operable Unit	Location	Group: Species	Field Instrument Levels	Cs-137 (pCi/g)	Sr-90 (pCi/g)	Pu-239 (pCi/g)	Uranium (pCi/g)
1992	93b	200-UP-02	2W Ditch: 216-U-14	Vegetation: Russian Thistle	5,000 c/min	<9.6E-01			3.1E-01
1992	93b	200-UP-02	2W Ditch: 216-U-14	Vegetation: Russian Thistle	Unspecified Levels of Contamination				
1980	82c	200-UP-02	2W Ditch: 216-U-14	Vegetation: Smartweed		3.5E+01 max 2.6E+01 avg	3.6E+00 max 1.8E+00 avg	1.6E+01	
1980	82c	200-UP-02	2W Ditch: 216-U-14	Vegetation: Thistle		4.5E+01 max 2.4E+01 avg	4.9E+00 max 2.3E+00 avg		
1980	82c	200-UP-02	2W Ditch: 216-U-14	Vegetation: Wild Lettuce		7.0E-01	5.0E-02		
1976	79b	200-UP-02	2W Ditch: 216-Z-19	Mammal: Mouse (Great Basin Pocket)		<det			
1976	79b	200-UP-02	2W Ditch: 216-Z-19	Mammal: Mouse (Deer)		5.2E+01			
1976	79b	200-UP-02	2W Ditch: 216-Z-19	Mammal: Mouse (Deer)		3.2E+01			
1975	79b	200-UP-02	2W Ditch: 216-Z-19	Mammal: Mouse (Deer)		average: <det (f/k/lu/gi) 2.8E+00 (li) 7.8E-01 (m/b)			
1976	79b	200-UP-02	2W Ditch: 216-Z-19	Mammal: Mouse (Deer)		5.6E+01			
1976	79b	200-UP-02	2W Ditch: 216-Z-19	Mammal: Mouse (Deer)		1.6E+02			
1976	79b	200-UP-02	2W Ditch: 216-Z-19	Mammal: Mouse (Great Basin Pocket)		<det			
1975	79b	200-UP-02	2W Ditch: 216-Z-19	Mammal: Mouse (Great Basin Pocket)		average: 9.9E-01 (f) <det (li/k/lu/gi/m/b)			

Table B-1. Biological Sampling Results from the 200-CW-5, 200-CW-2, 200-CW-4, 200-SC-1 Operable Unit Waste Sites (Summarized From WHC-MR-0418). (28 Pages)

Year	Ref [a]	Operable Unit	Location	Group: Species	Field Instrument Levels	Cs-137 (pCi/g)	Sr-90 (pCi/g)	Pu-239 (pCi/g)	Uranium (pCi/g)
1975	79b	200-UP-02	2W Ditch: 216-Z-19	Mammal: Mouse (House)		average: 4.7E+02 (f) 7.2E+02 (li) 1.0E+03 (k) 1.4E+03 (lu) 1.6E+03 (gi) 8.9E+02 (m/b)			
1975	79b	200-UP-02	2W Ditch: 216-Z-19	Mammal: Mouse (Great Basin Pocket)		average: 1.7E+00 (f) <det (li/lu/gi/m/b) 2.7E+01 (k)			
1975	79b	200-UP-02	2W Ditch: 216-Z-19	Mammal: Mouse (Great Basin Pocket)		average: <det (f/lu/m/b) 5.8E+00 (li) 1.8E+01 (k) 2.6E-01 (gi)	average: 3.7E+0 (f/s)		
1975	79b	200-UP-02	2W Ditch: 216-Z-19	Mammal: Mouse (Deer)		average: 8.7E+00 (f) 9.8E+00 (li) 1.8E+01 (k) 1.2E+01 (lu) 1.3E+01 (gi) 1.5E+01 (m/b)			
1975	79b	200-UP-02	2W Ditch: 216-Z-19	Mammal: Mouse (Deer)		average: 1.2E+01 (f) 1.1E+01 (li) <det (k/lu) 9.7E+00 (gi) 2.3E+01 (m/b)			
1975	79b	200-UP-02	2W Ditch: 216-Z-19	Mammal: Mouse (Deer) (3)				average: 9.8E-01	
1977	79b	200-UP-02	2W Ditch: 216-Z-19	Mammal: Mouse (Great Basin Pocket)		<det			
1977	79b	200-UP-02	2W Ditch: 216-Z-19	Mammal: Mouse (Deer)		1.1E+01			

Table B-1. Biological Sampling Results from the 200-CW-5, 200-CW-2, 200-CW-4, 200-SC-1 Operable Unit Waste Sites (Summarized From WHC-MR-0418). (28 Pages)

Year	Ref [a]	Operable Unit	Location	Group: Species	Field Instrument Levels	Cs-137 (pCi/g)	Sr-90 (pCi/g)	Pu-239 (pCi/g)	Uranium (pCi/g)
1977	79b	200-UP-02	2W Ditch: 216-Z-19	Mammal: Mouse (Great Basin Pocket)		<det			
1977	79b	200-UP-02	2W Ditch: 216-Z-19	Mammal: Mouse (Deer)		9.3E+00			
1977	79b	200-UP-02	2W Ditch: 216-Z-19	Mammal: Mouse (Great Basin Pocket)		<det			
1977	79b	200-UP-02	2W Ditch: 216-Z-19	Mammal: Mouse (Great Basin Pocket)		<det			
1977	79b	200-UP-02	2W Ditch: 216-Z-19	Mammal: Mouse (Great Basin Pocket)		<det			
1977	79b	200-UP-02	2W Ditch: 216-Z-19	Mammal: Mouse (Great Basin Pocket)		<det			
1977	79b	200-UP-02	2W Ditch: 216-Z-19	Mammal: Mouse (Great Basin Pocket)		<det			
1977	79b	200-UP-02	2W Ditch: 216-Z-19	Mammal: Mouse (Great Basin Pocket)		<det			
1977	79b	200-UP-02	2W Ditch: 216-Z-19	Mammal: Mouse (Great Basin Pocket)		<det			
1977	79b	200-UP-02	2W Ditch: 216-Z-19	Mammal: Mouse (Great Basin Pocket)		<det			
1975	76a	200-UP-02	2W Ditch: 216-Z-19	Vegetation: Aquatic Composite		4.0E+00	8.9E+02		
1976	77c	200-UP-02	2W Ditch: 216-Z-19	Vegetation: Aquatic Composite		<det	1.5E+02	3.7E+02	
1978	80a	200-UP-02	2W Ditch: 216-Z-19 (234-5Z Outfall)	Vegetation: Aquatic Composite		5.2E+00	5.3E+00	5.2E+01	
1978	80a	200-UP-02	2W Ditch: 216-Z-19 (231-Z Outfall)	Vegetation: Aquatic Composite		4.6E+00	1.7E+00	1.6E+00	
1979	80b	200-UP-02	2W Ditch: 216-Z-19 (Inlet to 216-U-10)	Vegetation: Aquatic Composite		<1.3E+00	5.8E+00	4.6E+00	
1979	80b	200-UP-02	2W Ditch: 216-Z-19 (234-5Z Outfall)	Vegetation: Aquatic Composite		7.0E-01	1.9E+00	1.1E+01	
1979	80b	200-UP-02	2W Ditch: 216-Z-19 (16th Street)	Vegetation: Aquatic Composite		<7.0E-01	9.0E+00	5.6E+00	

Table B-1. Biological Sampling Results from the 200-CW-5, 200-CW-2, 200-CW-4, 200-SC-1 Operable Unit Waste Sites (Summarized From WHC-MR-0418). (28 Pages)

Year	Ref [a]	Operable Unit	Location	Group: Species	Field Instrument Levels	Cs-137 (pCi/g)	Sr-90 (pCi/g)	Pu-239 (pCi/g)	Uranium (pCi/g)
1979	80b	200-UP-02	2W Ditch: 216-Z-19 (231-Z Outfall)	Vegetation: Aquatic Composite		<1.1E+00	<9.0E-01	1.5E+00	
1980	81d	200-UP-02	2W Ditch: 216-Z-19 (234-5Z Outfall)	Vegetation: Aquatic Composite		2.0E+01	1.1E+01	3.2E+00	
1981	82a	200-UP-02	2W Ditch: 216-Z-19	Vegetation: Aquatic Composite		<det	3.5E+00	2.0E+00	
1987	88a	200-PO-04	2E Crib: 216-A-06	Vegetation: Russian Thistle	Up to 12 mrads/h				
1991	92d	200-PO-04	2E Crib: 216-A-06	Vegetation: Russian Thistle	500 c/min				
1992	93b	200-PO-04	2E Crib: 216-A-06	Vegetation: Russian Thistle	900 c/min				
1991	92d	200-PO-04	2E Crib: 216-A-06	Vegetation: Terrestrial Composite		7.1E+00		<7.4E-01	1.5E-01
1982	83a	200-PO-04	2E Crib: 216-A-30	Vegetation: Russian Thistle	Unrecorded Levels of Contamination				
1983	84a	200-PO-04	2E Crib: 216-A-30	Vegetation: Russian Thistle	Unrecorded Levels of Contamination				
1990	92c	200-PO-04	2E Crib: 216-A-30	Vegetation: Russian Thistle	Unreported Levels of Contamination				
1992	93b	200-PO-04	2E Crib: 216-A-30	Vegetation: Russian Thistle	3,000 c/min				
1991	92d	200-PO-04	2E Crib: 216-A-30 (Site 95)	Vegetation: Terrestrial Composite		3.2E-01	3.1E-01	2.8E-03	5.4E-02
1992	93b	200-PO-04	2E Crib: 216-A-30 (Site 95)	Vegetation: Terrestrial Composite		1.3E-01		1.1E-03	
1991	92d	200-PO-04	2E Crib: 216-A-37-2 (Site 94)	Vegetation: Terrestrial Composite		2.5E-01	1.7E-01	9.2E-04	7.8E-02
1992	93b	200-PO-04	2E Crib: 216-A-37-2 (Site 94)	Vegetation: Terrestrial Composite		4.6E-02		6.7E-04	
1984	85a	200-BP-09	2E Basin: 216-B-64 west	Insect: Harvester Ant Mound		5.7E+03	2.9E+02	<det	
1984	85a	200-BP-02	2E Basin: 216-B-64 west	Insect: Harvester Ants		4.8E+01	2.0E+01	<det	

Table B-1. Biological Sampling Results from the 200-CW-5, 200-CW-2, 200-CW-4, 200-SC-1 Operable Unit Waste Sites (Summarized From WHC-MR-0418). (28 Pages)

Year	Ref [a]	Operable Unit	Location	Group: Species	Field Instrument Levels	Cs-137 (pCi/g)	Sr-90 (pCi/g)	Pu-239 (pCi/g)	Uranium (pCi/g)
1984	85a	200-BP-09	2E Basin: 216-B-64 west	Insect: Harvester Ant Mound		1.6E+03	2.8E+02	7.4E+01	
1984	85a	200-BP-09	2E Basin: 216-B-64 west	Insect: Harvester Ant Mound		3.2E+02	6.5E+03	9.0E+00	
1988	89a	200-BP-09	2E Basin: 216-B-64	Insect: Harvester Ants	1,500 c/min				
1989	90b	200-BP-09	2E Basin: 216-B-64	Insect: Harvester Ants	Unspecified Levels of Contamination				
1990	92c	200-BP-09	2E Basin: 216-B-64	Insect: Harvester Ants	Unreported Levels of Contamination				
1990	92c	200-BP-09	2E Basin: 216-B-64 west (UN-216-E-36)	Vegetation: Russian Thistle	2,000 c/min	1.0E+02	3.5E+03	<3.0E-01	1.9E+00
1982	83a	200-RO-01	2W Crib: 216-S-05	Vegetation: Russian Thistle	Unrecorded Levels of Contamination				
1983	84a	200-RO-01	2W Crib: 216-S-05	Vegetation: Russian Thistle	Unrecorded Levels of Contamination				
1989	90b	200-RO-03	2W Crib: 216-S-05	Vegetation: Russian Thistle	2.5 mrads/h				
1982	83a	200-RO-01	2W Crib: 216-S-06	Vegetation: Russian Thistle	Unrecorded Levels of Contamination				
1983	84a	200-RO-01	2W Crib: 216-S-06	Vegetation: Russian Thistle	Unrecorded Levels of Contamination				
1989	90b	200-RO-03	2W Crib: 216-S-06	Vegetation: Russian Thistle	2.5 mrads/h				
1975-78	80a	200-RO-01	2W Crib: 216-S-06	Vegetation: Unspecified Weeds	10,000 c/min (multiple)				
1979	80b	200-RO-01	2W Crib: 216-S-06	Vegetation: Unspecified Weeds	10,000 c/min (multiple)				

WHC-MR-0418, *Historical Records of Radioactive Contamination in Biota at the 200 Areas of the Hanford Site.*

[a] Reference code numbers refer to citations provided in WHC-MR-0418, Chapter 9.0, References.

(f) = feces. (k) = kidneys. (li) =liver.

(gi) = gastrointestinal. (l) = lungs. (m/b) = muscle/brain.

