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200-CS-1 Operable Unit RI/FS Work Plan and RCRA TSD Unit Sampling Plan

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200-CS-1 Operable Unit RI/FS Work Plan and RCRA TSD Unit Sampling Plan

November 1999

United States Department of Energy

P.O. Box 550, Richland, Washington 99352

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ACRONYMS

ARAR	applicable or relevant and appropriate requirement
bgs	below ground surface
BHI	Bechtel Hanford, Inc.
$BiPO_4$	bismuth phosphate
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
CMS	corrective measures study
COC	contaminant of concern
COPC	contaminant of potential concern
cpm	counts per minute
DCG	derived concentration guideline
DOE	U.S. Department of Energy
DQA	data quality assessment
DQO	data quality objective
DSS	double-shell slurry
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ERC	Environmental Restoration Contractor
FS	feasibility study
FY	fiscal year
GRA	general response action
HASP	health and safety plan
HPGe	high-purity germanium
IDW	investigation-derived waste
K_d	distribution coefficient
LWC	laundry waste crib
MTCA	*Model Toxics Control Act*
NEPA	*National Environmental Policy Act of 1969*
NTU	nephelometric unit
OU	operable unit
PRG	preliminary remediation goal
PUREX	Plutonium/Uranium Extraction (Plant)
QRA	qualitative risk assessment
RAO	remedial action objective
RAWP	remedial action work plan
RCRA	*Resource Conservation and Recovery Act of 1976*
RDR	remedial design report
REDOX	Reduction-Oxidation (Facility)
RESRAD	RESidual RADioactivity dose model

ACRONYMS (continued)

RFI	RCRA facility investigation
RI	remedial investigation
ROD	Record of Decision
RPP	RCRA past-practice
SAP	sampling and analysis plan
SGL	spectral gamma-ray logging
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TSD	treatment, storage, and disposal
TWRS	Tank Waste Remediation System
WAC	*Washington Administrative Code*

METRIC CONVERSION CHART

The following conversion chart is provided to aid the reader in conversion.

Into Metric Units

If You Know	*Multiply By*	*To Get*
Length		
inches	25.4	millimeters
inches	2.54	centimeters
feet	0.305	meters
yards	0.914	meters
miles	1.609	kilometers
Area		
sq. inches	6.452	sq. centimeters
sq. feet	0.093	sq. meters
sq. yards	0.0836	sq. meters
sq. miles	2.6	sq. kilometers
acres	0.405	hectares
Mass (weight)		
ounces	28.35	grams
pounds	0.454	kilograms
ton	0.907	metric ton
Volume		
teaspoons	5	milliliters
tablespoons	15	milliliters
fluid ounces	30	milliliters
cups	0.24	liters
pints	0.47	liters
quarts	0.95	liters
gallons	3.8	liters
cubic feet	0.028	cubic meters
cubic yards	0.765	cubic meters
Temperature		
Fahrenheit	subtract 32, then multiply by 5/9	Celsius
Radioactivity		
picocuries	37	millibecquerel

Out of Metric Units

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

1.0 INTRODUCTION

The *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1990) identifies approximately 700 soil waste sites (and associated structures) resulting from the discharge of liquids and solids from 200 Area processing facilities to the ground. These 700 sites have been arranged into 23 separate waste groups that contain *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) past-practice sites; *Resource Conservation and Recovery Act* (RCRA) past-practice (RPP) sites; and RCRA treatment, storage, and disposal (TSD) units.

The 200-CS-1 Chemical Sewer Group Operable Unit (OU) is one of the 200 Area waste site groups defined in the Tri-Party Agreement. The chemical sewer wastes were generated by several of the separation/concentration process facilities (e.g., Reduction-Oxidation [REDOX] Facility, Plutonium-Uranium Extraction [PUREX] Plant, and B Plant cesium/strontium recovery operations). Generally these wastes were disposed of above ground in ponds or ditches. This work plan implements the framework for obtaining characterization information to support the remedial investigation (RI) and feasibility study (FS) for the 200-CS-1 Chemical Sewer Group OU. Waste sites included in the 200-CS-1 Chemical Sewer Group OU are as follows:

- 216-A-29 Ditch (PUREX Plant chemical sewer)
- 216-S-10 Ditch
- 216-S-10 Pond
- 216-B-63 Trench (B Plant chemical sewer)
- 216-W-LWC (laundry waste crib)
- UPR-200-W-34 (overflow at 216-S-10 Ditch)
- 216-S-11 Pond.

This work plan contains the requirements for characterization of the first four waste sites: the 216-A-29 Ditch, the 216-S-10 Ditch, the 216-S-10 Pond, and the 216-B-63 Trench. All four of these sites are RCRA TSD units. Two of these four sites are also representative sites as identified in the *200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program* (hereinafter referred to as the Implementation Plan) (DOE-RL 1999); for purposes of this document, and to be consistent with the Implementation Plan, these two sites will be referred to as representative sites. All four sites are identified as interim status units under *Washington Administrative Code* (WAC) 173-303. The current Part A Permit application for these units are contained in Appendix A. The remaining sites (i.e., 216-W-LWC, the 216-S-11 Pond, and UPR-200-W-34) are RPP sites. The logic for selecting sites from this OU to be characterized is contained in Section 2.2.

The schedule for work at the Hanford Site is governed by Tri-Party Agreement milestones. The milestone controlling the schedule for the 200-CS-1 OU is Milestone M-13-21, "Submit Chemical Sewer Group Work Plan" (August 31, 1999). All characterization work in the 200 Areas is scheduled to be completed by December 31, 2008 (Milestone M-15-00C). An associated milestone is Milestone M-20-39, which requires submittal of the 216-S-10 Pond and Ditch closure/post-closure plans to the Washington State Department of Ecology (Ecology) by

February 28, 2003. Milestone M-20-00, "Submit Part B Permit Applications or Closure/ Post-closure Plans for All RCRA TSD Units," requires permit applications, closure, and post-closure plans to be submitted to Ecology for approval by February 28, 2004.

1.1 SCOPE AND OBJECTIVES

This work plan provides details for characterizing chemical, radiological, and physical conditions in the soil at the four RCRA TSD sites in the 200-CS-1 OU. This work plan presents background information, existing data regarding contamination, and the approach that will be used to investigate and characterize the sites. The preliminary remedial action alternatives that are likely to be considered for remediation of the OU waste sites are also identified. A discussion of the remedial investigation planning and execution process is also included, as well as a schedule for the characterization work. Details on sampling and analysis are provided in Appendix B to guide work in the field. Waste management will be conducted under a waste control plan to be prepared prior to field activities.

After characterization data have been collected, the results will be presented in a group-specific RI report that includes the specific RCRA TSD unit characterization. The RI report will support the evaluation of remedial alternatives and closure options that will be included in the group-specific FS and specific RCRA TSD unit closure plan. The schedule for assessment activities at the 200-CS-1 OU is presented in Section 6.0. Remedial alternatives may be applied to any or all of the waste sites in an OU, and different alternatives may be applied to different waste sites depending on site characteristics. These preliminary remedial alternatives will be further developed and agreed to in the FS/closure plan, in the proposed plan/proposed permit conditions to the Hanford Facility RCRA Permit, and in the eventual Record of Decision (ROD) and Permit modification for this OU.