Table B-2. 1998 Surface Soil and Vegetation Data (pCi/g). (2 Pages)

Isotope	216-U-10 Pond		216-U-11 Trench		216-U-14 Ditch	216-Z-11 Ditch
	Soil (D002)	Soil (D004)	Soil (D104)	Soil (D110)	Soil (D004)	Soil (D008)
Co-60	3.8E-03	2.4E-04	3.2E-03	1.3E-04	2.4E-04	-2.0E-03
Zn-65	-5.5E-03	4.6E-03	-7.3E-03	-3.0E-03	4.6E-03	-3.7E-03
Sr-90	5.5E-03	3.2E-02	2.5E-01	3.4E-01	3.2E-02	-1.0E-01
Ru-103	-1.8E-03	3.6E-03	3.9E-04	-1.6E-03	3.6E-03	-4.6E-03
Ru-106	-2.5E-02	-3.2E-02	-3.0E-02	7.4E-02	-3.2E-02	-7.8E-04
Sn-113	-2.8E-03	-7.0E-03	-8.8E-03	1.1E-03	-7.0E-03	2.5E-03
Sb-125	3.6E-03	1.3E-02	-1.0E-02	3.5E-03	1.3E-02	9.7E-03
Cs-134	3.4E-02	3.0E-02	2.4E-02	4.4E-02	3.0E-02	3.9E-02
Cs-137	1.4E-01	6.2E-01	3.4E+00	6.0E-03	6.2E-01	5.0E-02
Ce-144	-4.4E-02	3.2E-02	-1.6E-02	4.4E-02	3.2E-02	-1.6E-02
Eu-152	-1.6E-02	-1.5E-02	-9.3E-03	5.9E-02	-1.5E-02	-5.2E-03
Eu-154	-9.5E-03	-3.1E-03	-7.5E-03	-6.9E-03	-3.1E-03	4.5E-03
Eu-155	5.1E-02	2.1E-02	5.4E-02	3.8E-02	2.1E-02	4.0E-02
U-234	2.0E-01	1.9E-01	2.1E-01	1.6E-01	1.9E-01	1.3E-01
U-235	2.0E-02	1.3E-02	1.4E-02	2.7E-02	1.3E-02	1.3E-02
U-238	2.1E-01	2.4E-01	2.4E-01	1.4E-01	2.4E-01	1.5E-01
Pu-238	4.0E-03	9.7E-04	-5.9E-03	2.3E-03	9.7E-04	2.0E-02
Pu-239/240	1.0E-02	2.2E-02	4.9E-03	2.3E-03	2.2E-02	1.4E+00
Isotope	**216-U-10 Pond**		**216-U-11 Trench**		**216-U-14 Ditch**	**216-Z-11 Ditch**
	Vegetation (D002)	**Vegetation (D004)**	**Vegetation (D104)**	**Vegetation (D110)**	**Vegetation (D004)**	**Vegetation (D008)**
Co-60	-1.5E-02	-1.7E-02	8.2E-03	-9.1E-03	-1.7E-02	-1.4E-02
Zn-65	1.1E-01	1.1E-01	-5.9E-02	1.3E-01	1.1E-01	-3.1E-02
Sr-90	4.8E-01	-3.5E-02	4.4E-04	1.3E-02	-3.5E-02	-3.3E-02
Ru-103	-3.4E-02	-2.2E-02	9.5E-03	-1.1E-02	-2.2E-02	-2.1E-02
Ru-106	-2.5E-02	-1.5E-01	-1.5E-01	-7.6E-02	-1.5E-01	2.1E-01
Sn-113	-2.9E-02	-4.2E-02	3.8E-03	-1.8E-02	-4.2E-02	-3.4E-02
Sb-125	2.3E-02	-1.2E-01	-3.0E-02	5.7E-02	-1.2E-01	2.6E-02
Cs-134	1.8E-02	5.2E-02	2.9E-03	-1.7E-02	5.2E-02	1.5E-02
Cs-137	2.5E-01	5.8E-02	-7.7E-03	-2.0E-02	5.8E-02	-1.4E-03
Ce-144	4.7E-02	-1.7E-01	-6.7E-02	3.5E-02	-1.7E-01	-2.4E-01

Table B-2. 1998 Surface Soil and Vegetation Data (pCi/g). (2 Pages)

Isotope	216-U-10 Pond		216-U-11 Trench		216-U-14 Ditch	216-Z-11 Ditch
	Vegetation (D002)	**Vegetation (D004)**	**Vegetation (D104)**	**Vegetation (D110)**	**Vegetation (D004)**	**Vegetation (D008)**
Eu-152	1.1E-01	5.3E-02	1.5E-02	-9.1E-03	5.3E-02	4.3E-02
Eu-154	-3.3E-02	-1.4E-01	-9.4E-03	-3.7E-02	-1.4E-01	3.5E-02
Eu-155	6.2E-02	-3.6E-02	2.4E-02	8.2E-02	-3.6E-02	1.1E-01
U-234	4.2E-02	1.1E-02	3.5E-02	3.0E-02	1.1E-02	9.4E-03
U-235	1.3E-02	6.0E-03	2.1E-02	1.5E-02	6.0E-03	5.7E-03
U-238	1.1E-02	8.7E-03	8.9E-03	7.3E-03	8.7E-03	7.3E-03
Pu-238	-5.7E-04	6.2E-03	3.7E-03	3.0E-03	6.2E-03	5.5E-03
Pu-239/240	1.1E-03	3.4E-03	-2.5E-03	1.0E-02	3.4E-03	6.1E-02

[a]Data from PNNL-12088, Appendix 2, *Hanford Site Near-Facility Environmental Monitoring Data Report for Calendar Year 1998*.

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APPENDIX C

200-CW-5, 200-CW-2, 200-CW-4, AND 200-SC-1 OPERABLE UNIT WASTE SITES CONSOLIDATION LOGIC

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APPENDIX C

200-CW-5, 200-CW-2, 200-CW-4, AND 200-SC-1 OPERABLE UNIT WASTE SITES CONSOLIDATION LOGIC

Table C-1 summarizes the consolidation logic for the 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 Operable Unit waste sites. Table C-2 summarizes the consolidation logic for the 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 Operable Unit rejected waste sites. Table C-3 shows the consolidation logic for the 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 Operable Unit waste sites conforming to the work plan contaminant distribution models. Table C-4 describes the waste sites that conform to other operable unit contaminant distribution models. Figures C-1 through C-7 show the conceptual models for the 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC--1 Operable Units.

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Table C-1. 200-CW-5, 200-CW-2, 200-CW-4, 200-SC-1 Operable Unit Consolidation Logic Waste Site Summary. (4 Pages)

Site Code	Site Names	Type	Status	Class Status	Reclass Status	Table Assignment[a]
200-CW-5 Operable Unit Waste Sites[b]						
200-W-28	200-W-28, 216-U-10 Borrow Pit, U Pond Borrow Area	Depression/ Pit (nonspecific)	Inactive	Rejected		Table C-2
200-W-29	200-W-29, 216-U-11 Borrow Pit	Depression/ Pit (nonspecific)	Inactive	Rejected		Table C-2
200-W-84	200-W-84, U Plant Process Sewer	Process Sewer	Inactive	Accepted		No
200-W-102	200-W-102, Pipeline from Laundry/Powerhouse to 216-U-14 Ditch	Process Sewer	Inactive	Accepted		No
200-W PP	200-W PP, 200-W Powerhouse Pond, 200 West Powerhouse Ponds, 284-W-B	Pond	Inactive	Accepted	Rejected	Table C-2
207-U	207-U, 207-U Retention Basin	Retention Basin	Active	Accepted		No
216-U-9	216-U-9, U Swamp-S Swamp Ditch, 216-U-6	Ditch	Inactive	Accepted		No
216-U-10	216-U-10, U Swamp, 216-U-1, 216-U-10 Pond, 231 Swamp	Pond	Inactive	Accepted		No
216-U-11	216-U-11, U Swamp Extension Ditch, 216-U-12, 216-U-11 Trench, 216-U-11 Ditch, 216-U-11 (old ditch), 216-U-11 (new ditch)	Ditch	Inactive	Accepted		No
216-U-14	216-U-14, 216-U-14 Ditch, Laundry Ditch	Ditch	Inactive	Accepted		No
216-W-LWC	216-W-LWC, 216-W-LC, Laundry Waste Crib, 216-W-LWC Crib, 216-W-1	Crib	Inactive	Accepted		No
216-Z-1D	216-Z-1D, 216-Z-1, Drain Ditch to U Swamp, Z Plant Ditch	Ditch	Inactive	Accepted		No
216-Z-11	216-Z-11, 216-Z-11 Ditch, Z Plant Ditch	Ditch	Inactive	Accepted		No
216-Z-19	216-Z-19, 216-U-10 Ditch, Z Plant Ditch, 216-Z-19 Ditch	Ditch	Inactive	Accepted		No
216-Z-20	216-Z-20, Z-19 Ditch Replacement Tile Field	Crib	Inactive	Accepted		No
UPR-200-W-18	UPR-200-W-18, Liquid Release to 216-U-9	Unplanned Release	Inactive	Accepted	Rejected	Table C-2
UPR-200-W-104	UPR-200-W-104, UN-216-W-14, 216-U-10 Pond Leach Trench, U Pond Fingers	Unplanned Release	Inactive	Accepted	Rejected	Table C-2
UPR-200-W-105	UPR-200-W-105, UN-216-W-15, 216-U-10 Pond Leach Trench	Unplanned Release	Inactive	Accepted	Rejected	Table C-2

Table C-1. 200-CW-5, 200-CW-2, 200-CW-4, 200-SC-1 Operable Unit Consolidation Logic Waste Site Summary. (4 Pages)

Site Code	Site Names	Type	Status	Class Status	Reclass Status	Table Assignment[a]
UPR-200-W-106	UPR-200-W-106, UN-216-W-16, 216-U-10 Pond Leach Trench	Unplanned Release	Inactive	Accepted	Rejected	Table C-2
UPR-200-W-107	UPR-200-W-107, UN-216-W-17, 216-U-10 Pond Flood Plain	Unplanned Release	Inactive	Accepted	Rejected	Table C-2
UPR-200-W-110[c]	UPR-200-W-110, Contaminated Soil from 216-Z-1, UN-216-W-20 Spoil Trench	Unplanned Release	Inactive	Accepted		No
UPR-200-W-111	UPR-200-W-111, Sludge Trench at 207-U, UN-216-W-21	Unplanned Release	Inactive	Accepted		No
UPR-200-W-112	UPR-200-W-112, Sludge Trench at 207-U, UN-216-W-22	Unplanned Release	Inactive	Accepted		No
UPR-200-W-139	UPR-200-W-139, Liquid Release to the 216-U-9 Ditch, UN-20-W-139, UPR-200-W-18	Unplanned Release	Inactive	Accepted	Rejected	Table C-2
200-CW-2 Operable Unit Waste Sites						
200-W-25	200-W-25, 216-S-16 Borrow Pit	Depression/ Pit (nonspecific)	Inactive	Rejected		Table C-2
200-W-26	200-W-26, 216-S-17 Borrow Pit	Depression/ Pit (nonspecific)	Inactive	Rejected		Table C-2
207-S	207-S, REDOX Retention Basin, 207-S Retention Basin	Retention Basin	Inactive	Accepted		Table C-4
216-S-16D	216-S-16D, 202-S Swamp (New) and Ditch, 202-S Swamp #1, REDOX Pond #2, 216-S-24 Ditch	Ditch	Inactive	Accepted		Table C-3
216-S-16P	216-S-16P, 202-S Swamp and Ditch, 202-S Swamp #1, REDOX Pond #2	Pond	Inactive	Accepted		Table C-3
216-S-17	216-S-17, 202-S Swamp, 202-S REDOX Swamp, 216-S-1 REDOX Pond No. 1, REDOX Swamp, 216-S-1	Pond	Inactive	Accepted		Table C-3
216-S-172	216-S-172, 216-S-172 Weir Box and Control Structure, 2904-S-172 Weir, 216-S-172 Control Structure	Control Structure	Inactive	Accepted		Table C-4
2904-S-160	2904-S-160, 2904-S-160 Control Structure, 2904-S-160 Weir	Control Structure	Inactive	Accepted		Table C-4
2904-S-170	2904-S-170, 2904-S-170 Weir Box, 2904-S-170 Control Structure	Control Structure	Inactive	Accepted		Table C-4

Table C-1. 200-CW-5, 200-CW-2, 200-CW-4, 200-SC-1 Operable Unit Consolidation Logic Waste Site Summary. (4 Pages)

Site Code	Site Names	Type	Status	Class Status	Reclass Status	Table Assignment[a]
2904-S-171	2904-S-171, 2904-S-171 Weir Box, 2904-S-171 Control Structure, 216-S-171	Control Structure	Inactive	Accepted		Table C-4
UPR-200-W-13	UPR-200-W-13, Liquid Release from REDOX to 207-S and 216-S-17 Pond, UN-200-W-13	Unplanned Release	Inactive	Accepted	Rejected	Table C-2
UPR-200-W-15	UPR-200-W-15, Liquid Release from REDOX to 207-S and 216-S-17 Pond, UN-200-W-15	Unplanned Release	Inactive	Accepted	Rejected	Table C-2
UPR-200-W-47	UPR-200-W-47, 216-S-16P Dike Release, UN-200-W-47	Unplanned Release	Inactive	Accepted	Rejected	Table C-2
UPR-200-W-59	UPR-200-W-59, Contaminated Liquid Released to 216-S-16P	Unplanned Release	Inactive	Accepted	Rejected	Table C-2
UPR-200-W-95	UPR-200-W-95, UN-216-W-2, 207-S Retention Basin	Unplanned Release	Inactive	Accepted	Rejected	Table C-2
UPR-200-W-124	UPR-200-W-124, Dike break at the REDOX Pond, UN-200-W-124	Unplanned Release	Inactive	Accepted		Table C-3
200-CW-4 Operable Unit Waste Sites						
200-W-88	200-W-88, T Plant Process Sewers	Process Sewer	Inactive	Accepted		Table C-4
207-T	207-T, T Plant Retention Basin, 207-T, 207-T Retention Basin	Retention Basin	Inactive	Accepted		Table C-4
216-T-1	216-T-1, 221-T Ditch, 221-T Trench, 216-T-1 Trench	Ditch	Inactive	Accepted		Table C-3
216-T-4-1D	216-T-4-1D, 216-T-4 Ditch, 216-T-4 Swamp	Ditch	Inactive	Accepted		Table C-3
216-T-4A	216-T-4A, 216-T-4 Swamp, 216-T-4-1 (P), 216-T-4-1 Pond	Pond	Inactive	Accepted		Table C-3
216-T-4B	216-T-4B, 216-T-4 New Pond, 216-T-4-2 (P), 216-T-4-2 Pond	Pond	Inactive	Accepted		Table C-3
216-T-4-2	216-T-4-2, 216-T-4-2 Ditch	Ditch	Inactive	Accepted		Table C-3
216-T-12	216-T-12, 207-T Sludge Grave, 207-T Sludge Pit, 216-T-11	Trench	Inactive	Accepted		Table C-4
200-SC-1 Operale Unit Waste Sites						
200-E-113	200-E-113; Pipeline from PUREX to 216-A-30 Crib, 216-A-42C Valve Box	Process Sewer	Inactive	Accepted		Table C-4
200-W-79	200-W-79; 216-T-36 Crib pipeline	Process Sewer	Inactive	Accepted		Table C-4

Table C-1. 200-CW-5, 200-CW-2, 200-CW-4, 200-SC-1 Operable Unit Consolidation Logic Waste Site Summary. (4 Pages)