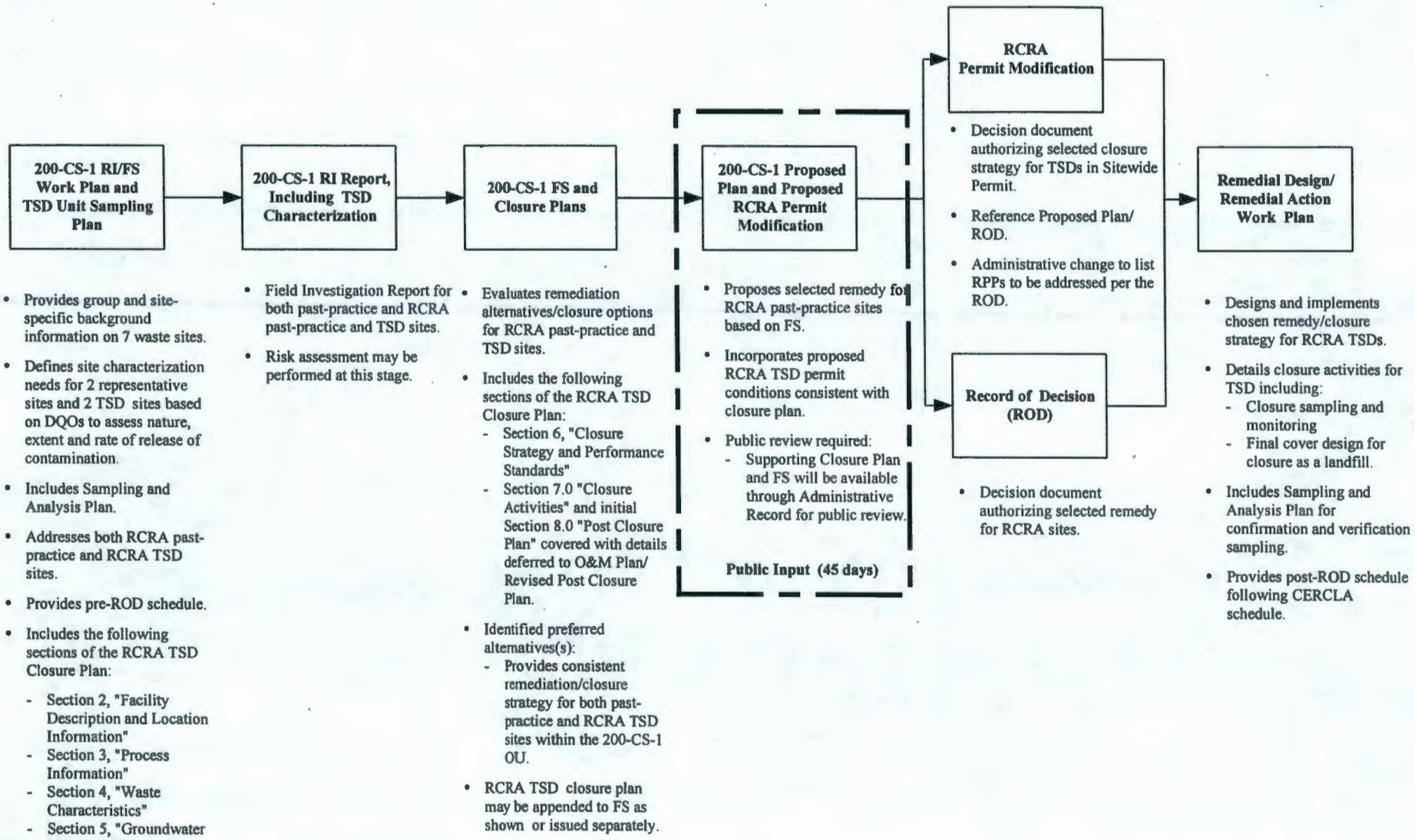
1.2 200 AREAS IMPLEMENTATION PLAN

The Tri-Party Agreement requires that characterization and remediation of waste sites integrate the requirements of CERCLA and RCRA and provide a standard approach to direct cleanup activities in a consistent manner and ensure that applicable regulatory requirements are met. The Implementation Plan (DOE-RL 1999) outlines a framework to provide for consistent, integrated cleanup actions (i.e., characterization and remediation) at the 23 waste groups in the 200 Areas. The Implementation Plan integrates the requirements of RCRA and CERCLA into one standard approach for cleanup activities. This approach is illustrated in Figure 1-1.

The Implementation Plan consolidates much of the information normally found in an OU-specific work plan to avoid duplication of this information for each of the 23 waste groups in the 200 Areas. The Implementation Plan also lists potential applicable or relevant and appropriate requirements (ARARs), lists preliminary remedial action objectives (RAOs), and contains a discussion of potentially feasible remedial technologies that may be employed in the 200 Areas.

This work plan references the Implementation Plan (DOE-RL 1999) for further details on several topics, including general information on the physical setting and operational history of 200 Areas facilities, ARARs, RAOs, and general post-work plan activities.

Figure 1-1. Integrated Regulatory Process for CERCLA, RCRA Past-Practice, and RCRA TSD Unit Closure (modified from Figure 2-2, DOE-RL 1999).



2.0 BACKGROUND AND SETTING

The purpose of this section is to provide a detailed description of the 200-CS-1 OU and associated waste sites so the background and setting are well understood. Information is presented and discussed in a logical manner beginning with the physical setting (i.e., topography, geology, vadose zone, and groundwater), waste site descriptions, and waste stream contaminants, and ending with the conceptual model. The information is summarized from several reports, as referenced. Of these, the key reports referenced are as follows:

- *Waste Site Grouping for 200 Areas Soil Investigations* (DOE-RL 1997)
- *200 Areas Remedial Investigation/Feasibility Study Implementation Plan - Environmental Restoration Program* (DOE-RL 1999)
- *PUREX Source Aggregate Area Management Study Report* (DOE-RL 1993b)
- *B Plant Source Aggregate Area Management Study Report* (DOE-RL 1993a)
- *S Plant Aggregate Area Management Study Report* (DOE-RL 1992b)
- *200-BP-11 Operable Unit RFI/CMS and 216-B-3 Main Pond, 216-B-63 Trench, and 216-A-29 Ditch Work/Closure Plan* (DOE-RL 1995).

The waste sites in the 200-CS-1 OU are located on the Hanford Site in southeastern Washington State, in and around the 200 East and 200 West Areas (Figure 2-1). This OU consists of seven waste sites that received mostly chemical sewer discharges from a variety of 200 Area operations. These seven waste sites are contained within four areas (see Figures 2-2 through 2-5 for additional detail).

Certain subsections of this section contain information that will be used for portions of the RCRA TSD closure plan. Section 2.1 describes the physical setting that corresponds to the closure plan facility and location. Section 2.2 provides waste descriptions and history that correspond to the closure plan facility description, location, and process information.

2.1 PHYSICAL SETTING

Data on physical characteristics of the contaminated sites and surrounding areas are needed to define potential contaminant transport pathways in the subsurface from the disposal sites, toward groundwater, and toward potential receptors. These data (which are summarized from the Implementation Plan, Appendix F [DOE-RL 1999]), describe the physical setting for the conceptual models of contaminant distribution and exposure. Data on physical characteristics are also needed to provide sufficient engineering information for developing and screening remedial action alternatives.

2.1.1 Topography

The 200 Area Plateau is the common reference used to describe the broad, flat area that constitutes a local topographic high around the 200 Areas. The plateau is one of the flood bars (i.e., Cold Creek Bar) formed during the cataclysmic flooding events of the Missoula floods (which was the last major flood approximately 13,000 years ago). The northern boundary of the flood bar 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 waning stages of flooding as floodwaters drained from the basin. The northern half of the 200 East Area lies within this ancient flood channel. The southern half of the 200 East Area and most of the 200 West Area are situated on the flood bar. A secondary flood channel running southward off the main channel bisects the 200 West Area. The buried former river and flood channels may provide preferential pathways for groundwater and contaminant movement.

2.1.2 Geology

The 200-CS-1 OU is located in the Pasco Basin on the Columbia Plateau. It is 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, and the Hanford formation. The Ringold Formation is informally divided into several informal units (from oldest to youngest): unit A, lower mud, unit E, and upper unit. The Plio-Pleistocene unit contains an upper distally derived subunit and a lower locally derived subunit that is interpreted to be a weathering surface developed on the top of the Ringold Formation (WHC 1994, Bjornstad 1990). The upper subunit is not present in the 200 East or 200 West Areas. The locally derived subunit is present under the 200 West Area. The Hanford formation has two major facies (i.e., gravel-dominated and sand-dominated) and is present beneath the 200 East and 200 West Areas. A generalized stratigraphic column for the area around the 200-CS-1 OU is shown in Figure 2-6.

The Elephant Mountain Basalt Member is overlain by the Ringold Formation in the east, south, and central sections 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): 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 unit.

Overlying the Ringold Formation in the 200 West Area is the locally derived subunit of the Plio-Pleistocene unit. The locally derived subunit consists of poorly sorted, locally derived, interbedded reworked loess, silt, sand, and basaltic gravel (WHC 1994). The subunit consists of a lower carbonate-rich part and an upper silty part. The carbonate-rich part consists of interbedded carbonate-poor and carbonate-rich strata. The upper silty part was previously interpreted to be early Pleistocene loess and is referred to as the early Palouse soil (Bjornstad 1990). Generally, it is well-sorted quartz-rich/basalt-poor silty sand to sandy silt (BHI 1996).

Where the Ringold Formation and Plio-Pleistocene unit are not present, the Hanford formation overlies basalt. 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 consists 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 this 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 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 200 Area 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-aged 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 have also 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 0.3 m (1 ft) near West Lake. Sediments in the vadose zone are dominated by the Ringold and Hanford Formations. 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 dominantly composed of Hanford formation sediments between the northern part of the 200 Areas and Gable Mountain. Areas of basalt also project above the water table north of the 200 East Area. The lower mud sequence is the most significant aquitard in the 200 East Area and can be a significant perching layer.

In the 200 West Area, the vadose zone thickness ranges from 79 m (261 ft) in the southeast corner to 102 m (337 ft) in the northwest corner. 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 historically been documented above the Plio-Pleistocene unit at various locations in the 200 West Area.

Recharge to the unconfined aquifer within the 200 Areas is from artificial and possibly natural sources. If natural recharge occurs, it originates from precipitation. Estimates of recharge from precipitation range from 0 to 10 cm/yr (0 to 4 in./yr) and are largely dependent on soil texture

and the type and density of vegetation. Artificial recharge occurred when effluent such as cooling water was disposed of to the ground. Zimmerman et al. (1986) report that between 1943 and 1980, 6.33×10^{11} L (1.67×10^{11} gal) of liquid wastes were discharged to the soil column. Most sources of artificial recharge have been halted. The artificial recharge that does continue is largely limited to liquid discharges from sanitary sewers, two state-approved land disposal structures, and 140 small-volume, uncontaminated, miscellaneous streams. One of the approved land disposal structures is located 600 m (approximately 1,969 ft) east of the 216-B-3C lobe and receives plant-treated liquid wastes from the 200 East and 200 West Area facilities (Figure 2-7).

While the liquid waste disposal facilities were operating, many localized areas of saturation or near saturation were created in the soil column. With the reduction of artificial recharge in the 200 Areas, the downward flux of moisture in the vadose zone beneath these waste sites decreased but may continue to be significant for a period of time because of gravity drainage of the saturated/near-saturated soil column. When unsaturated conditions are reached, the moisture flux becomes increasingly less significant because unsaturated hydraulic conductivities decrease with decreasing moisture content. In the absence of artificial recharge, the potential for recharge from precipitation becomes more important as a driving force for any contamination remaining in the vadose zone.

2.1.4 Groundwater

The groundwater in the 200 East Area occurs in the Hanford and Ringold Formations. In the northern part of the 200 East Area, the water table is within gravelly and sandy sediments of the Hanford formation, except in areas where basalt extends above the water table. In the central and southern sections of the 200 East Area, the water table is located near the contact of the Ringold and Hanford Formations, and the saturated thickness of the aquifer is predominantly within the Ringold Formation.

The groundwater table near the 200 East Area ranges in depth from about 65 m (213 ft) to over 100 m (328 ft). As shown in Figure 2-7, groundwater flows radially outward from a hydraulic mound in the 200 East Area (Barnett and Chou 1998). The apex of the mound is beneath the approximate center of the 216-B-3B expansion pond. As discussed in the previous section, the mound in the 200 East Area was created by artificial recharge from the 200-CW-1 OU waste sites and, to a lesser degree, the 200-CS-1 OU waste sites. Gable Mountain Pond and 216-B-3 Pond were the main areas of recharge based on the location and size of the mound during the active period of discharge. The current location of the mound is likely the result of historically higher recharge in the expansion ponds to the east of the main pond, which were constructed because of limited infiltration capacity of the main pond. The upper surface of the Ringold lower mud unit, which pinches out between 216-B-3C lobe and 216-B-3 Pond, may also influence the current position of the groundwater mound. The water table beneath 216-B-3 Pond is currently dropping at a rate of approximately 2 m/yr (7 ft/yr), based on water measurements collected in 1997 and 1998.

The groundwater in the 200 West Area occurs primarily in the Ringold Formation. The depth to the water table varies from about 50 m (164 ft) to greater than 100 m (328 ft). A large groundwater mound created by 216-U-10 Pond raised the water table by about 20 m (66 ft)

above pre-operational conditions (PNNL 1998). Since 1984 (when 216-U-10 Pond was decommissioned), water levels have declined over 6 m (20 ft).

The depth to the water table beneath each waste site varies greatly. The depth to water beneath the 216-B-63 Trench is about 73 m (240 ft) below ground surface and is nearly flat with local groundwater flow from east to west due to groundwater recharge from the 216-B-3 Pond system. The depth to water beneath the 216-A-29 Ditch varies from about 85 m (279 ft) at the head end to about 53 m (174 ft) at the lower end, with groundwater flow generally to the west-southwest due to groundwater recharge from the 216-B-3 Pond system. The depth to water beneath the 216-S-10 Ditch and Pond area (including 215-S-11) varies from about 68 m (223 ft) at the head end to about 61 m (200 ft) at the lower end with groundwater flow generally to the east-southeast. The depth to water beneath the 216-W-LWC is about 85 m (279 ft), with groundwater flow generally to the east.

2.2 WASTE SITE DESCRIPTION AND HISTORY

The 200-CS-1 OU consists of seven waste sites, as defined in the Tri-Party Agreement and the Implementation Plan (DOE-RL 1999) and as listed in Table 2-1. These sites are primarily surface man-made ponds, ditches, or trenches and were created to dispose of the chemical sewer waste streams from the separation/concentration processes (e.g., PUREX Plant, REDOX Facility, and B Plant cesium/strontium recovery operations). The 200-CS-1 OU consists primarily of waste sites that received unknown but probable dilute quantities of inorganic and/or organic chemicals. Radionuclide inventories are very small to negligible, although several sites have a uranium component, particularly the 216-S-10 Ditch, which received 215 kg of uranium in an unplanned release (UPR-200-W-34, which is a discrete site included in the 200-CS-1 OU).

A summary of waste site information is provided in Table 2-1. This summary includes the dates of operation, physical size (i.e., depth from surface at time of operation and dimensions), general description and status, category of the unit, and the source facility.

As defined in the waste site groupings report (DOE-RL 1997), chemical sewer wastes were generated at many of the separation/concentration processes conducted at the large canyon buildings. Early chemical sewer wastes were combined with the larger cooling water and steam condensate streams during the bismuth phosphate ($BiPO_4$) and uranium recovery processes and were discharged to ponds and ditches. With the advent of continuous solvent extraction processes at the Hanford Site, new plants such as the REDOX Facility, PUREX Plant, and the 1970s cesium/strontium recovery operations at B Plant were designed with separated chemical sewers and separate waste disposal sites. In most cases, these sites were aboveground pond or ditch structures.

It is clear that, by the original design definitions, the chemical sewers were designed to serve nonradioactive operations in the plants at areas such as operating galleries, service areas, aqueous makeup galleries, and maintenance areas. The plants discharged acidic/basic solutions from demineralizers, out-of-specification chemical batches, noncontaminated floor drain waste liquids, nonradiological process wastes, nonprocess steam condensates, noncontaminated vessel

coil waste, and other wastes into the chemical sewers, which also received a quantity of raw water to dilute any chemical additions. These chemical sewers became contaminated with generally low levels of radionuclides at some unspecified time and by unknown processes.

The primary waste sites in this group are the 216-A-29 Ditch (which fed into the 216-B-3 Pond main lobe), the 216-B-63 Trench, and the 216-S-10/S-11 Pond/Ditch complex. All of these sites have been active from their start date to the 1994-1995 time frame and, except for the 216-S-11 Pond, are all RCRA TSD units.

The 216-S-11 Pond (located on the southeast side of the 216-S-10 Ditch) was constructed to provide additional leaching surface in May 1954 and operated until 1965 and, therefore, received wastes similar to the 216-S-10 Pond and Ditch. This site is obviously included in the 200-CS-1 OU because of geographic and waste characteristics similar to the 216-S-10 Pond and Ditch.

The 216-W-LWC (i.e., the 200 West Area laundry waste crib) received process wastewater from the contaminated laundry facility and mask cleaning station (i.e., 2724-W and 2723-W Buildings). This crib is included in the 200-CS-1 OU because it received predominantly dilute nonradionuclide or low-level radionuclide effluents.

No specific chemical characterization was applied to any of the waste streams associated with 200-CS-1 OU waste sites during operations, suggesting that the liquids were mostly raw water possessing neutral characteristics. The occasional chemical releases to the waste stream probably temporarily altered the pH of the waste stream. However, much of this effect is expected to be reduced through mixing during flow through the sewer lines or immediately upon discharge to the soil column (e.g., through buffering actions in the soil).

2.2.1 Process Information

The chemical sewer group includes those waste sites within the 200 Areas that predominately received chemical sewer wastes from various processes conducted at many of the separation/concentration facilities. Initially, the chemical sewer wastes and non-contact cooling waters were combined and disposed of in concert with each other, thus, similar characteristics may be found in the resultant ponds (e.g., 216-B-3 Pond). As processes progressed and operations were revised, designs were modified to separate waste disposal for these various streams.

As a rule, the chemical sewers were designed to capture nonradioactive waste from operations in the process facilities. These waste streams included operating galleries, service areas, aqueous makeup galleries, maintenance areas, overflow tanks, and various floor drains. As stated in the waste site groupings report (DOE-RL 1997), the discharges included out-of-specification chemical batches, noncontaminated floor drain wastes, nonradiological process wastes, nonprocess steam condensate, noncontaminated vessel coil wastes, and other wastes into these streams, which also received a quantity of raw water to dilute any chemical additions. From various environmental monitoring evaluations, it is known that low levels of radionuclides were

introduced into these waste streams, although the specific time and circumstances of these releases are unknown.