Site Code	Site Names	Type	Status	Class Status	Reclass Status	Table Assignment[a]
207-A-NORTH	207-A-NORTH, 207-A, 207-A Retention Basin, 207-A-NORTH Retention Basin, 207-A North	Retention Basin	Inactive	Accepted		Table C-4
207-Z	207-Z, 207-Z Retention Basin, 241-Z Retention Basin, 241-Z-RB	Retention Basin	Inactive	Accepted		Table C-4
216-A-6	216-A-6, 216-A-6 Cavern	Crib	Inactive	Accepted		Table C-4
216-A-30	216-A-30, 216-A-30 Crib	Crib	Inactive	Accepted		Table C-4
216-A-37-2	216-A-37-2, 216-A-37-2 Crib	Crib	Inactive	Accepted		Table C-4
216-B-55	216-B-55, 216-B-55 Enclosed Trench, 216-B-55 Crib	Crib	Inactive	Accepted		Table C-4
216-B-64	216-B-64, 216-B-64 Retention Basin, 216-B-64 Trench, 216-B-64 Crib	Retention Basin	Inactive	Accepted		Table C-4
216-S-5	216-S-5, 216-S-5 Cavern #1, 216-S-6 Crib, 216-S-9	Crib	Inactive	Accepted		Table C-4
216-S-6	216-S-6, 216-S-6 Cavern #2, 216-S-5 Crib, 216-S-13 Crib	Crib	Inactive	Accepted		Table C-4
216-S-25	216-S-25, 216-S-25 Crib	Crib	Inactive	Accepted		Table C-4
216-T-36	216-T-36 Crib	Crib	Inactive	Accepted		Table C-4
UPR-200-E-19	UPR-200-E-19, Contamination Release at 216-A-6 Sampler, UN-200-E-19	Unplanned Release	Inactive	Accepted		Table C-4
UPR-200-E-21	UPR-200-E-21, 216-A-6 Overflow, UN-200-E-21	Unplanned Release	Inactive	Accepted		Table C-4
UPR-200-E-29	UPR-200-E-29, 216-A-6 Overflow, UN-200-E-29	Unplanned Release	Inactive	Accepted		Table C-4

[a] Specific table assignments for each waste site are based on the most applicable contaminant distribution model.
[b] 200-CW-5 accepted waste sites have no table listing because they already have been approved in Revision 0 of this document.
[c] This waste site is awaiting final approval of Appendix C of the Tri-Party Agreement before the *Waste Information Data System* will change the site from the 200-PW-1 Operable Unit to the 200-CW-5 Operable Unit.

Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, as amended.

PUREX = Plutonium-Uranium Extraction (Facility or process).
REDOX = Reduction-Oxidation (Facility or process).
Tri-Party Agreement = *Hanford Federal Facility Agreement and Consent Order*.
UPR = unplanned release.

Table C-2. 200-CW-5, 200-CW-2, 200-CW-4, 200-SC-1 Operable Unit Consolidation Logic Rejected Waste Sites

Site code	Site Names	Type	Status	Class Status	Reclass Status
200-CW-5 Operable Unit Waste Sites					
200-W-28[a]	200-W-28, 216-U-10 Borrow Pit, U Pond Borrow Area	Depression/Pit (nonspecific)	Inactive	Rejected	
200-W-29[a]	200-W-29, 216-U-11 Borrow Pit	Depression/Pit (nonspecific)	Inactive	Rejected	
200-W PP[b]	200-W PP, 200-W Powerhouse Pond, 200 West Powerhouse Ponds, 284-W-B	Pond	Inactive	Accepted	Rejected
UPR-200-W-18[b]	UPR-200-W-18, Liquid Release to 216-U-9	Unplanned Release	Inactive	Accepted	Rejected
UPR-200-W-104[b]	UPR-200-W-104, UN-216-W-14, 216-U-10 Pond Leach Trench, U Pond Fingers	Unplanned Release	Inactive	Accepted	Rejected
UPR-200-W-105[b]	UPR-200-W-105, UN-216-W-15, 216-U-10 Pond Leach Trench	Unplanned Release	Inactive	Accepted	Rejected
UPR-200-W-106[b]	UPR-200-W-106, UN-216-W-16, 216-U-10 Pond Leach Trench	Unplanned Release	Inactive	Accepted	Rejected
UPR-200-W-107[b]	UPR-200-W-107, UN-216-W-17, 216-U-10 Pond Flood Plain	Unplanned Release	Inactive	Accepted	Rejected
UPR-200-W-139[b]	UPR-200-W-139, Liquid Release to the 216-U-9 Ditch, UN-200-W-139, UPR-200-W-18	Unplanned Release	Inactive	Accepted	Rejected
200-CW-2 Operable Unit Waste Sites					
200-W-25[a]	200-W-25, 216-S-16 Borrow Pit	Depression/Pit (nonspecific)	Inactive	Rejected	
200-W-26[a]	200-W-26, 216-S-17 Borrow Pit	Depression/Pit (nonspecific)	Inactive	Rejected	
UPR-200-W-13[b]	UPR-200-W-13, Liquid Release from REDOX to 207-S and 216-S-17 Pond, UN-200-W-13	Unplanned Release	Inactive	Accepted	Rejected
UPR-200-W-15[b]	UPR-200-W-15, Liquid Release from REDOX to 207-S and 216-S-17 Pond, UN-200-W-15	Unplanned Release	Inactive	Accepted	Rejected
UPR-200-W-47[b]	UPR-200-W-47, 216-S-16P Dike Release, UN-200-W-47	Unplanned Release	Inactive	Accepted	Rejected
UPR-200-W-59[b]	UPR-200-W-59, Contaminated Liquid Released to 216-S-16P	Unplanned Release	Inactive	Accepted	Rejected
UPR-200-W-95[b]	UPR-200-W-95, UN-216-W-2, 207-S Retention Basin	Unplanned Release	Inactive	Accepted	Rejected

[a] No waste was disposed to this site.
[b] UPR was consolidated with another site(s).
UPR = unplanned release.
REDOX = Reduction-Oxidation (Plant or process).

Table C-3. 200-CW-5, 200-CW-2, 200-CW-4, 200-SC-1 Operable Unit Consolidation Logic Waste Sites Conforming to the Work Plan Contaminant Distribution Models. (4 Pages)

											Contaminant Inventory											
Representative Site or TSD	Accepted Waste Site Name	Waste Site Type	Rationale	Site Size	Area	Plant Process	Case (effluent vol.)	Soil Pore Volume Exceeded	Characterized or Data Evaluated	Case (Inventory)	Total U (kg)	Total Pu (g)	Am-241 (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	CCl_4 (kg)	Ferrocyanide (kg)	Hexone (kg)	Nitrate (kg)	NPH (kg)	$Na_2Cr_2O_7$ (kg)	TBP (kg)
216-U-10		Pond	The contaminant distribution model is developed in the Work Plan for this 200-CW-5 representative waste site. A limited field investigation of high-priority waste units was conducted from August 1993 through August 1994 and is documented in DOE/RL-95-13.	12 ha (30 ac)	200 West	Multiple Plant Processes 1944-1985 The site received effluents from various facilities at various times. It received steam condensate from 231-Z and 234-5Z Building and 231-Z Laboratory wastes via 216-Z-1, 216-Z-11 and 216-Z-19 Ditches. It received 284-W Powerhouse process cooling water, waste water from 2723-W Original Laundry/Mask Cleaning Station and the 2724-W (new) Laundry, chemical sewer wastes from 221-U Building, cooling water from 224-U Building, 241-U-110 Tank condenser, and 242-S Evaporator steam condensate water via 216-U-14 Ditch.	Worst Case	Yes/92	Yes	Worst Case	1.88	8.00E+03	0.492	11.0	11.0							
200-CW-2 Operable Unit Consolidated Representative Waste Sites																						
	216-S-17	Pond	Based on structure, size, and expected contaminant distribution, this site is believed to be similar to the 216-U-10 Pond.	292 m x 292 m (958 ft x 958 ft)	200 West	REDOX: 1951-1954 process cooling water and steam condensate from the 202-S Building. After January 1953, the site received the 202-S Building effluent via the 207-S Retention Basin and the overflow from the 216-U-10 Pond via the 216-U-9 Ditch.	Worst Case	Yes/ 4	No	Worst Case	134	3.00		12.7	15.9				140			
200-CW-2 Operable Unit Consolidated Analogous Waste Sites																						
	216-S-16P	Pond	The pond received cooling water and steam condensate discharge from the REDOX facility via the 216-S-16 Ditch and also overflow from the 216-U-10 Pond via the 216-U-9 Ditch. Based on structure, size, and expected contaminant distribution, this site is believed to be similar to the 216-U-10 Pond.	NA	200 West	REDOX: 1957-1975 The site received process cooling water and steam condensate from 202-S Building and later condenser and vessel cooling water from concentrator boil-down operations in the 202-S Building via the 216-S-16D Ditch. In 1973, the 216-U-9 Ditch was connected to the 216-S-16 Ditch to allow the 216-U-10 Pond overflow to reach the 216-S-16 Pond.	Typical	Yes/ 18	No	Worst Case	3.12E+03			30	45.1							
	UPR-200-W-124	Unplanned Release	The site is an unplanned release of the REDOX Pond (possibly S-17) caused by a dike breakage. Thus, based on structure, size, and expected contaminant distribution, this site is believed to be similar to the 216-U-10 Pond.	305 m x 9 m (1,000 ft x 30 ft)	200 West	REDOX: 1959 process cooling water and steam condensate from the 202-S Building process tanks.	UNKN	UNKN	No	UNKN												

Table C-3. 200-CW-5, 200-CW-2, 200-CW-4, 200-SC-1 Operable Unit Consolidation Logic Waste Sites Conforming to the Work Plan Contaminant Distribution Models. (4 Pages)

											Contaminant Inventory											
Representative Site or TSD	Accepted Waste Site Name	Waste Site Type	Rationale	Site Size	Area	Plant Process	Case (effluent vol.)	Soil Pore Volume Exceeded	Characterized or Data Evaluated	Case (Inven-tory)	Total U (kg)	Total Pu (g)	Am-241 (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	CCl_4 (kg)	Ferro-cyanide (kg)	Hexone (kg)	Nitrate (kg)	NPH (kg)	$Na_2Cr_2O_7$ (kg)	TBP (kg)
200-CW-4 Operable Unit Consolidated Representative Waste Sites																						
	216-T-4A	Pond	The pond no longer exists. The entire surface of the bottom of the original pond (216-T-4A) was scraped to a depth of 15 to 23 centimeters (6 to 9 inches) and placed in the 218-W-2A Burial Ground (Trench #27). The scraped area was covered with clean soil in February 1973. In April 1973, 20,000 square meters (5 acres) of the scraped pond bottom were seeded with Siberian Wheat Grass to help stabilize the ground surface. In May 1972, an earthen dike was built to separate the replacement pond area (216-T-4B) from the 218-W-2A Burial Ground expansion. Based on structure, size, and expected contaminant distribution, this site is believed to be similar to the 216-U-10 Pond, but less contaminated.	6.5 ha (16 ac)	200 West	T Plant (bismuth phosphate and decontamination operations): 1944-1972 The pond received cooling water and steam condensate from 221-T and 224-T via the 207-T Retention Basin and the 216-T-4-1 Ditch. The site also received condenser cooling water and steam condensate from the 242-T Evaporator. The wastewater in the ditch flowed through a culvert that went under the 218-W-2A Burial Ground railroad spur and then ran into a shallow ditch cut to a natural surface depression in the desert floor.	Typical	Yes/ 3110	No	UNKN												
200-CW-4 Operable Unit Consolidated Analogous Waste Sites																						
	216-T-4B	Pond	The inventory and contaminant distribution in 216-T-4A and 216-T-4B are believed to be similar. Effluent from the 207-T basin to the original ditch (216-T-4-1) was redirected to the new pond area (216-T-4B). The volume of water in the new ditch (216-T-4-2) was usually not large enough to fill the 216-T-4B Pond. The effluent was usually absorbed in the first quarter of the 216-T-4-2 Ditch, leaving the pond area dry. The 216-T-4B Pond was considered to be dry after 1977. However, the 1995 end date refers to the 216-T-4-2 Ditch discharge end date. Based on structure size, purpose, operational history and volume of effluent discharged, the contaminant distribution is believed to be similar to the 216-U-10 Pond.	0.6 ha (1.5 ac)	200 West	T Plant (Decontamination operations): 1972-1995 The site may have received steam condensate and condenser cooling water from the 242-T Evaporator and nonradioactive wastewater from 221-T air conditioning filter units and floor drains via the 216-T-4-2 Ditch.	Typical	UNKN	No	Typical	690	3.71		6.23	3.37							

Table C-3. 200-CW-5, 200-CW-2, 200-CW-4, 200-SC-1 Operable Unit Consolidation Logic Waste Sites Conforming to the Work Plan Contaminant Distribution Models. (4 Pages)

											Contaminant Inventory										
Representative Site or TSD	**Accepted Waste Site Name**	**Waste Site Type**	**Rationale**	**Site Size**	**Area**	**Plant Process**	**Case (effluent vol.)**	**Soil Pore Volume Exceeded**	**Characterized or Data Evaluated**	**Case (Inventory)**	**Total U (kg)**	**Total Pu (g)**	**Am-241 (Ci)**	**Cs-137 (Ci)**	**Sr-90 (Ci)**	**CCl_4 (kg)**	**Ferrocyanide (kg)**	**Hexone (kg)**	**Nitrate (kg)**	**NPH (kg)**	**$Na_2Cr_2O_7$ (kg)**	**TBP (kg)**
216-U-14		Ditch	The contaminant distribution model is developed in this work plan for this 200-CW-5 representative waste site. The representative waste site is listed as typical based on the waste groupings report (DOE/RL-96-81). As stated in that report, the inventories for the 216-U-14 Ditch are included in the 216-U-10 Pond data and are not separable.	1,731 m x 2.4 m (5,680 ft x 8 ft)	200 West	Multiple Processes 1944-1985 The 216-U-14 Ditch was excavated in 1944 and was the original effluent route to the 216-U-10 Pond. It received powerhouse waste water, laundry waste water (until 1981) via the 200-W-102 Pipeline, and steam condensate and cooling water from 221-U/224-U, powerhouse waste water/laundry waste water, 221-U, 224-U, 241-U-110 condenser tank, and in 1985-1995 steam condensate/cooling water from 224-U and 242-S Evaporator.	Typical	UNKN	Yes	Typical												
200-CW-2 Operable Unit Consolidated Analogous Waste Site																					
	216-S-16D	Ditch	Cooling water and steam condensate were discharge from the REDOX facility. Based on structure, size, and expected contaminant distribution, this site is believed to be similar to the 216-U-14 Ditch.	518 m x 1.2 m (1700 ft x 4 ft)	200 West	REDOX: 1957-1975 The site received process cooling water and steam condensate from 202-S Building and later condenser and vessel cooling water from concentrator boil-down operations in the 202-S Building. In 1973, the 216-U-9 Ditch was connected to the 216-S-16 Ditch to allow the 216-U-10 Pond overflow to reach the 216-S-16 Pond.	Worst Case	Yes/ 20	No	UNKN									10			
200-CW-4 Operable Unit Consolidated Analogous Waste Sites																					
	216-T-1	Ditch	Based on structure size, purpose, operational history and volume of effluent discharged, the contaminant distribution is believed to be similar to the 216-U-14 Ditch.	216 m x 10 m (710 ft x 33 ft)	200 West	T Plant (bismuth phosphate and decontamination operations) 1944 –1995. The site received miscellaneous waste from pilot plant experimental work, intermittent decontamination waste, and waste from the head end of the 221-T Building. The site also received cooling water from the blowdown vessel in the 271-T Building, miscellaneous waste from PNL head end operations in the 221-T Building, condensate from steam-heated radiators at the head end of 221-T Building and sodium hydroxide wash water waste solution from the Sodium-Air-Water Reaction Emergency Air Cleaning Development-HEDL.	Typical	Yes/ 5	No	Typical	5.94	0.10		0.0387	0.0363							