The primary, large volume waste sites within the group include PUREX Plant chemical sewer ditch (216-A-29 Ditch), the B Plant chemical sewer ditch (216-B-63 Trench), and the 202-S chemical sewer system (216-S-10 Ditch and Pond and 216-S-11 Pond). These sites represent the worst-case (i.e., 216-A-29 Ditch) and typical (i.e., 216-S-10 Ditch) waste sites and the TSD facilities (i.e., 216-A-29 Ditch, 216-S-10 Ditch and Pond, and 216-B-63 Trench). These individual waste sites are discussed in the following subsection.

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 1999). The use of this approach relies on first grouping sites with similar location, geology, waste site history, and contaminants, then choosing one or more representative sites for comprehensive field investigations, including sampling. Findings from site investigations at representative sites are extended to apply to other waste group sites that were not characterized. Sites for which field data have not been collected are assumed to have chemical characteristics similar to the sites that were characterized.

Data from representative sites will be used to evaluate remedial alternatives and to select a preferred remedy that is applicable to the entire waste group. Confirmation sampling of the analogous sites after remedy selection will be required and is built into the remedial design planning to demonstrate that analogous conditions exist. Confirmatory investigations of limited scope can be performed at the sites not selected as representative sites rather than performing full characterization efforts. Although there is a degree of uncertainty in employing the analogous site concept, there is a substantial benefit in the early selection of remedies that allow early cleanup action to be performed.

Several features common to waste sites in the 200-CS-1 OU make this characterization effort amenable to the analogous site concept. The most significant of these attributes are geography, physical setting, waste characteristics (i.e., effluent volume and waste stream chemistry), and expected distribution of contaminants. As stated previously, the 200-CS-1 OU consists primarily of waste sites that received unknown but probable dilute concentrations of inorganic and/or organic chemicals. Radionuclide inventories are very small to negligible, although several sites contain a uranium component. The proximity of sites within the same geochemical setting suggests that conditions affecting contaminant fate and transport should be very similar (i.e., the 216-S-10 Pond and Ditch are representative of 200 West Area, and the 216-A-29 Ditch and 216-B-63 Trench are representative of 200 East Area).

Sites within the OU that best represent typical and worst-case conditions were identified as representative sites (DOE-RL 1997). The sites with large contaminant inventories relative to the waste group and a high volume of effluent received were considered first, as these sites are considered worst-case situations and represent the sites with the highest contamination and greatest potential impact on the vadose zone and groundwater.

The analogous site approach is applied to RPP sites only; all TSD sites are usually characterized separately. Specifically for this OU, the representative sites are also TSD sites. The sites chosen to represent the 200-CS-1 OU are the 216-A-29 Ditch and the 216-S-10 Ditch. These waste sites were selected for comprehensive field investigation because they are the worst-case site and typical type of sites, respectively, in terms of effluent volume and/or contaminant inventory. The following sections describe the four TSD sites in the 200-CS-1 OU, two of which are representative.

2.2.2.1 216-A-29 Ditch. The 216-A-29 Ditch received discharge from the PUREX Plant chemical sewer. The ditch was uncovered and unlined and followed the natural topography (Figure 2-2). The ditch originated outside the perimeter fence and was estimated to be 1,220 m (4,000 ft) in length and 1.8-m (6-ft) wide. The depth of the ditch varied from 0.6 to 4.6 m (2 to 15 ft). The first 3 m (10 ft) from the point of influent was a concrete spillway designed to control erosion. The end of the ditch connects to the 216-B-3-3 Ditch and finally to the 216-B-3 Pond. The representative stratigraphy beneath the 216-A-29 Ditch is shown in Figure 2-8.

The waste streams contributing to the 216-A-29 Ditch included the following, which are summarized from the stream-specific report (WHC 1990d):

- Various floor drains: 202-A pipe and operations gallery; air compressor, process blower, and service blower rooms in 202-A; 211-A pumphouse; and 202-A instrument and maintenance shops
- 618-1 and 618-2 flash tanks containing heating coils, spray water, and steam condensate
- 206-A fractionator condensers and reboiler cooling water and steam condensate
- Sink drain from the battery room, instrument shop, and maintenance shop in 202-A
- 202-A laboratory ventilation room; heating, ventilation, and air conditioning-related drainage
- 202-A laboratory nonradioactive clothing change room drains
- 202-A blower room condensate
- Overflow from various demineralized water storage tanks
- Overflow from the emergency water supply tank
- Raw water used to continuously flush the PUREX Plant chemical sewer line.

The operational time frame for the PUREX Plant chemical sewer was between November 1955 and July 1991. At the beginning of its operation, the 216-A-29 Ditch received discharge from

the PUREX Plant cooling water and discharge from the chemical sewer. Historical information (GE 1959) indicates an area labeled "A Swamp," which was located where the cooling water may have joined the chemical sewer ditch (i.e., within the Grout Treatment Facility).

In early 1980, due to effluent monitoring requirements, the chemical sewer lines feeding the 216-A-29 Ditch required upgrades to allow for monitoring and diversion capabilities. A diversion box was upgraded and connected to the 216-A-42 Retention Basin. The basin received chemically or radioactively contaminated diversions from the PUREX Plant chemical sewer line, cooling water line, and steam condensate discharge (Viita 1980).

During 1990, plans were developed and approved to discontinue discharges and to close the 216-A-29 Ditch (WHC 1990b). In 1991, all discharges were discontinued and the ditch was isolated (i.e., concrete was placed in the vitrified clay pipes) from the chemical sewer lines. Contaminated soil from the ditch banks was consolidated in the bottom of the ditch and the side slopes were regraded (using nearby clean soil fill) to minimize erosion and facilitate surveillance. Inside the perimeter fence, the ditch has been filled to grade and surrounded with a light chain barricade, and the area was posted with underground contamination placards. Outside the perimeter fence, the ditch has been completely covered with backfill and stabilized. As a final measure, the site was revegetated and reposted.

2.2.2.2 216-B-63 Trench. The 216-B-63 Trench was constructed prior to1970 as a percolation trench to receive emergency cooling water and chemical sewer wastes from B Plant. The trench was taken out of service in 1992. The ditch was an open, unlined, man-made earthen trench that was closed at one end (i.e., did not convey effluent to any other facility). The trench is located entirely within the 200 East Area perimeter fence (Figure 2-3). The trench was approximately 427 m (1,400 ft) in length, 1.2-m (6-ft) wide, and averaged 3 m (10 ft) in depth. The side slope was 1.5:1. There was a 5.1-cm (2-in.) rockfill for the first 3.1 m (10 ft) of the trench and a 40.6-m (16-in.) inlet pipe approximately 1.5-m (5-ft) long that entered the trench 1 m (3 ft) below grade. The representative stratigraphy beneath the 216-B-63 Trench is shown in Figure 2-9.

Contributors to the 216-B-63 Trench included floor, funnel, and sink drains; steam condensate and/or cooling water; tank overflow and drain effluent; sump effluent; and rainwater. Specific sources of each are presented in the stream-specific report (WHC 1990a).

The 216-B-63 Trench was used to receive B Plant cooling water and in-tank solidification No. 2 cooling water from March 1970 to May 1970 (ARH 1971). The trench began receiving cooling water on March 22, 1970, after an unplanned release (UPR-200-E-138) of 1,000 Ci of strontium-90 into the 216-B-2-2 Ditch. In May 1970, the trench began receiving B Plant chemical sewer effluent. The B Plant chemical sewer pipeline went directly to the 216-B-63 Trench. The 207-B Retention Basin was used to retain low-level liquid waste (cooling water) in route to the 216-B-2 series ditches (located east of the structure). Chemical sewer waste did not pass through the 207-B Retention Basin, but cooling water was routed through the retention basin from March to May of 1970. In August 1970, the bottom and sides of the 216-B-63 Trench were dredged out and buried in the 218E-12B burial grounds. The 216-B-2 series ditches, which are parallel to the

216-B-63 Trench, were initially used to dispose of liquid waste from the 207-B Retention Basin. The basin is located 610 m (2,000 ft) northeast of B Plant, immediately south of the B tank.

An upgrade to the chemical sewer system that discharged to the 216-B-63 Trench was planned in 1980 after it was determined that an estimated loss of more than 1,140,000 L/day (300,000 gal/day) could be leaking into the ground from the sewer (RHO 1980a). Leakage had been documented at the chemical sewer for about 10 years from the date of this recommended upgrade. It was determined that about half of this amount of liquid was lost by leakage prior to reaching a measuring station at the 207-B Retention Basin. The pipelines that were known or suspected of leaking were relined or replaced by Project B-496 in 1985. The 38-cm (15-in.) vitrified clay pipe downstream of manhole No. 12 (which is the beginning of the TSD unit piping and conveyed effluent to 216-B-63 Trench) was not replaced because it did not have known leakage problems (RHO 1984). Chemical and radiological analyses of the contaminated sediments excavated during the pipeline upgrade were not found. No investigations of the area are planned at this time. The leak occurred at the head end of the pipeline adjacent to the B plant facility boundary.