Table C-3. 200-CW-5, 200-CW-2, 200-CW-4, 200-SC-1 Operable Unit Consolidation Logic Waste Sites Conforming to the Work Plan Contaminant Distribution Models. (4 Pages)

											Contaminant Inventory											
Representative Site or TSD	Accepted Waste Site Name	Waste Site Type	Rationale	Site Size	Area	Plant Process	Case (effluent vol.)	Soil Pore Volume exceeded	Characterized or Data Evaluated	Case (Inventory)	Total U (kg)	Total Pu (g)	Am-241 (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	CCl_4 (kg)	Ferro-cyanide (kg)	Hexone (kg)	Nitrate (kg)	NPH (kg)	$Na_2Cr_2O_7$ (kg)	TBP (kg)
	216-T-4-1D	Ditch	The original ditch is not currently visible. The 216-T-4-2 Ditch replaced the 216-T-4-1D Ditch in 1972. The first 15 meters (50 feet) of the original 216-T-4-1D Ditch was reused in the replacement ditch construction. 216-T-4-1 Ditch was surface stabilized along with the 216-T-4-2 replacement ditch in 1995. Based on structure size, purpose, operational history and volume of effluent discharged, the contaminant distribution is believed to be similar to that of the 216-U-14 Ditch.	259 m x 2.4 m (850 ft x 8 ft)	200 West	T Plant (bismuth phosphate and decontamination operations): 1944-1972 The site received process cooling water from the 221-T and 224-T Buildings via the 207-T Retention Basin and steam condensate from 221-T Building. The site also received condenser cooling water and steam condensate from 242-T Evaporator and decontamination waste from the 2706-T Building.	UNKN	UNKN	No	UNKN												
	216-T-4-2	Ditch	Based on structure size, purpose, operational history and volume of effluent discharged, the contaminant distribution appears to be bounded by 216-U-14 Ditch. Effluent from the 207-T basin to the original ditch (216-T-4-1) was redirected to the new pond area (216-T-4B). Volume of water in the new ditch (216-T-4-2) usually was not large enough to fill the 216-T-4B Pond. The effluent usually was absorbed in the first quarter of 216-T-4-2 Ditch, leaving the pond area dry. The 216-T-4B Pond was considered to be dry after 1977. However, the 1995 end date refers to the 216-T-4-2 Ditch discharge end date.	533.4 m x 2.4 m (1750 ft x 8 ft)	200 West	T Plant (Decontamination operations): 1972-1995 The site received steam condensate and condenser cooling water from the 242-T Evaporator and nonradioactive wastewater from 221-T air conditioning filter units and floor drains.	UNKN	UNKN	No	UNKN									1			
216-Z-11		Ditch	The contaminant distribution model for this 200-CW-5 representative waste site is developed in this work plan. The representative waste site is listed as typical based on the Waste Groupings report (DOE/RL-96-81). The contaminant inventory for this site is included in the 216-U-10 Pond data and is not separable. Further discussion on the inventory is presented in the Work Plan, Section 3.3.2.2.	797 m x 1.2 m (2,615 ft x 4 ft)	200 West	Z Plant Complex: 1959-1971 The 216-Z-11 Ditch was installed to replace the 216-Z-1D Ditch. The 216-Z-11 Ditch received liquid waste (steam condensate/ cooling/ sealing water/ laboratory waste/ storm water) from Plutonium Finishing Plant process sewer, 291-Z, and 231-Z until it was deactivated. The 216-Z-19 Ditch replaced the 216-Z-11 Ditch in 1971. During the 1960's a special Space Nuclear Auxiliary Power program was operating in Z-Plant. The program isolated Pu-238 and released an unknown amount of plutonium 239/240 to the 216-Z-11 Ditch as waste.	Typical	UNKN	Yes	Typical												

[a] No waste sites were identified as analogous to the 216-Z-11 Ditch.

DOE/RL-95-13, *Limited Field Investigation for the 200-UP-2 Operable Unit.*

DOE/RL-96-81, *Waste Site Grouping for 200 Areas Soil Investigations.*

HEDL = Hanford Engineering and Development Laboratory.

NPH = normal paraffin hydrocarbon.

REDOX = Reduction-Oxidation (Facility or process).

TBP = tributyl phosphate.

UNKN = unknown.

Table C-4. Waste Sites Conforming to Other Operable Unit Contaminant Distribution Models. (11 Pages)

											Contaminant Inventory											
Representative Site or TSD/OU	Accepted Waste Site Name	Waste Site Type	Rationale	Site Size	Area	Plant Process	Case (effluent vol.)	Soil Pore Volume exceeded	Characterized or Data Evaluated	Case (Inventory)	Total U (kg)	Total Pu (g)	Am-241 (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	CCl_4 (kg)	Ferro-cyanide (kg)	Hexone (kg)	Nitrate (kg)	NPH (kg)	$Na_2Cr_2O_7$ (kg)	TBP (kg)
[redacted]																						
200-CW-2 Operable Unit Consolidated Analogous Wastes																						
	207-S	Retention Basin	The waste site is a concrete structure associated with the 216-S-6 Crib and the 216-S-16 and 216-S-17 Ponds. Based on structure, size, and expected contaminant distribution, the contaminant distribution model of this site is analogous to the 207-A-South Retention Basin. Contamination should be within a few feet of the release point. Waste contaminants are bounded by the 216-S-1&2 Cribs and were investigated in RHO-ST-39.	40 m x 40 m (130 ft x 130 ft)	200 West	REDOX: 1951-1954 process cooling water and steam condensate from 202-S before it was discharged to the 216-S-17 and 216-S-16 Ponds. The basin was removed from service in 1954 following a 202-S coil leak that contaminated the basin above permissible limits. Contaminated soil from an S/SX Tank Farm unplanned release was disposed to this basin in 1993.	UNKN	UNKN	No	UNKN												

Table C-4. Waste Sites Conforming to Other Operable Unit Contaminant Distribution Models. (11 Pages)

Representative Site or TSD/OU	Accepted Waste Site Name	Waste Site Type	Rationale	Site Size	Area	Plant Process	Case (effluent vol.)	Soil Pore Volume exceeded	Characterized or Data Evaluated	Case (Inventory)	Contaminant Inventory: Total U (kg)	Total Pu (g)	Am-241 (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	CCl_4 (kg)	Ferro-cyanide (kg)	Hexone (kg)	Nitrate (kg)	NPH (kg)	$Na_2Cr_2O_7$ (kg)	TBP (kg)
	216-S-172	Control Structure	This site is an underground concrete structure with interior hand-operated sluice gates. Float wells were attached to the outside north and south walls. Based on structure, size, and expected contaminant distribution, the contaminant distribution model of this site is represented by the 207-A-South Retention Basin. Contamination should be within a few feet of the release point. Waste contaminants are bounded by the 216-S-1&2 Cribs and were investigated in RHO-ST-39.	4.1 m x 2.2 m (13 ft x 7 ft)	200 West	REDOX: 1956-1976 The control structure was used to divert 202-S process vessel cooling water and steam condensate to the 216-S-16 Ditch.	UNKN	UNKN	No	UNKN												
	2904-S-160	Control Structure	The 2904-S-160 Control Structure is a below grade pentagonal structure with reinforced concrete walls, floor, and roof. Based on structure, size, and expected contaminant distribution, the contaminant distribution model of this site is represented by the 207-A South Retention Basin. Contamination should be within a few feet of the release point. Waste contaminants are bounded by the 216-S-1&2 Cibs and were investigated in RHO-ST-39.	3 m x 3 m (10 ft x 10 ft)	200 West	REDOX: 1954-1976 The unit was built to divert process vessel cooling waste and steam condensate from 202-S Building to the 216-S-17 Pond, 216-S-6 Crib, and 216-S-16 Pond.	UNKN	UNKN	No	UNKN												
	2904-S-170	Control Structure	The 2904-S-170 Control Structure is an inactive, below grade concrete structure. Based on structure, size, and expected contaminant distribution, the contaminant distribution model of this site is represented by the 207-A South Retention Basin. Contamination should be within a few feet of the release point. Waste contaminants are bounded by the 216-S-1&2 Cribs and were investigated in RHO-ST-39.	4.9 m x 1.5 m (16 ft x 5 ft)	200 West	REDOX: 1954-1976 The unit was built to divert process vessel cooling waste and steam condensate from 202-S Building to various waste sites.	UNKN	UNKN	No	UNKN												

Table C-4. Waste Sites Conforming to Other Operable Unit Contaminant Distribution Models. (11 Pages)

Representative Site or TSD/OU	Accepted Waste Site Name	Waste Site Type	Rationale	Site Size	Area	Plant Process	Case (effluent vol.)	Soil Pore Volume exceeded	Characterized or Data Evaluated	Case (Inventory)	Contaminant Inventory: Total U (kg)	Total Pu (g)	Am-241 (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	CCl_4 (kg)	Ferro-cyanide (kg)	Hexone (kg)	Nitrate (kg)	NPH (kg)	$Na_2Cr_2O_7$ (kg)	TBP (kg)
	2904-S-171	Control Structure	The 2904-S-171 Control Structure is a below grade, rectangular concrete weir. The contaminant distribution model of this site is analogous to the 207-A-South Retention Basin. Contamination should be within a few feet of the release point. Waste contaminants are analogous to the 216-S-1&2 Cribs and were investigated in RHO-ST-39.	4 m x 2.6 m (13 ft x 9 ft)	200 West	REDOX: 1954-1976 regulate waste being routed to 216-S-6 Crib that contained process vessel cooling water and steam condensate from 202-S Building via the 207-S Retention Basin. The waste was acidic and contained nitrates.	UNKN	UNKN	No	UNKN												
200-CW-4 Operable Unit Consolidated Analogous Waste Sites																						
	207-T	Retention Basin	The unit was a concrete structure, divided into two sections, with a 3,800,000 L (1,000,000 gal) capacity. The contaminant distribution model of this site is analogous to the 207-A-South Retention Basin. Waste inventory is bounded by the 216-T-26 and 216-T-33 Cribs (both bismuth phosphate and decontamination wastes).	75 m x 37 m (246 ft x 123 ft)	200 West	T Plant (Bismuth Phosphate and Decontamination Operations): 1944-1995 The basin received cooling water effluent from 221-T and 224-T buildings and condensate from the 242-T Evaporator. The basin effluent was released to the 216-T-4-1 and 216-T-4-2 Ditches. Contamination should be within a few feet of the release point. Contaminated soil from a T Tank Farm unplanned release was disposed to this basin in 1996.	UNKN	UNKN	No	UNKN												
200-SC-1 Operable Unit Consolidated Analogous Waste Sites																						
	207-A-NORTH	Retention Basin	The 207-A North Retention Basins consist of three Hypalon lined, concrete basins. The contaminant distribution model of this site is analogous to the 207-A South Retention Basin physically and chemically. Contamination should be within a few feet of the release point.	16.8 m x 3 m x 2.1 m (55 ft x 10 ft x 7 ft)	200 East	PUREX: 1977-1999 The basin received steam condensate from the 242-A Evaporator since 1977. Waste types include: dilute non-complexed PUREX radioactive waste, PUREX dilute miscellaneous waste, PUREX cladding removal waste, and complexed radioactive waste. Hazardous chemicals used include: sodium nitrate used to regenerate ion exchange column, sodium hydroxide used for decontamination applications, and the antifoam agent used in the evaporator vessel.	UNKN	UNKN	No	UNKN												

Table C-4. Waste Sites Conforming to Other Operable Unit Contaminant Distribution Models. (11 Pages)

Representative Site or TSD/OU	Accepted Waste Site Name	Waste Site Type	Rationale	Site Size	Area	Plant Process	Case (effluent vol.)	Soil Pore Volume exceeded	Characterized or Data Evaluated	Case (Inventory)	Contaminant Inventory: Total U (kg)	Total Pu (g)	Am-241 (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	CCl_4 (kg)	Ferro-cyanide (kg)	Hexone (kg)	Nitrate (kg)	NPH (kg)	$Na_2Cr_2O_7$ (kg)	TBP (kg)
	207-Z	Retention Basin	Two concrete basin structures within one concrete structure. Each basin contains a sump with a sump pump. The contaminant distribution model of this site is analogous to the 207-A South Retention Basin. Contamination should be within a few feet of the release point. From a COC perspective, the site is analogous to the 216-Z-19 or 216-Z-1D Ditches.	15 m x 12 m (50 ft x 40 ft)	200 West	Z Plant Complex (PIF, RECUPLEX, 291-Stack) 1949-1959: The site received process cooling water, steam condensate, pump sealant waters, and lab wastes via the D-3 piping system. Waste was sent to this holding facility and then released to the 216-Z-1 and 216-Z-11 Ditches.	UNKN	UNKN	No	UNKN												
	216-B-64	Retention Basin	Even though the unit has not been used except for an initial test but is capable of receiving diverted wastes from 221-B, any contamination discharged during the test would have been within a few feet of the release point. Thus, the contaminant distribution model of this site is analogous to the 207-A South Retention Basin.	51 m x 13 m (167 ft x 42 ft)	200 East	Never Used: 1974-1997 Built in 1974, the purpose of the basin was to receive steam condensate from the 221 B Building that exceeded release limits, however, it was never used.	UNKN	UNKN	No	UNKN												
200-E-111/ 200-IS-1		Process Piping	The 200-E-111 conceptual contaminant distribution model is developed in the 200-IS-1 DQO (CP-13196) and the 200-IS-1 RI/FS Work Plan (DOE/RL-2002-14). The conceptual contaminant distribution model illustrates a shallow vertical extent of contaminants that potentially occurred during process operations. Leaks are the primary source of potential contamination.	3 m long (9 ft long)	200 East	The underground, encased pipeline was used to transfer waste from 241-ER-151 Diversion Box to the C Tank Farm and the 244-AR Vault. The pipeline transported liquid effluent from the 241-ER-151 Diversion Box to the tank farms. Some adjacent soil has been contaminated from pipeline leaks.	UNKN	UNKN	No	Typical												
200-CW-4 Operable Unit Consolidated Analogous Waste Sites																						
	200-W-88	Process Sewer	The waste site is a shallow pipeline with the potential of leaking and is analogous to the contaminant distribution model of 200-E-111 generated during the 200-IS-1 OU DQO process. Waste contaminants are bounded by the 216-T-26 and 216-T-33 Cribs (both bismuth phosphate and decontamination wastes).	1829 m x 0.6 m (6,000 ft x 2 ft)	200 West	T Plant (bismuth phosphate and decontamination operations): 1944-1995 The 200-W-88 Process Sewer lines transferred process cooling water, air conditioning condensate, and floor-drain waste from 221-T, 224-T, and 242-T to the 207-T Retention Basin and the 216-T-4-1 and 216-T-4-2 Ditches.	UNKN	UNKN	No	UNKN												

Table C-4. Waste Sites Conforming to Other Operable Unit Contaminant Distribution Models. (11 Pages)

Representative Site or TSD/OU	Accepted Waste Site Name	Waste Site Type	Rationale	Site Size	Area	Plant Process	Case (effluent vol.)	Soil Pore Volume exceeded	Characterized or Data Evaluated	Case (Inventory)	Contaminant Inventory: Total U (kg)	Total Pu (g)	Am-241 (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	CCl_4 (kg)	Ferro-cyanide (kg)	Hexone (kg)	Nitrate (kg)	NPH (kg)	$Na_2Cr_2O_7$ (kg)	TBP (kg)
200-SC-1 Operable Unit Consolidated Analogous Waste Sites																						
	200-E-113	Process Sewer	The waste site is a shallow pipeline with the potential of leaking and is analogous to the contaminant distribution model of 200-E-111 generated during the 200-IS-1 OU DQO process. From a COC perspective, the waste site is similar to 216-A-42 and bounded by the 216-A-10 Crib.	538 m x 0.4 m (1,765 ft x 1.3 ft)	200 East	PUREX: 1961-1995 The pipeline transported steam condensate waste (steam condensate, the equipment disposal tunnel floor drainage, the water-filled door drainage and the slug storage basin overflow) from the PUREX Facility to the 216-A-30 Crib via Distribution Box 1. The effluent was monitored for radionuclides with an in-line monitoring system. If concentrations exceeded the discharge limits, an alarm was sounded and the stream automatically diverted to the 216-A-42 Retention Basin.	UNKN	UNKN	No	UNKN												
	200-W-79	Process Sewer	The waste site is a shallow pipeline with the potential of leaking and is analogous to the contaminant distribution model of 200-E-111 generated during the 200-IS-1 OU DQO process. From a COC perspective, the 216-T-33 Crib bounds the site.	225 m x 0.1 m (738.2 ft x 0.3 ft)	200 West	T Plant and U Plant decontamination operations: 1967-1973 The pipeline originated at both T Plant and U Plant. It sent steam condensate, decontamination waste, and miscellaneous waste from the 221-T and 221-U Buildings and decontamination waste from the 2706-T Building to 216-T-36 via the 241-T-151 Diversion Box.	UNKN	UNKN	No	UNKN												
216-T-26/ 200-TW-1		Crib	The contaminant distribution model is developed in the 200-TW-1 RI report (DOE/RL-2002-42) based on characterization during the summer of 2001.	9 m x 9 m (30 ft x 30 ft)	200 West	T Plant (bismuth phosphate) 1955-1956 The site received first-cycle scavenged supernatant waste from T Plant containing ferrocyanide, fluoride, nitrate, nitrite, phosphate, sodium, sodium aluminate, sodium hydroxide, sodium silicate, and sulfate.	Typical	Yes/18	Yes	Typical	150	59		45.6	282	[illegible]	6000		1E+06	[illegible]		

Table C-4. Waste Sites Conforming to Other Operable Unit Contaminant Distribution Models. (11 Pages)

											Contaminant Inventory											
Representative Site or TSD/OU	**Accepted Waste Site Name**	**Waste Site Type**	**Rationale**	**Site Size**	**Area**	**Plant Process**	**Case (effluent vol.)**	**Soil Pore Volume exceeded**	**Characterized or Data Evaluated**	**Case (Inventory)**	**Total U (kg)**	**Total Pu (g)**	**Am-241 (Ci)**	**Cs-137 (Ci)**	**Sr-90 (Ci)**	**CCl_4 (kg)**	**Ferro-cyanide (kg)**	**Hexone (kg)**	**Nitrate (kg)**	**NPH (kg)**	**$Na_2Cr_2O_7$ (kg)**	**TBP (kg)**
200-CW-4 Operable Unit Consolidated Analogous Waste Sites																						
	216-T-12	Trench	Based on structure size, purpose, operational history and volume of effluent discharged, the contaminant distribution is believed to be similar to the 216-T-26 Crib as most of the contamination is expected to be within a few feet of the release. The 216-T-26 Crib bounds waste contaminants.	4.6 m x 3 m (15 ft x 10 ft)	200 West	T Plant (bismuth phosphate): 1954 The trench received sludge from the 207-T Retention Basin that received cooling water effluent from 221-T and 224-T Buildings and condensate from the 242-T Evaporator.	Typical	Yes/ 23	No	Typical	44.6	1.0		4.34	2.05							
216-A-10/ 200-PW-2		Crib	Site is a RCRA TSD unit that requires characterization as part of closure activities. The contaminant distribution model is developed in the 200-PW-2 RI/FS Work Plan (DOE/RL-2000-60).	83.8 m x 13.7 m (275 ft x 45 ft)	200 East	PUREX: 1956-1987 RCRA TSD. The crib, with vitrified clay distribution pipe, was a replacement for 216-A-5 Crib that received cooling water, acidic waste stream from process distillate discharge, and corrosive/mixed waste process distillates and condensates from 202-A.	Worst Case	Yes/ 114	Yes	Typical	241	350	0.773	80.5	82.5							
200-SC-1 Operable Unit Consolidated Representative Waste Sites																						
	216-A-6	Crib	The flow capacity of the 216-A-6 Crib was exceeded and three UPRs are associated with the site because of overflow. The UPRs contain minimal amounts of contamination compared to the crib. All UPRs were surface stabilized after occurrence and again in 1993 with the crib. The 216-A-6 Cribcontaminant distribution model is analogous to the 216-A-10 Crib model based on size, similar structure, volume discharged, and potential inventory distribution.	31 m x 31 m (100 ft x 100 ft)	200 East	PUREX: 1955-1970. The crib received the steam condensate, the equipment disposal tunnel floor drainage, the water-filled door drainage and the slug storage basin overflow waste from the 202 A Building.	Typical	Yes/ 148	No	Typical	164	35.6		105	44.1				10000			

Table C-4. Waste Sites Conforming to Other Operable Unit Contaminant Distribution Models. (11 Pages)

											Contaminant Inventory											
Representative Site or TSD/OU	Accepted Waste Site Name	Waste Site Type	Rationale	Site Size	Area	Plant Process	Case (effluent vol.)	Soil Pore Volume exceeded	Characterized or Data Evaluated	Case (Inventory)	Total U (kg)	Total Pu (g)	Am-241 (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	CCl_4 (kg)	Ferro-cyanide (kg)	Hexone (kg)	Nitrate (kg)	NPH (kg)	$Na_2Cr_2O_7$ (kg)	TBP (kg)
	216-S-5	Crib	The unit (originally called an underground swamp) was built as a temporary replacement for the grossly contaminated 216-S-17 Pond. In 1956, the cooling water discharge volumes made it necessary to cut a hole along the top edge of the crib to discharge overflow cooling water to a trench immediately southwest of the crib structure rather than allowing the crib to flood. The overflow of 50 to 100 gal/min represented approximately 5% of the total flow to the 216-S-5 Crib. The emergency overflow continued throughout the summer of 1956. The overflow was surface stabilized and contains minimal amounts of contamination compared to the crib. The 216-S-5 Crib contaminant distribution model is analogous to the 216-A-10 Crib model based on size, similar structure, volume discharged, and potential inventory distribution. Chemically the 216-S-1&2 Cribs bound it.	64 m x 64 m (210 ft x 210 ft)	200 West	REDOX: 1954-1957. The site received process vessel cooling water and steam condensate from 202-S Building via the 207-S Retention Basin. The waste was acidic and contained nitrates.	Typical	Yes/ 56	No	Typical	271	580		26.4	54.1				100			

Table C-4. Waste Sites Conforming to Other Operable Unit Contaminant Distribution Models. (11 Pages)

											Contaminant Inventory											
Representative Site or TSD/OU	Accepted Waste Site Name	Waste Site Type	Rationale	Site Size	Area	Plant Process	Case (effluent vol.)	Soil Pore Volume exceeded	Characterized or Data Evaluated	Case (Inventory)	Total U (kg)	Total Pu (g)	Am-241 (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	CCl_4 (kg)	Ferro-cyanide (kg)	Hexone (kg)	Nitrate (kg)	NPH (kg)	$Na_2Cr_2O_7$ (kg)	TBP (kg)
200-SC-1 Operable Unit Consolidated Analogous Waste Sites																						
	216-A-30	Crib	During the winter of 1971 and early 1972, an alkaline/salt deposit formed by condensing vapors being emitted from the unit through the porous soil over the surface of the 216-A-30 Crib. Corrective actions were taken in June 1972, including covering the ground with layers of sand and plastic. The deposits contain minimal amounts of contamination compared to the crib. The 216-A-30Crib contaminant distribution model is analogous to the 216-A-10 Crib model based on size, similar structure, volume discharged, and potential inventory distribution. The site is also bounded by the 216-A-10 Crib waste stream constituents.	427 m x 3 m x 37 m (1,400 ft x 10 ft x 12 ft)	200 East	PUREX: 1961-1992. The site received the steam condensate, equipment disposal tunnel floor and water-filled door drainage, and the slug storage basin overflow waste from 202-A Building. The waste was low in salt and is neutral to basic.	Worst Case	Yes/ 224	No	Worst Case	297	73.1	19.8	117	102				16000			
	216-S-6	Crib	The 216-S-6 Crib contaminant distribution model is analogous to the 216-A-10 Crib model based on size, similar structure, volume discharged, and potential inventory distribution. Waste contaminants are bounded by the 216-S-1&2 Cribs and were investigated in RHO-ST-39.	64 m x 64 m (210 ft x 210 ft)	200 West	REDOX: 1954-1972. The site received process vessel cooling water and steam condensate from the D-12 and D-14 Waste Concentrators in the 202-S Building via the 207-S South Retention Basin. The waste was acidic and contained nitrates.	Typical	Yes/ 127	No	Typical	271	473		115	204				140			
	216-S-25	Crib	The 216-S-25 Crib contaminant distribution model is analogous to the 216-A-10 Crib model based on size, similar structure, volume discharged, and potential inventory distribution with the exception of not impacting groundwater. Waste contaminants are bounded by the 216-S-1&2 Cribs and were investigated in RHO-ST-39.	175 m x 3.1 m (575 ft x 10 ft)	200 West	REDOX: 1973-1992. The site received 242-S Evaporator process steam condensate, effluent from the 216-U-1 & 2 Crib groundwater pump and treat effort, and SX Tank Farm cooling water.	Typical	Yes/ 30	No	Typical	167	0.0466		0.0647	0.041				1			

Table C-4. Waste Sites Conforming to Other Operable Unit Contaminant Distribution Models. (11 Pages)

											Contaminant Inventory											
Representative Site or TSD/OU	**Accepted Waste Site Name**	**Waste Site Type**	**Rationale**	**Site Size**	**Area**	**Plant Process**	**Case (effluent vol.)**	**Soil Pore Volume exceeded**	**Characterized or Data Evaluated**	**Case (Inventory)**	**Total U (kg)**	**Total Pu (g)**	**Am-241 (Ci)**	**Cs-137 (Ci)**	**Sr-90 (Ci)**	**CCl_4 (kg)**	**Ferro-cyanide (kg)**	**Hexone (kg)**	**Nitrate (kg)**	**NPH (kg)**	**$Na_2Cr_2O_7$ (kg)**	**TBP (kg)**
	UPR-200-E-19	Unplanned Release	All UPRs were close in proximity and were surface stabilized after occurrence, and again in 1993 with the 216-A-6 Crib. They are considered part of the crib. The 216-A-6 Crib contaminant distribution model is similar to the 216-A-10 Crib model based on size, similar structure, volume discharged, and potential inventory distribution. The 216-A-10 Crib also chemically bounds the site.	NA	200 East	PUREX: 1959 release at 216-A-6 Crib	UNKN	UNKN	No	UNKN												
	UPR-200-E-21	Unplanned Release	All UPRs were close in proximity and were surface stabilized after occurrence, and again in 1993 with the 216-A-6 Crib. They are considered part of the crib. The 216-A-6 Crib contaminant distribution model is similar to the 216-A-10 Crib model based on size, similar structure, volume discharged, and potential inventory distribution. The 216-A-10 Crib also chemically bounds the site.	NA	200 East	PUREX: 1959 release at 216-A-6 Crib	UNKN	UNKN	No	UNKN												
	UPR-200-E-29	Unplanned Release	All UPRs were close in proximity and were surface stabilized after occurrence, and again in 1993 with the 216-A-6 Crib. They are considered part of the crib. The 216-A-6 Crib contaminant distribution model is similar to the 216-A-10 Crib model based on size, similar structure, volume discharged, and potential inventory distribution. The 216-A-10 Crib also chemically bounds the site.	NA	200 East	PUREX: 1961 release at 216-A-6 Crib	UNKN	UNKN	No	UNKN												
216-A-37-1/200-PW-4 [illegible]		Crib	The 216-A-37-1 Crib conceptual contaminant distribution model is in the 200-PW-2/4 Consolidated RI/FS Work Plan (DOE/RL-2000-60). The site is also a RCRA TSD.	213.4 m x 3 m (700 ft x 10 ft)	200 East	PUREX: 1956-1987 RCRA TSD. The crib with vitrified clay distribution pipe was a replacement for the 216-A-5 Crib that received cooling water, acidic waste stream from process distillate discharge, and corrosive/mixed waste process distillates and condensates from 202-A.	Typical	Yes/24	Yes	Typical	324	0.0283	3.69E-04	0.0987	0.0542				600			