The trench was isolated and interim stabilized in December 1994 and January 1995. The weir box at the head end of the trench was filled with concrete and the valve stems at the 207-B Retention Basin were cut off. A pre-stabilization civil survey was performed, the trench was covered with clean soil and marked with concrete posts, and a post-stabilization civil survey was performed.

2.2.2.3 216-S-10 Ditch. The 216-S-10 Ditch started receiving discharge from the REDOX Facility in May 1952. This ditch was part of a system that includes the 216-S-10 and 216-S-11 Ponds (Figure 2-4). In addition to these three sites, during May 1954 (GE 1956) there was an approximate 4,048 m^2 (1-acre) overflow from the ditch that released an estimated 215 kg of uranium. This unplanned release is referenced as UPR-200-W-34.

The 216-S-10 Ditch was an uncovered, unlined, man-made ditch that received wastewater from the REDOX Facility. The ditch originated outside the perimeter fence and was estimated to be 686 m (2,250 ft) in length, 1.8-m (6-ft) wide, and averaged 1.8 m (6 ft) in depth. The representative stratigraphy beneath the 216-S-20 Ditch is shown in Figure 2-10.

Approximately 50 waste streams contributed to the 216-S-10 Ditch (WHC 1990e). The routine waste stream sources include the compressor cooling water from the 202-S Building and the sanitary water overflow from the 2901-1-901 water tower. The remaining sources were infrequent additions and included 202-S Building floor drains and funnel drains, 211-S tank farm pump drains, tank drains, station drains, chemical sewer line manholes, and 276-S Building floor drains.

The 216-S-10 system was developed in February 1954 when it became apparent that more leaching surface was needed. At that time, the 216-S-10 Pond was constructed to provide more leaching surface. The two 216-S-11 leach pond lobes on the southeast side of the 216-S-10 Ditch were constructed to provide even more leaching surface in May 1954. Plugging of the system occurred in part due to inadvertent dumping of aluminum nitrate nonahydrate

solutions. In 1955, 0.6 m (2 ft) of sediment were dredged from the bottom of the 216-S-10 Ditch to improve water percolation in the ditch. The contaminated sediments were buried in excavation pits along the sides of the ditch. The depth and location of the pits is unknown (RHO 1979).

The south end of the 216-S-10 Ditch remained in use until 1984, when the ditch was backfilled and stabilized. The north end of the ditch remains open to a depth of approximately 3 m (10 ft) The north end of the 216-S-10 Ditch last received discharges during 1991 (BHI 1995) and the supplying pipeline was plugged with concrete near the outfall in July 1994..

2.2.2.4 216-S-10 Pond. The 216-S-10 Pond received discharge from the REDOX Facility. This pond was part of a system that included the 216-S-10 Ditch and the 216-S-11 Pond (Figure 2-3). The pond was dug in 1954 at the southwest end of the 216-S-10 Ditch to provide additional percolation surface. (See Section 2.2.2.3 for additional discussion on the 216-S-10 Ditch.) The 216-S-10 Pond was an irregular-shaped, man-made pond that covered approximately 20,234 m^2 (5 acres) and included four finger-leach trenches. The pond was approximately 2.4 m (8 ft) at its deepest point. The pond was fed by the 216-S-10 Ditch. Both the ditch and pond were designed to dispose of liquids through percolation into the soil column. The representative stratigraphy beneath the 216-S-10 Pond is shown in Figure 2-11.

Contributors to the pond and system description are similar to that of the 216-S-10 Ditch. In 1984, concurrent with the 216-S-10 Ditch, the pond was stabilized.

2.3 WASTE STREAM CONTAMINANTS

The 200 Area chemical sewers were designed to be uncontaminated but often contained limited quantities of radionuclides and chemicals. These contaminants accumulated in the sediment over time, and vegetation and algae within ponds and ditches tended to collect and concentrate the radionuclides. Commonly reported contaminants include plutonium, cesium, uranium, and strontium. Nonradioactive contaminants were also discharged; however, the quantity and type of contaminants are difficult to quantify, as nonradiological contamination was not routinely monitored. A detailed discussion of contaminants is presented in Section 3.1.

2.4 CONCEPTUAL MODEL

The effluent discharged to the ponds and ditches was predominantly chemical sewer waste with cooling water and steam condensate. Radionuclides and chemicals (e.g., nitrate) were also present in the effluent; the pH was typically between 4 and 10. The most significant contamination of the sites was caused by unplanned releases originating from both inside and outside of the generating facilities. Contaminants from these releases have migrated below the waste sites and have accumulated in the soil column. The following are general assumptions considered during development of the conceptual models:

- Most of the contaminants were retained by the sediments at the bottom of the liquid disposal sites.

- Some additional downward migration may have deposited trace amounts of some contaminants beneath the upper contaminated zone.

- Contaminant concentrations decrease with depth below the sediment layers in the waste sites.

- The contaminants retained in the upper zone of the soil column have high distribution coefficients (K_d). Contaminants with low K_ds (e.g., nitrate and tritium) are not readily adsorbed on soil particles and are carried downward toward the groundwater with the infiltrating effluent.

- Lateral spreading may have occurred in the vadose zone, especially in areas with layers of fine-grained sediment or in facilities that received a large amount of effluent.

- According to the applicable aggregate area management study reports, effluent percolated through the vadose zone beneath the liquid disposal units was hypothesized to have reached the groundwater..

Limited data are available from the 200-CS-1 waste sites. However data from the 216-A-29 Ditch site characterization studies (RFS 1997 and BHI 1998b) and from the nearby borehole at 216-B-Z-Z Ditch (BHI 1998a) indicate that most of the contaminants were retained in the sediments at the bottom of the ponds or in the upper few meters of the soil column. Trace amounts of some contaminants may be detected beneath this upper zone, but data from a borehole through the 216-B-2-2 Ditch (which is located adjacent to the 216-B-63 Trench and was a replacement disposal unit for the B Plant chemical sewer) indicate that contaminant concentrations decrease with depth below the waste sites (BHI 1998a).

The conceptual models for all the representative and TSD sites in the 200-CS-1 OU during the active periods of discharge are shown in Figures 2-12 through 2-14. The figures show that the highest concentration of contaminants is directly beneath the waste site. The wetting flux and mobile contaminants will impact groundwater where effluent volume exceeds soil pore volume (which is the case for all representative and TSD sites in this work plan).

Waste sites in the 200-CS-1 OU are no longer receiving effluent. Most of the sites in this group have also been stabilized and covered with clean soil. With the cessation of artificial recharge, the moisture flux on the vadose zone will decline. The moisture flux may be significant for a time because of gravity drainage from the saturated or near-saturated soil column. Conceptual models showing expected recent conditions beneath the representative and TSD sites are presented in Figures 2-15 through 2-17.