Table C-4. Waste Sites Conforming to Other Operable Unit Contaminant Distribution Models. (11 Pages)

											Contaminant Inventory										
Representative Site or TSD/OU	Accepted Waste Site Name	Waste Site Type	Rationale	Site Size	Area	Plant Process	Case (effluent vol.)	Soil Pore Volume exceeded	Characterized or Data Evaluated	Case (Inventory)	Total U (kg)	Total Pu (g)	Am-241 (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	CCl_4 (kg)	Ferro-cyanide (kg)	Hexone (kg)	Nitrate (kg)	NPH (kg)	$Na_2Cr_2O_7$ (kg)	TBP (kg)
200-SC-1 Operable Unit Consolidated Analogous Waste Sites																						
	216-A-37-2	Crib	The 216-A-37-2 contaminant distribution model is analogous to the 216-A-37-1 model based on size, similar structure, volume discharged, and potential inventory distribution. It is also chemically analogous to the 216-A-37-1 site.	427 m x 3.1 m (1,400 ft x 10 ft)	200 East	PUREX: 1983-1995. The site received steam condensate from PUREX (parallel operation of this unit and 216-A-30).	Typical	Yes/ 36	No	Typical	51.1		0.098	0.204	0.307							
216-B-12 200-PW-2 [illegible]		Crib	The contaminant distribution model for this representative waste site is developed in the 200-PW-2 RI/FS Work Plan (DOE/RL-2000-60).	48.8 m x 15.2 m (160 ft x 50 ft)	200 East	Uranium recovery and B Plant processes: 1952-1973. Three cascading wood box design, process condensate from 221-U, 224-U, and 221-B process condensates low salt, neutral to basic, ammonium nitrate, uranium from the uranium recovery process condensate, and other radionuclides.	Typical	Yes/ 28	No	Worst Case	2.10E+04	374		716	79.3							
200-SC-1 Operable Unit Consolidated Analogous Waste Sites																						
	216-B-55	Crib	The 216-B-55 contaminant distribution model is analogous to the 216-B-12 model based on size, similar structure, volume discharged, and potential inventory distribution. The 216-B-12 crib also bounds the waste site chemically.	229m x 3.1 m (750 ft x 10ft)	200 East	B Plant (waste fractionalization and WESF operations): 1967-1991 The site has received steam condensate from 221-B Building during the recovery of strontium, cerium, and rare earths using an acid side, oxalate precipitation process as part of the first phase of processing for the 221 B Building Waste Fractionalization Project.	Typical	Yes/ 68	No	Typical	6.71	0.653	3.80E-06	13.7	7.23							
216-T-33 200-MW-1 [illegible]		Crib	The contaminant distribution model for this representative waste site is developed in the 200-MW-1 RI/FS Work Plan (DOE/RL-2000-65).	9 m x 1.5 m (30 ft x 5 ft)	200 West	T Plant (decontamination operations): 1963 The site received equipment decontamination waste from the 2706-T Building. The waste is low in salt, neutral to basic, and contains sodium hydroxide. The total effluent discharged to the crib is questionable, due to the fact that the discharge line plugged shortly after the crib became active.	Typical	No	No	Typical	5.94	5.00		0.267	0.256							

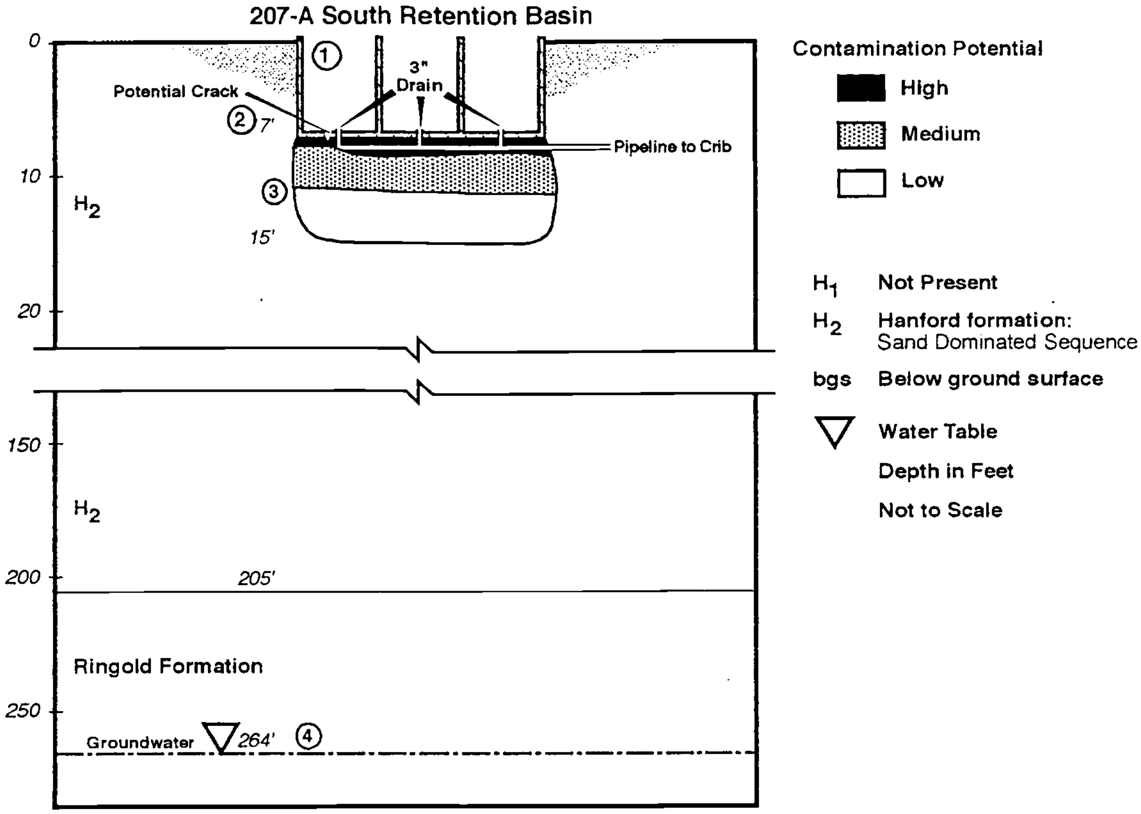
Table C-4. Waste Sites Conforming to Other Operable Unit Contaminant Distribution Models. (11 Pages)

											Contaminant Inventory												
Representative Site or TSD/OU	Accepted Waste Site Name	Waste Site Type	Rationale	Site Size	Area	Plant Process	Case (effluent vol.)	Soil Pore Volume exceeded	Characterized or Data Evaluated	Case (Inventory)	Total U (kg)	Total Pu (g)	Am-241 (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	CCl_4 (kg)	Ferro-cyanide (kg)	Hexone (kg)	Nitrate (kg)	NPH (kg)	$Na_2Cr_2O_7$ (kg)	TBP (kg)
200-SC-1 Operable Unit Consolidated Analogous Waste Sites																						
	216-T-36	Crib	The 216-T-36 Crib contaminant distribution model is analogous to the 216-T-33 Crib model based on size, similar structure, volume discharged, and potential inventory distribution. The site is also chemically bounded by the 216-T-33 Crib. Discharged effluent volume at 0.1% of calculated pore volume. No impact to groundwater is likely.	49 m x 3.1 m (160 ft x 10 ft)	200 West	T Plant and U Plant decontamination operations: 1967-1973. It received steam condensate, decontamination waste, and miscellaneous waste from the 221-T and 221-U Buildings and decontamination waste from the 2706-T Building via the 241-T-151 Diversion Box.	Typical	No	No	Typical	1.18	2.48		3.79	4.36							

CP-13196, *Remedial Investigation Data Quality Objective Summary Report – 200-IS-1 and 200-ST-1 Operable Units*, Draft A.
DOE/RL-2000-60, *200-PW-2 Uranium-Rich Process Waste Group Operable Unit RI/RS Work Plan and RCRA TSD Unit Sampling Plan.*
DOE/RL-2000-65, *Cleanup, Constraints, and Challenges Team (C3T): Team Status, Interim Report.*
DOE/RL-2002-14, *200-IS-1 and 200-ST-1 Groups OUs RI/FS Work Plan*, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
DOE/RL-2002-42, *Remedial Investigation Report for the 200-TW-1 and 200-TW-2 Operable Units (Includes the 200-PW-5 Operable Unit).*
RHO-ST-39, *216-S-1 and S-2 Mixed Fission Product Crib Characterization Study.*

COC = contaminant of concern.
DQO = data quality objective.
NPH = normal paraffin hydrocarbon.
OU = operable unit.
PIF = Plutonium Isolation Facility.
PUREX = Plutonium-Uranium Extraction (Facility).
RCRA = *Resource Conservation and Recovery Act of 1976.*
RECUPLEX = Recovery of Uranium and Plutonium by Extraction (Facility or process).
REDOX = Reduction-Oxidation (Facility or process).
RI/FS = remedial investigation/feasibility study.
TBP = tributyl phosphate.
TSD = treatment, storage, and disposal.
UNKN = unknown.
UPR = unplanned release.
WESF = Waste Encapsulation and Storage Facility.

Figure C-1. 207-A South Retention Basin Conceptual Distribution Model.



① The retention basin is a concrete structure that received effluent from 1977 to 1989. It was used for the interim storage of 242-A Evaporator process condensate to allow for sampling and analysis prior to being discharged to the 216-A-37-1 Crib. The process liquid contained cesium, plutonium, strontium, uranium, acetone, and butanol. The amount of liquid passing through the basin is likely equivalent to the volume discharged [377,000,000 liters (99,528,000 gal)] to the 216-A-37-1 Crib.

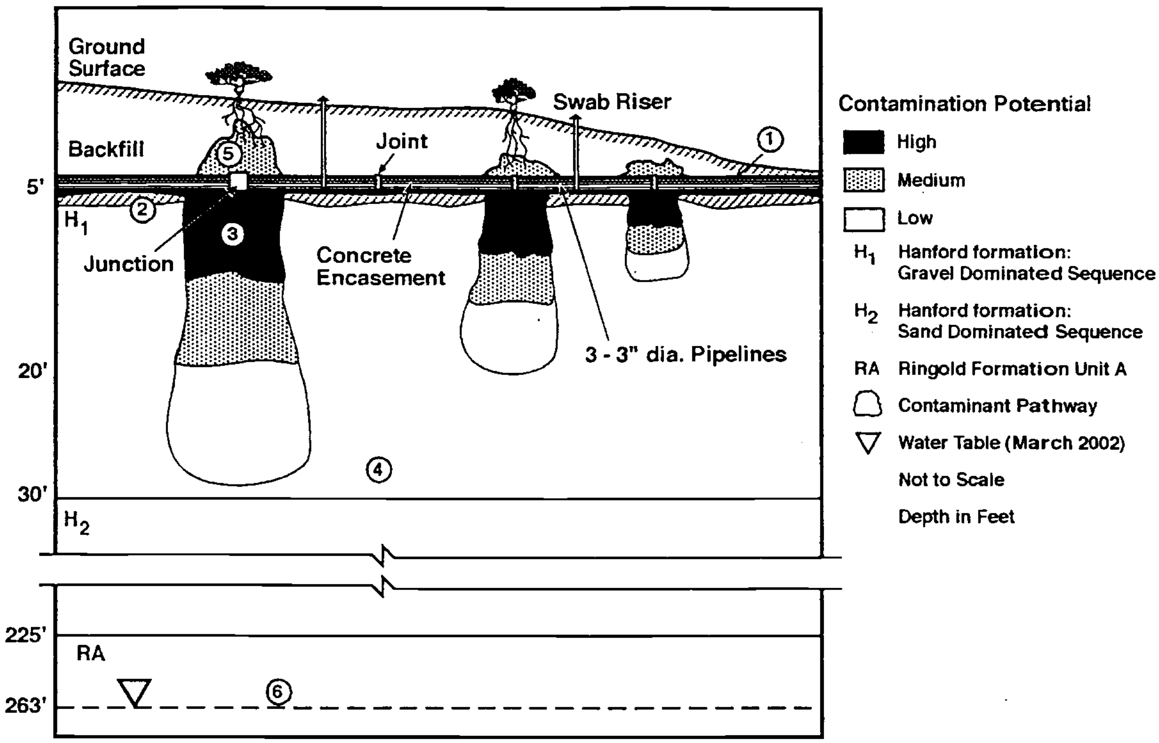
② The basin was designed to hold liquids. There has been no evidence of leaks. Little or no contamination is expected beneath the concrete structure. Any contamination present may be located near cracks in, and drains within, the structure. No structural failures have been documented associated with the basin. Low mobility and moderately mobile contaminants such as cesium and strontium, respectively, will sorb near the bottom of the basin. Contaminant concentrations decrease with depth. Releases would impact H2.

③ High mobility contaminants migrate with the moisture front and may be detected in low concentrations to a depth of about 4.6 m (15 ft). Halogenated and non-halogenated solvents might be detected in the vicinity of the crib in low concentrations.

④ The low potential for the release of effluent to the subsurface suggest that this site has not impacted groundwater. There are no boreholes in the vicinity of the basin and no characterization has been performed.

G02090024-2

Figure C-2. 200-E-111 Pipeline Conceptual Distribution Model.



① 200-E-111 is an encasement that contains three 3-inch diameter stainless steel waste transfer pipelines. The pipelines were used to transport Bismuth Phosphate and Uranium Recovery Waste (uranium and fission product rich process wastes) from 1946 to 1957, Waste Fractionalization fission product waste from 1961 to 1978 and Interim Stabilization and Isolation waste from 1975 to 2001. The pipelines transferred waste to the 241-C Tank Farm and the 244-AR- Vault from the 241-ER-151 Diversion Box.

② Effluent and contaminants were released to the subsurface from the encasement approximately 5-8 feet below the ground surface within H1. The releases are characterized as low volume leaks and are most likely attributed to faulty or degraded seals, joints, of fittings.

③ The effluent and contaminants move vertically down beneath the encasement at various points of release. Low mobility contaminants such as cesium and plutonium sorb near points of release and concentrations decrease with depth.

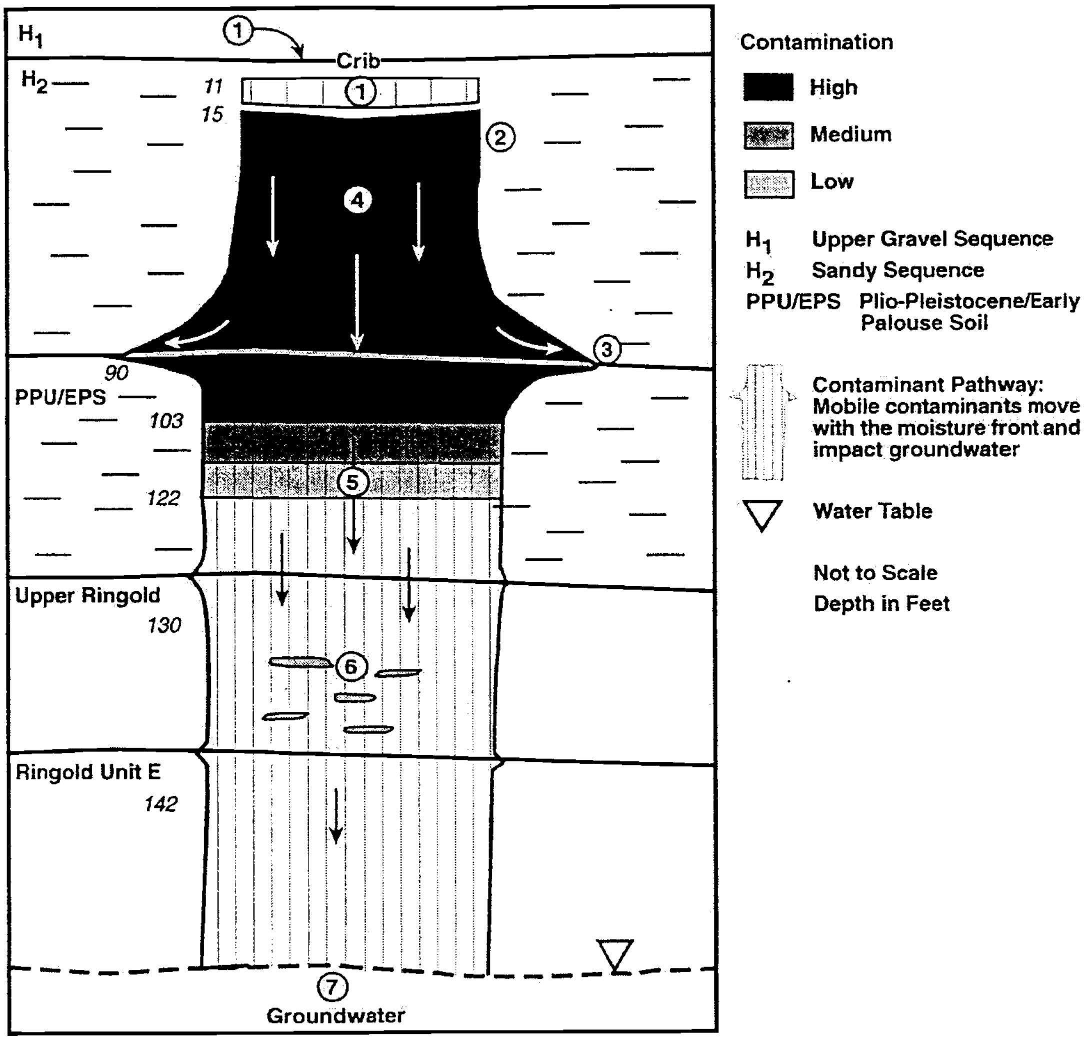
④ Mobile contaminants such as nitrate and tritium migrate with the moisture front to a maximum depth of 20 to 30 ft.

⑤ Contamination extends above the pipeline due to transport by vegetation (i.e., tumbleweed).

⑥ Waste water and contaminants do not impact groundwater because the suspected volume of releases are small.

G02090024-5

Figure C-3. 216-T-26 Crib Conceptual Contaminant Distribution Model.



① High salt, neutral/basic, low organic radioactive liquid waste containing cesium-137, cobalt-60, plutonium-239/240, strontium-90 and other contaminants from the single shell tank system were discharged to the crib between 1955 and 1956. The crib received a total volume of 12,000,000L (3.2 million gal) of wastewater.

② Wastewater moved vertically down beneath the crib into H_2. There is little or no lateral spreading. However, the lack of spreading is not supported by borehole data.

③ Effluent and contaminants intersect the PPU/EPS approximately 90 ft. bgs. Lateral spreading of wastewater and contaminants may occur associated with this unit. If spreading occurs it is to the south based on the topography of the PPU/EPS.

④ Immobile contaminants, such as cesium-137, sorb to the crib and are distributed near the point of release in high concentrations. However, enhanced mobility is indicated at this site as the highly contaminated zone of cesium-137 is 78 ft. thick. Mobile contaminants such as cobalt-60 migrate with the moisture front. Cobalt-60 mobility may be enhanced due to the presence of ferrocyanide complexants.

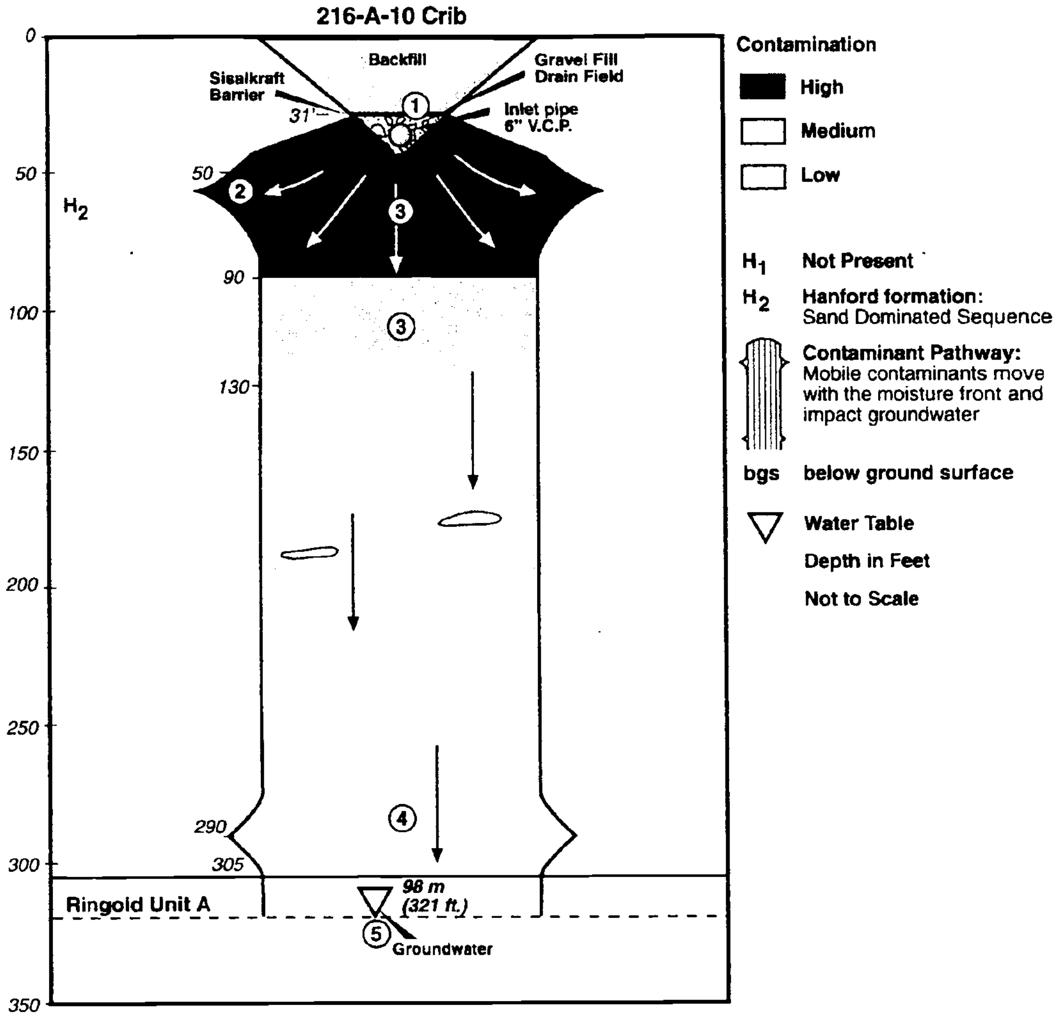
⑤ The activity of cesium-137 decreases with depth; it is not detected greater than 122 ft. bgs.

⑥ Antimony-125 and cobalt-60 were detected at low concentrations to a maximum depth of 140 ft.

⑦ Wastewater and mobile contaminants from the crib impact groundwater.

E9912036.3

Figure C-4. 216-A-10 Crib Conceptual Distribution Model.



(1) Uranium rich process wastes (pH 1 to 2.5) were discharged to the 216-A-10 Crib between 1961 and 1986. The crib received a total volume of 3.21×10^9 L (8.5×10^8 gal) of wastewater. The effluent contained uranium, cesium-137, plutonium, strontium-90, tritium, americium-241, iodine-129, and nitric acid.

(2) Effluent and contaminants were released to the environment from a buried vitrified clay pipe approximately 9.4 m (31 ft) bgs within a gravel filled drain field in H2. The wetting front and contaminants moved vertically down beneath the crib. There is moderate lateral spreading as evidenced by contamination in borehole 299-E24-60 which is located 6.1 m (20 ft) west of the crib.

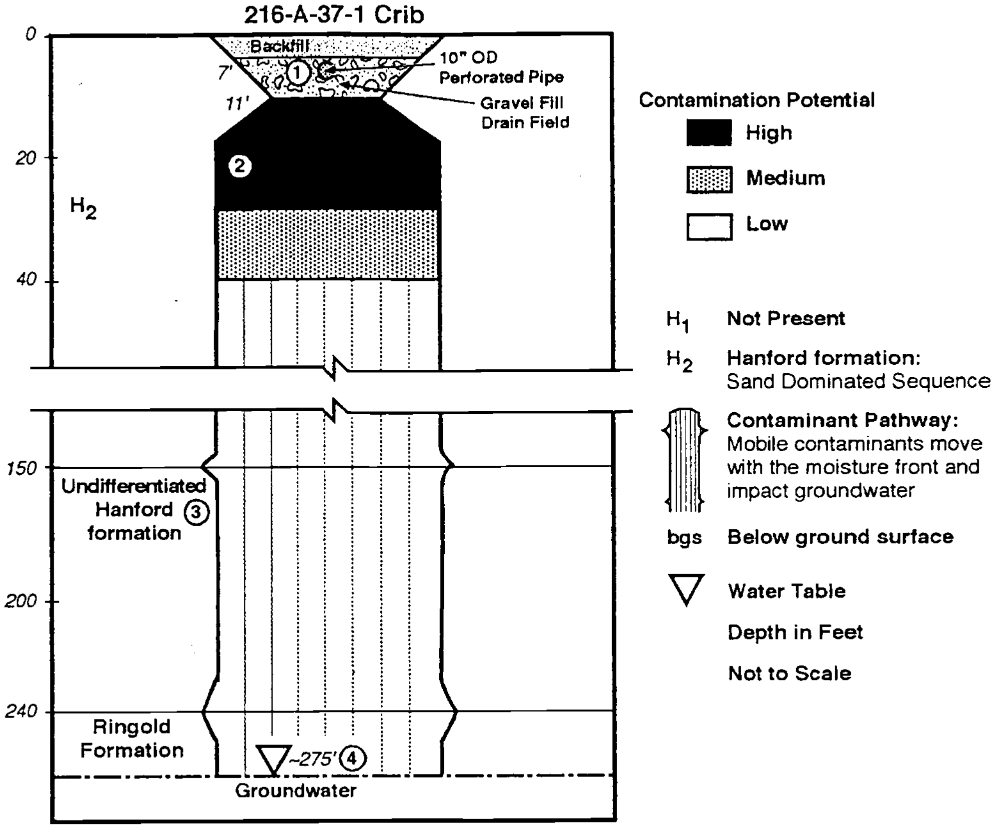
(3) The zone of greatest contamination is detected near the discharge pipe to a depth 27.4 m (90 ft). Contaminants that are immobile, such as cesium-137, sorb to soils near the bottom of the crib. Cesium-137 concentrations are highest (10,000 pCi/g) 18 to 23 m (59 to 76 ft) bgs. Contaminants that are moderately mobile, such as europium-154 and cobalt-60, are present deeper in the vadose zone at low concentrations. The most mobile contaminants, such as nitrate, moved with the moisture front and are present in trace amounts throughout the vadose zone.

(4) If additional lateral spreading occurs within the vadose zone, it is likely to be associated with the fine grained lenses within the H_2.

(5) Wastewater and mobile contaminants impact groundwater as the effluent volume discharged to the soil column (3,210,096 m^3) is greater than the soil pore volume (28,072 m^3) as evidenced by the tritium, iodine-129, and nitrate in the groundwater.

E0007007.2

Figure C-5. 216-A-37-1 Crib Conceptual Distribution Model.



① The 216-A-37-1 Crib received effluent from 1977 to 1989. It received process liquid waste from the 242-A Evaporator containing cesium, plutonium, strontium, uranium, acetone, and butanol. Effluent was distributed through a 25.4 cm (10 in.) diameter perforated pipe that runs the length of the crib. The pipe is buried about 2.1 m (7 ft) below the surface. Approximately 377,000,000 liters (99,528,000 gal) of effluent were released to the crib.