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

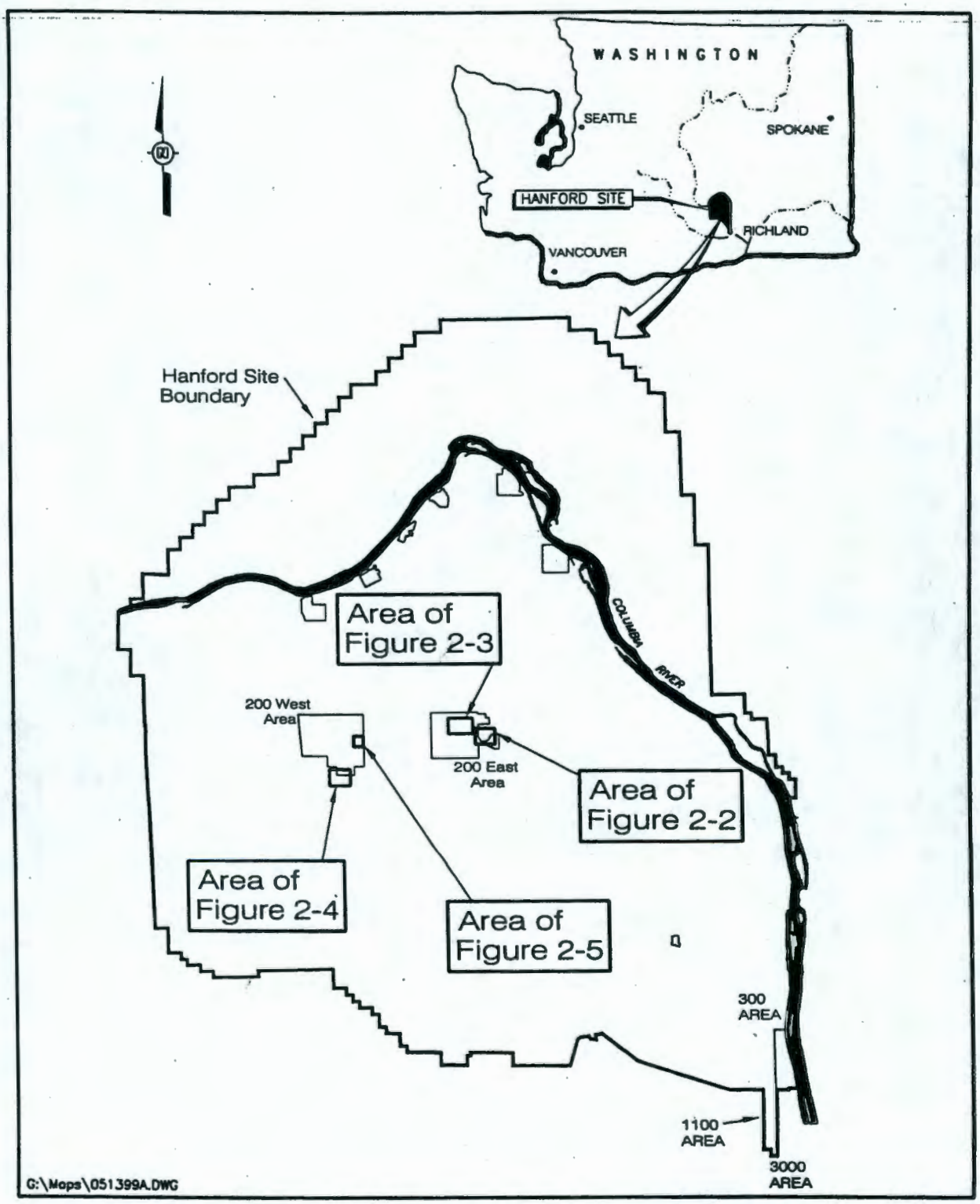
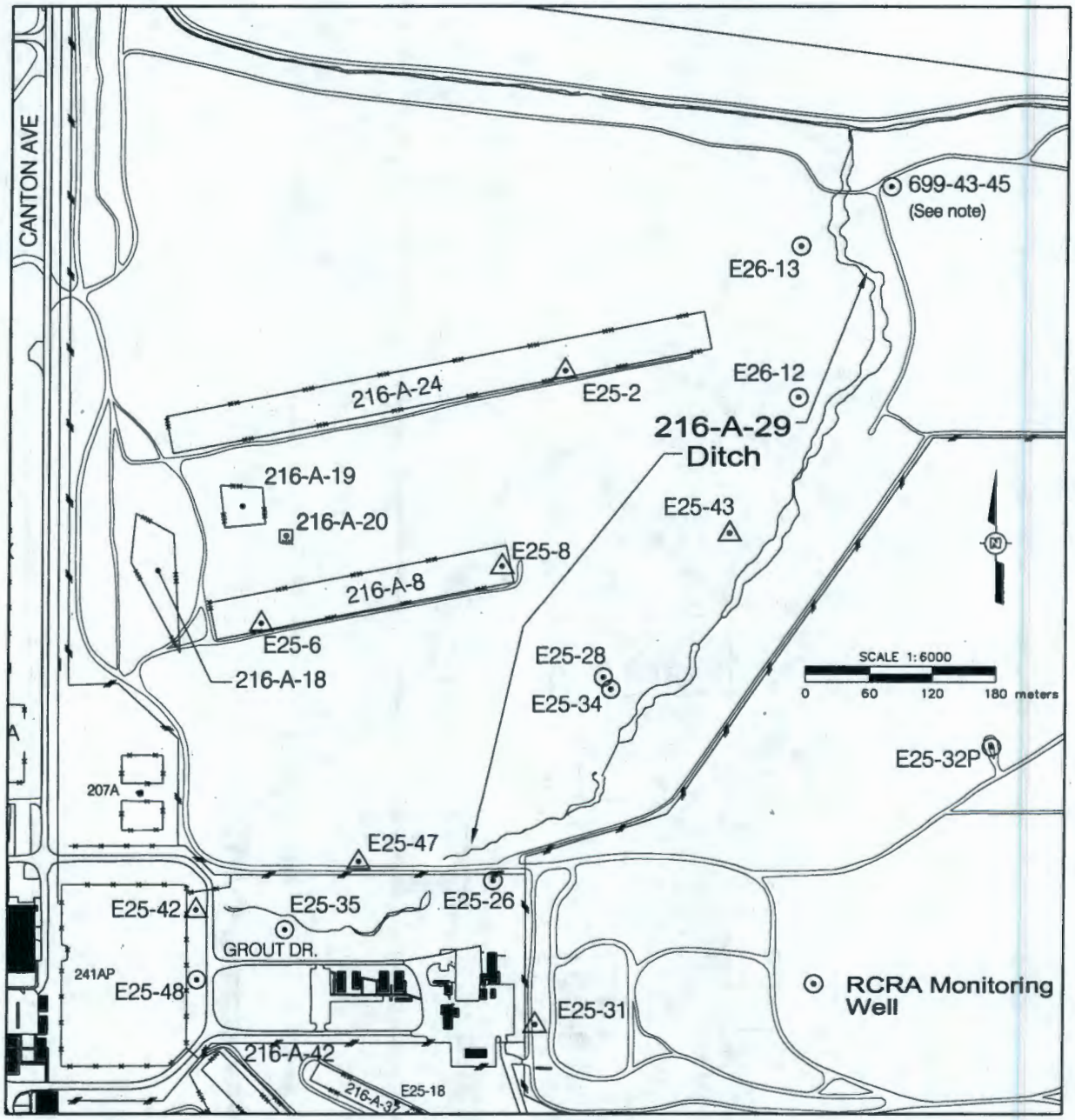


Figure 2-2. Location of the 216-A-29 Ditch in the 200 East Area.



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NOTE: Upgradient well 699-43-43 not shown on map. It is located about 450 meters east of well 699-43-45.

Figure 2-3. Location of the 216-B-63 Trench in the 200 East Area.

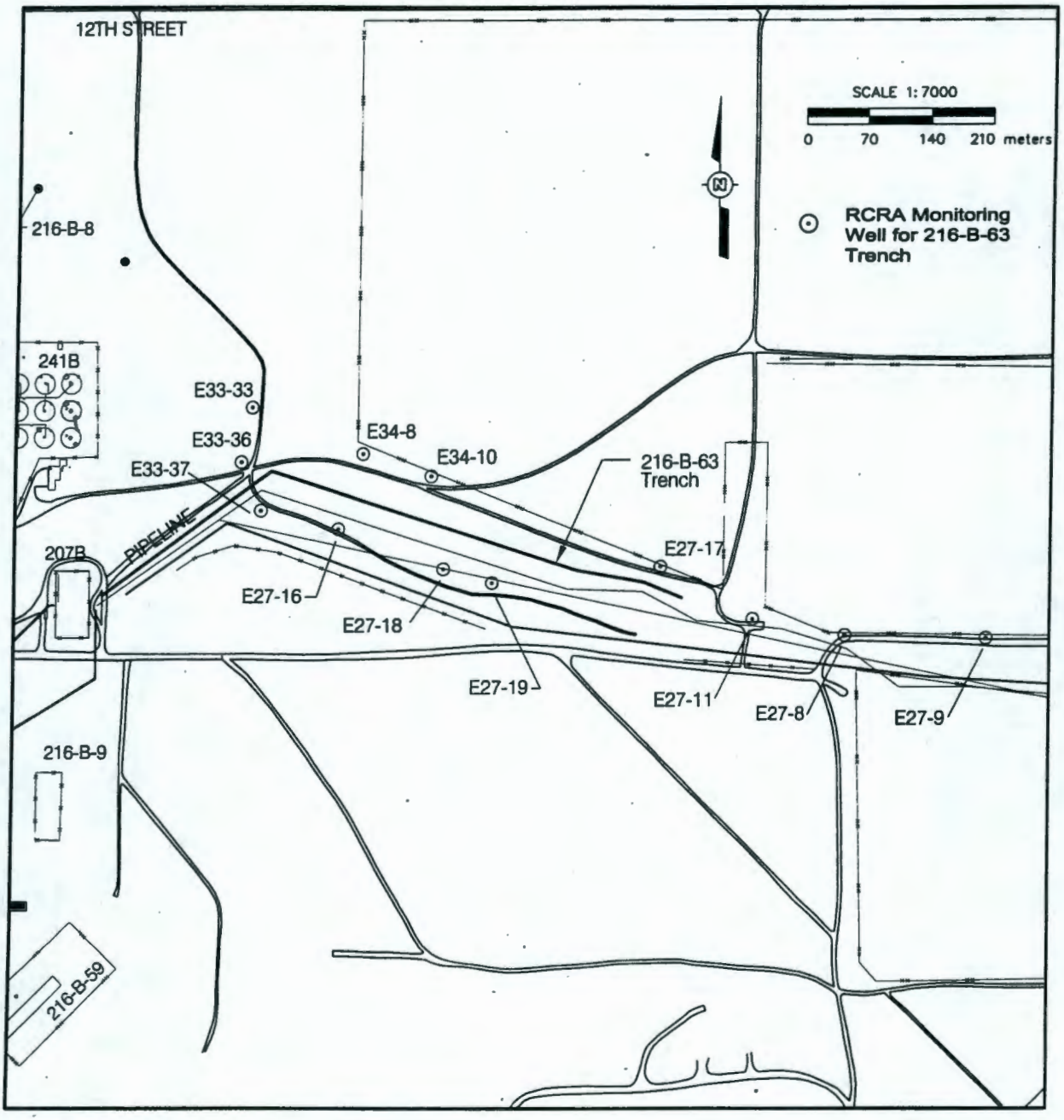

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Figure 2-4. Location of the 216-S-10 Ditch and Ponds in the 200 West Area.