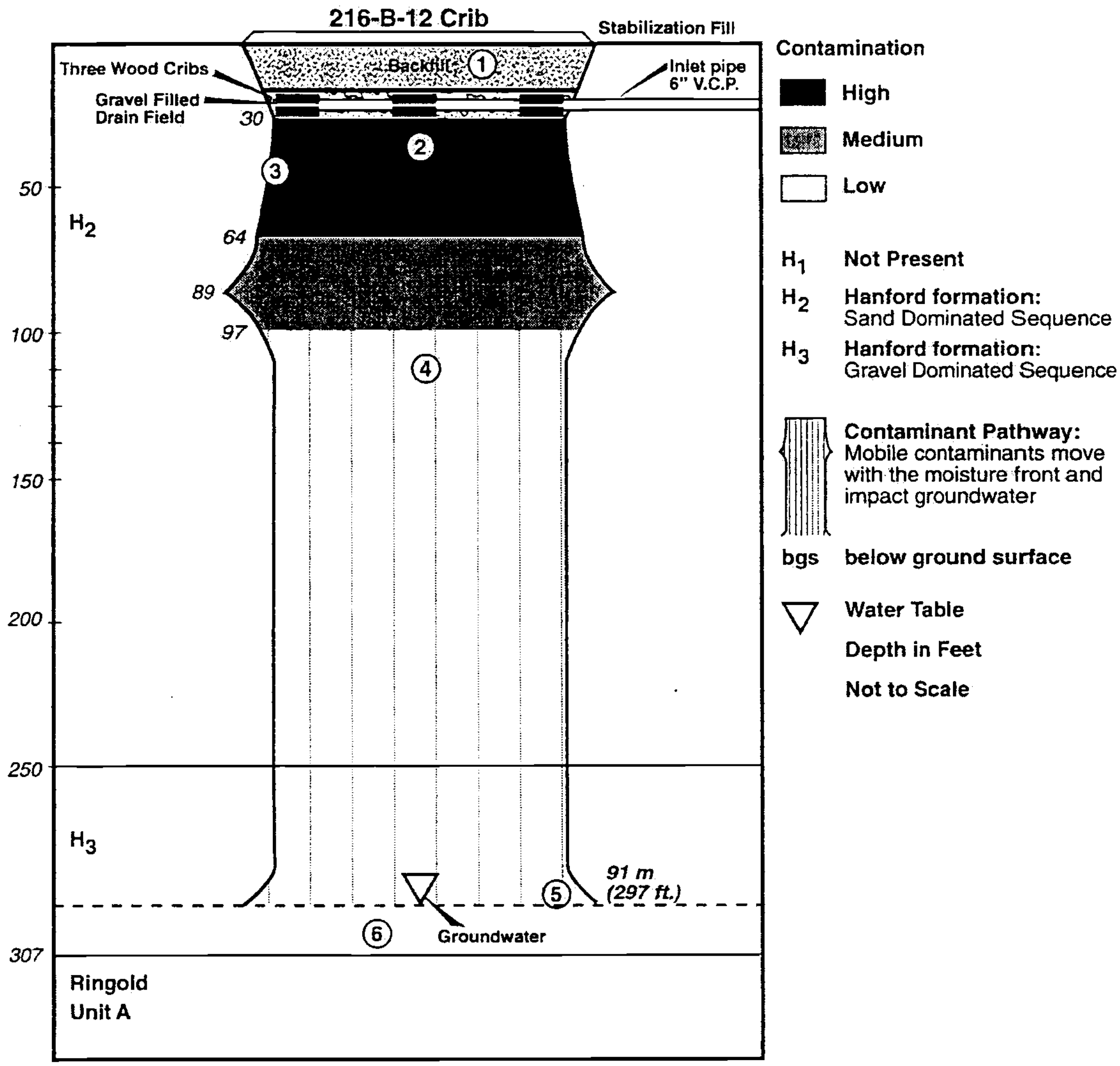
② Once discharged, the effluent and contaminants migrate vertically down beneath the crib, within H2. Low mobility contaminants such as cesium will sorb near the point of release. Contaminant concentrations decrease with depth. Moderately mobile contaminants may be present to a depth of 12.2 m (40 ft).

③ High mobility contaminants migrate with the moisture front and may be detected in low concentrations throughout the vadose zone. The available data (natural gamma logs) from four groundwater monitoring wells adjacent to the crib suggest that little or no lateral spreading has occurred. Halogenated and non-halogenated solvents may be detected in the vicinity of the crib in low concentrations throughout the vadose zone.

④ The volume of effluent discharged (377,011 m^3) to the crib is greater than the soil column pore volume (15,879 m^3). This data suggest that groundwater has been impacted beneath the crib. Tritium and iodine-129 exceed groundwater protection standards near the crib.

G02090024-4

Figure C-6. 216-B-12 Crib Conceptual Distribution Model.



① Uranium rich process wastes were discharged to the 216-B-12 Crib between 1952 and 1973. The crib received a total volume of 5.2×10^8 L (1.4×10^8 gal) of waste water.

② Effluent and contaminants were released to the environment at the bottom of the wooden structures into the H_2.

③ The wetting front and contaminants moved vertically down beneath the crib. There is little or no lateral spreading.

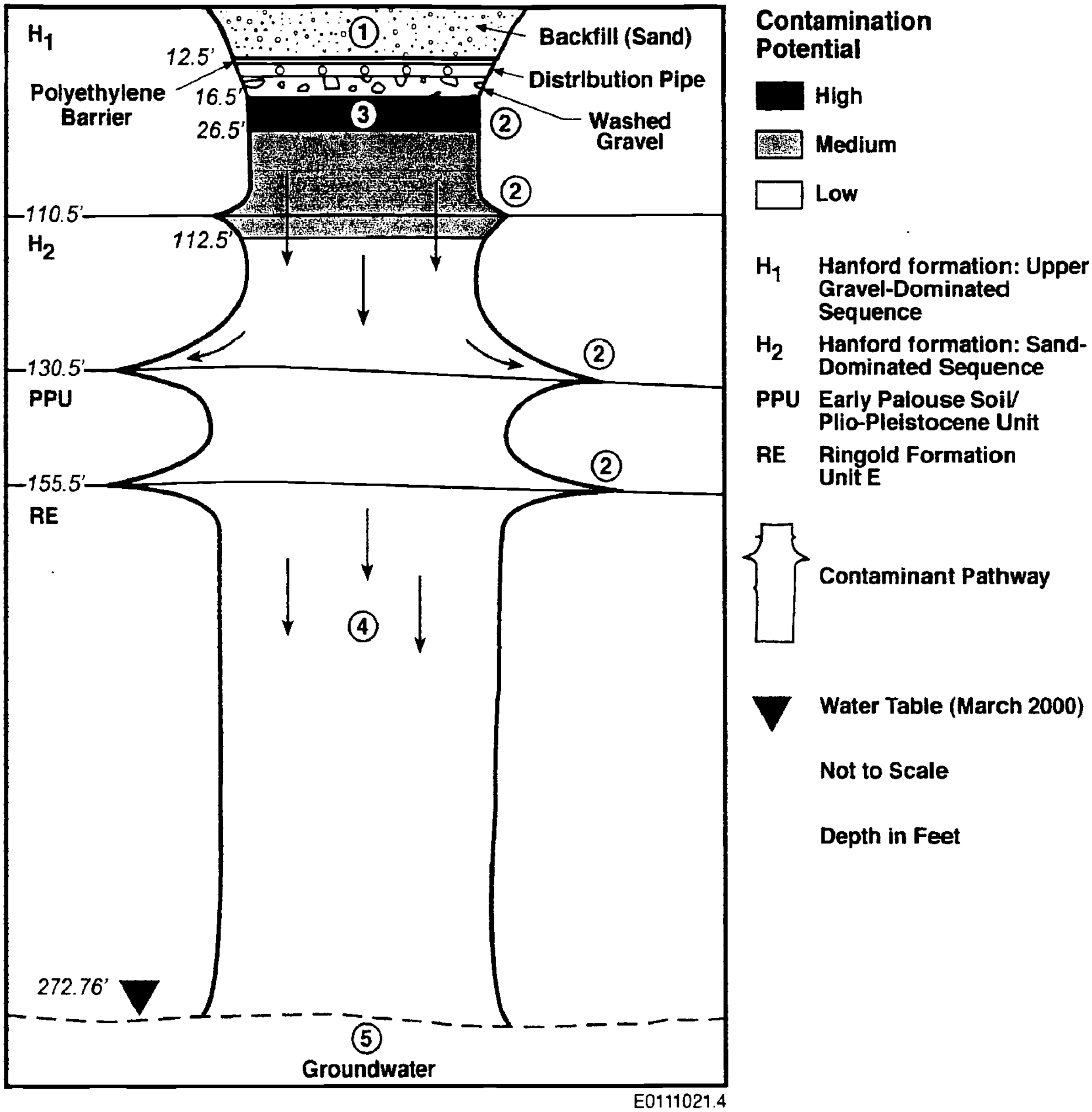
④ Contaminants with large contaminant distribution coefficients, such as cesium-137, sorb to soils with the highest concentrations within 34 ft. of the crib bottom. Contaminant concentration generally decreases with depth. Contaminants with moderate contaminant distribution coefficients, such as cobalt-60, are present throughout the vadose zone. Contaminants with contaminant distribution coefficients of 0 move with the moisture front and are present in trace amounts throughout the vadose zone.

⑤ If lateral spreading occurs within the vadose zone, it is associated with fine grained lenses within the H_2 and H_3.

⑥ Waste water and contaminants with moderate to very low distribution coefficients impacted groundwater since the effluent volume discharged to the soil column (520,000 m^3) is greater than the soil pore volume (18,300 m^3).

E0007007.1

Figure C-7. 216-T-33 Crib Conceptual Contaminant Distribution Model.



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APPENDIX D

QUALITY ASSURANCE CROSS-WALK FOR THE 200-CW-5, 200-CW-2, 200-CW-4, AND 200-SC-1 OPERABLE UNIT WASTE SITES

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APPENDIX D

QUALITY ASSURANCE CROSS-WALK FOR THE 200-CW-5, 200-CW-2, 200-CW-4, AND 200-SC-1 OPERABLE UNIT WASTE SITES

The quality assurance project plan (QAPjP) establishes the quality requirements for environmental data collection, including sampling, field measurements, and laboratory analysis. The overall QAPjP for environmental restoration waste sites in the 200 Areas is included in DOE/RL-98-28, *200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program*, (Implementation Plan), Appendix A. The Implementation Plan provides the general framework of technical and administrative requirements that apply to the Central Plateau. The QAPjP complies with the requirements of the following:

- 10 CFR 830.120, "Quality Assurance Requirements"
- ANSI/ASQ E4, 1994, *Quality Systems for Environmental Data and Technology Programs: Requirements with Guidance for Use*
- DOE O 414.1A, *Quality Assurance*
- DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Document*
- EPA/240/B-01/002, *EPA Requirements for Quality Management Plans*, March 2001 revision of EPA QA/R-2
- EPA/240/B-01/003, *EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations*, March 2001 revision of EPA QA/R-5

The following documents describe the supplemental waste group quality requirements and the procedural controls applicable to this investigation. The Implementation Plan (DOE/RL-98-28, Appendix A), and DOE/RL-2002-24, Revision 0, *200-CW-5 U Pond/Z Ditches Cooling Water Group Operable Unit Remedial Investigation Sampling and Analysis Plan* (SAP), included in Appendix A of this work plan for information, serves as the QAPjP for the 200 Areas and the Central Plateau. A crosswalk between the criteria in EPA/240/B-01/003, *EPA Requirements for Quality Assurance Project Plans*, (QA/R-5), and the references in the SAP and Implementation Plan is provided in Table D-1. The crosswalk has been provided to illustrate how the quality planning for the 200-CW-5 Operable Unit meets the requirements of EPA/240/B-01/003.

REFERENCES

10 CFR 830.120, "Quality Assurance Requirements," Title 10, *Code of Federal Regulations*, Part 830.120, as amended.

ANSI/ASQ E4, 1994, *Quality Systems for Environmental Data and Technology Programs: Requirements with Guidance for Use*, American National Standards Institute and the American Society for Quality, New York, New York.

DOE O 414.1A, *Quality Assurance*, "Contractor Requirements Document," as amended, U.S. Department of Energy, Washington, D.C.

DOE/RL-96-68, 1998, *Hanford Analytical Services Quality Assurance Requirements Documents*, Rev. 2, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-98-28, 1999, *200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2002-24, 2002, *200-CW-5 U Pond/Z Ditches Cooling Water Group Operable Unit Remedial Investigation Sampling and Analysis Plan*, Rev 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

EPA/240/B-01/002, 2001, *EPA Requirements for Quality Management Plans*, U.S. Environmental Protection Agency, Quality Assurance Division, Washington, D.C.

EPA/240/B-01/003, 2001, *EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations*, U.S. Environmental Protection Agency, Quality Assurance Division, Washington, D.C.

Table D-1. Quality Assurance Crosswalk.

EPA QA/R-5 Criteria	EPA QA/R-5 Title	DOE/RL-2002-24 Reference Section	DOE/RL-98-28 Reference Sections
Project Management	Project/Task Organization	1.0	A1.0; A2.0; A2.1; Table A-1
	Problem Definition and Background	1.0; 1.1; 1.2; 1.3; 1.5; 1.5.1	A2.2; Table A-1
	Project Task Description	1.0; 2.0; 3.0;3.2; 3.3	A2.3; Table A-1
	Quality Objectives and Criteria	1.5; 2.2	A2.4
	Special Training/Certification	2.0 refers to DOE/RL-98-28	A2.5
	Documents and Records	2.5; 2.7	A2.6
Data Generation and Acquisition	Sample Process Design	1.5; 1.5.4; 3.0; 3.3.6	6.2; A3.0
	Sampling Methods	2.4; 2.7; 3.2; 3.3	A3.1
	Sample Handling and Custody	2.1.5; 2.3; 2.7; 3.4	A3.2; A3.3
	Analytical Methods	1.5; 2.1	A3.4
	Quality Control	2.4; 2.7	A3.5; A3.5.1; A3.5.2; A3.5.3
Data Generation and Acquisition (cont)	Instrument/Equipment Testing, Inspection and Maintenance	2.7; 2.7.3	A3.6
	Instrument/Equipment Calibration and Frequency	2.7.3	A3.6
	Inspection and Acceptance of supplies and consumables	2.7 cites BHI-QA-03, Plan #5.2, Section 18.0	A1.0 cites BHI-QA-03, Plan #5.2, Section 18.0
	Non Direct Measurement	1.1; DOE/RL-99-66, Section 3.3	3.0 data sources
	Data Management	2.5	A3.7; A3.8
Assessment and Oversight	Assessment and Response Actions	2.7 cites BHI-QA-01, #03	A4.0
	Reports to Management	2.7 cites BHI-QA-01, #03	A4.0
Data Validation and Usability	Data Review, Verification and Validation	2.6	A5.0
	Verification and Validation Methods	2.6	A4.0; A5.0
	Reconciliation with User Requirements	5.2.5; DOE/RL-99-66	A4.0; A5.0

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