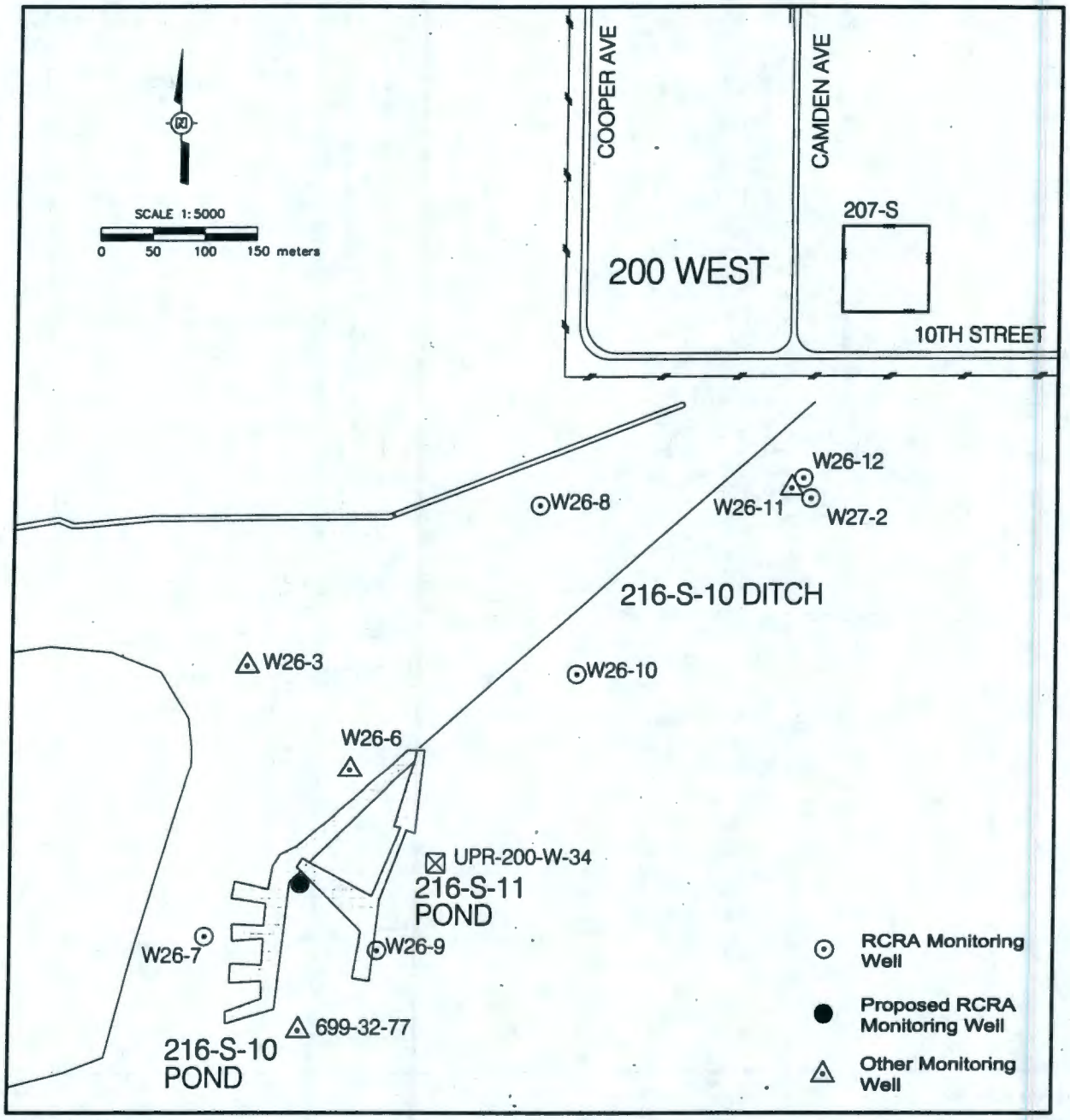

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Figure 2-5. Location of the 216-W-LWC in the 200 West Area.

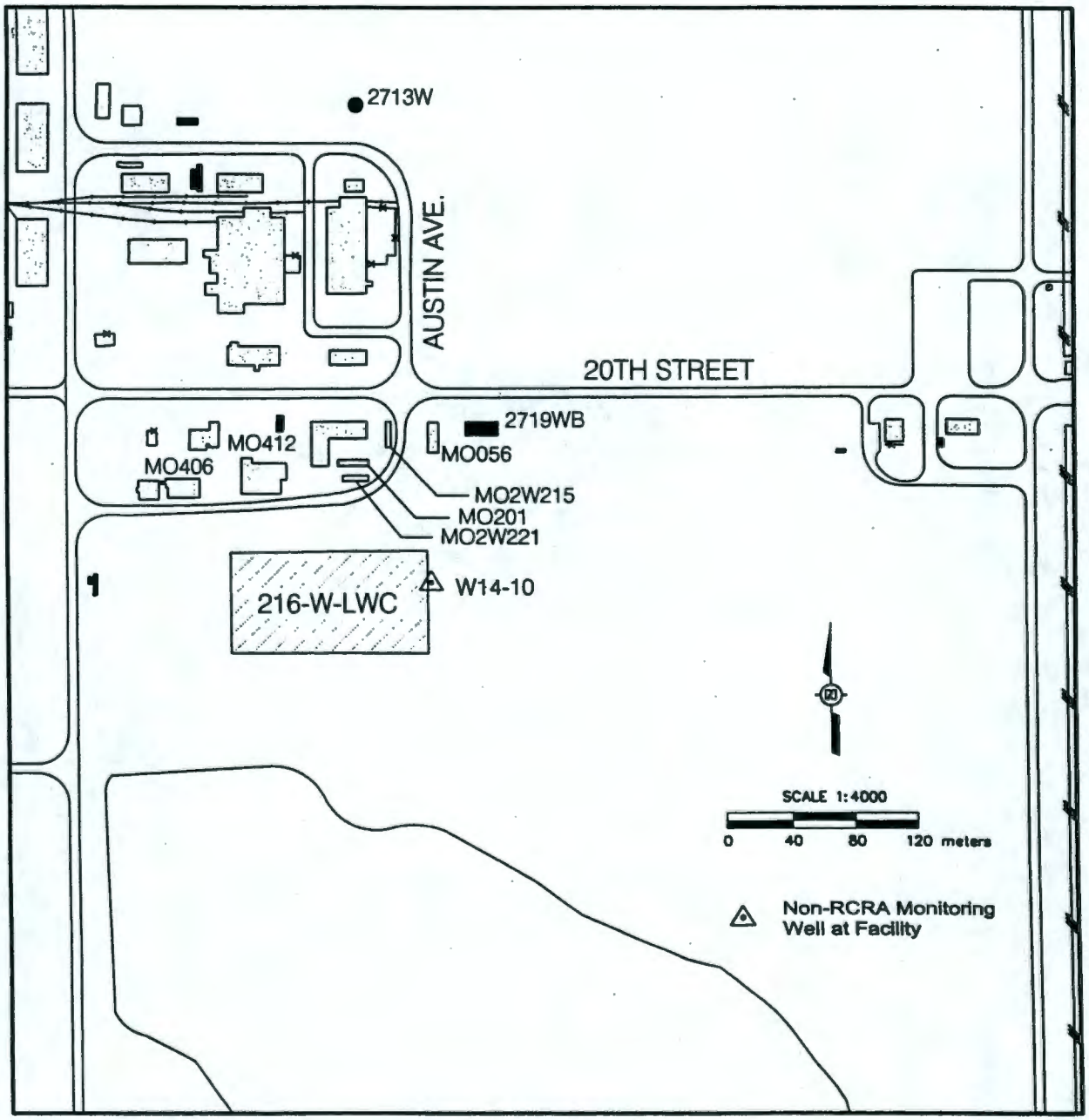

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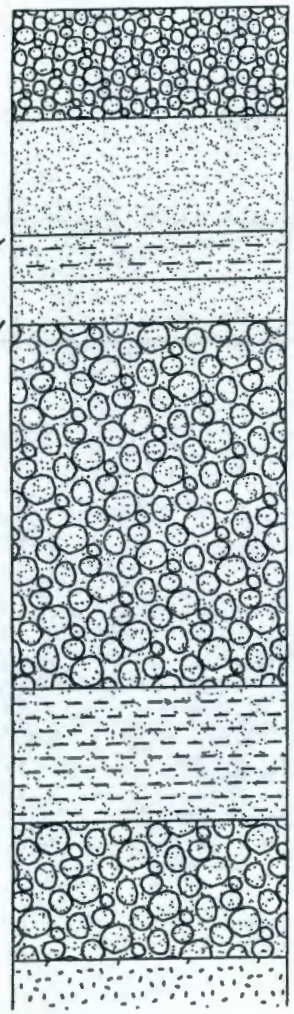
Figure 2-6. Generalized Stratigraphic Columns for the 200 East and 200 West Areas.

GENERALIZED 200 WEST SECTION



HANFORD FM UPPER GRAVELS (H1). MATRIX-POOR, UNCEMENTED, UNCONSOLIDATED, GRAVEL-DOMINATED UNIT.

HANFORD FM SANDS (H2). WELL-STATIFIED, UNCEMENTED, SAND-DOMINATED UNIT WITH VERTICAL-SUBVERTICAL LAYERS OF SILT AND SAND (i.e., CLASTIC DIKES) THAT COMMONLY CUT ACROSS BEDDING PLANES. OCCASIONAL SILT LENSES.

PLIO-PLEISTOCENE UNIT/EARLY PALOUSE SOIL. MASSIVE TO INTERBEDDED SAND, SILT AND SOME GRAVEL, ALSO THINLY LAMINATED, SILT-RICH DEPOSITS. THIS UNIT COMMONLY CONTAINS VERTICAL TO SUBVERTICAL LAYERS OF SILT AND SAND (i.e., CLASTIC DIKES) THAT CUT ACROSS BEDDING PLANES.

RINGOLD FM UPPER UNIT. MODERATELY WELL SORTED SAND WITH MINOR SILT.

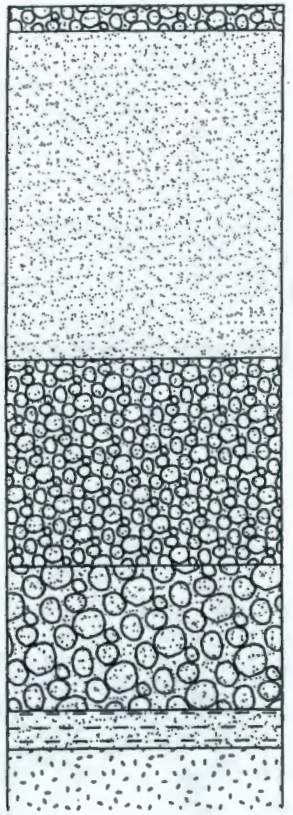
RINGOLD FM UNIT E. CLAST-SUPPORTED FLUVIAL GRAVEL AND SAND. THIS UNIT CONTAINS THE UNCONFINED AQUIFER.

RINGOLD FM LOWER MUD. CLAY INTERBEDDED WITH SILT AND SAND.

RINGOLD FM UNIT A. CLAST-SUPPORTED FLUVIAL GRAVEL AND SAND. THIS UNIT CONTAINS THE SEMI-CONFINED AND CONFINED AQUIFERS.

BASALT OF THE ELEPHANT MOUNTAIN MEMBER.

GENERALIZED 200 EAST SECTION



HANFORD FM UPPER GRAVELS (H1). MATRIX-POOR, UNCEMENTED, UNCONSOLIDATED, GRAVEL-DOMINATED UNIT.

HANFORD FM SANDS (H2). WELL-STRATIFIED, UNCEMENTED, SAND-DOMINATED UNIT WITH VERTICAL-SUBVERTICAL LAYERS OF SILT AND SAND (i.e., CLASTIC DIKES) THAT COMMONLY CUT ACROSS BEDDING PLANES. OCCASIONAL SILT LENSES.

HANFORD FM LOWER GRAVELS (H3). MATRIX-POOR, UNCEMENTED, GRAVEL-DOMINATED UNIT.

RINGOLD FM UNIT A/E. CLAST-SUPPORTED FLUVIAL GRAVEL AND SAND. THIS UNIT CONTAINS UNCONFINED AND CONFINED AQUIFERS.

RINGOLD FM LOWER MUD. CLAY INTERBEDDED WITH SILT AND SAND.

BASALT OF THE ELEPHANT MOUNTAIN MEMBER. LOW PERMEABILITY LAYER. TOWARD THE NORTHERN HALF OF 200 EAST AREA, THIS MEMBER HAS BEEN ERODED AWAY.

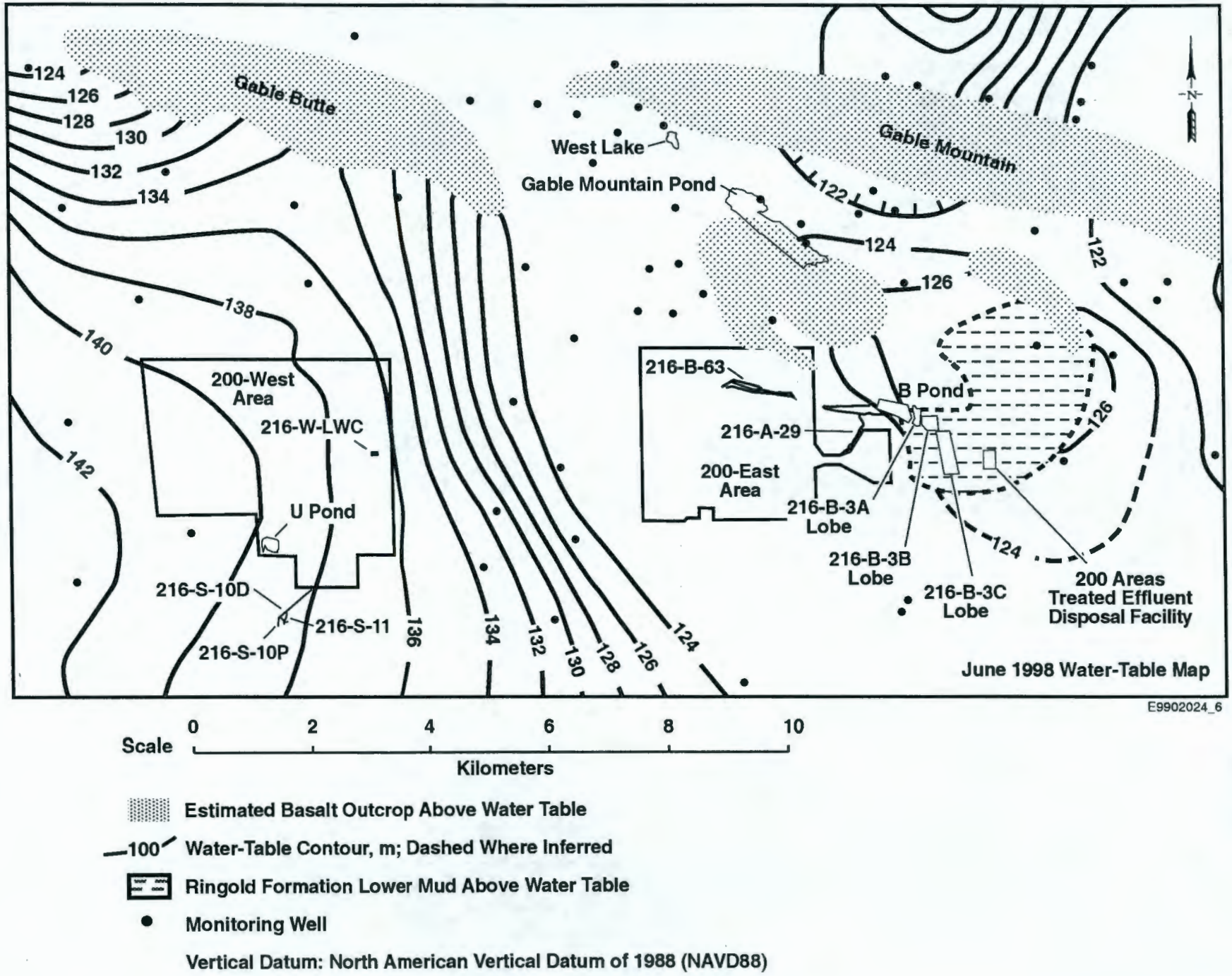


Figure 2-7. Groundwater Elevation Contours in the 200 East and West Areas.

Figure 2-8. Representative Stratigraphy Beneath the 216-A-29 Ditch.

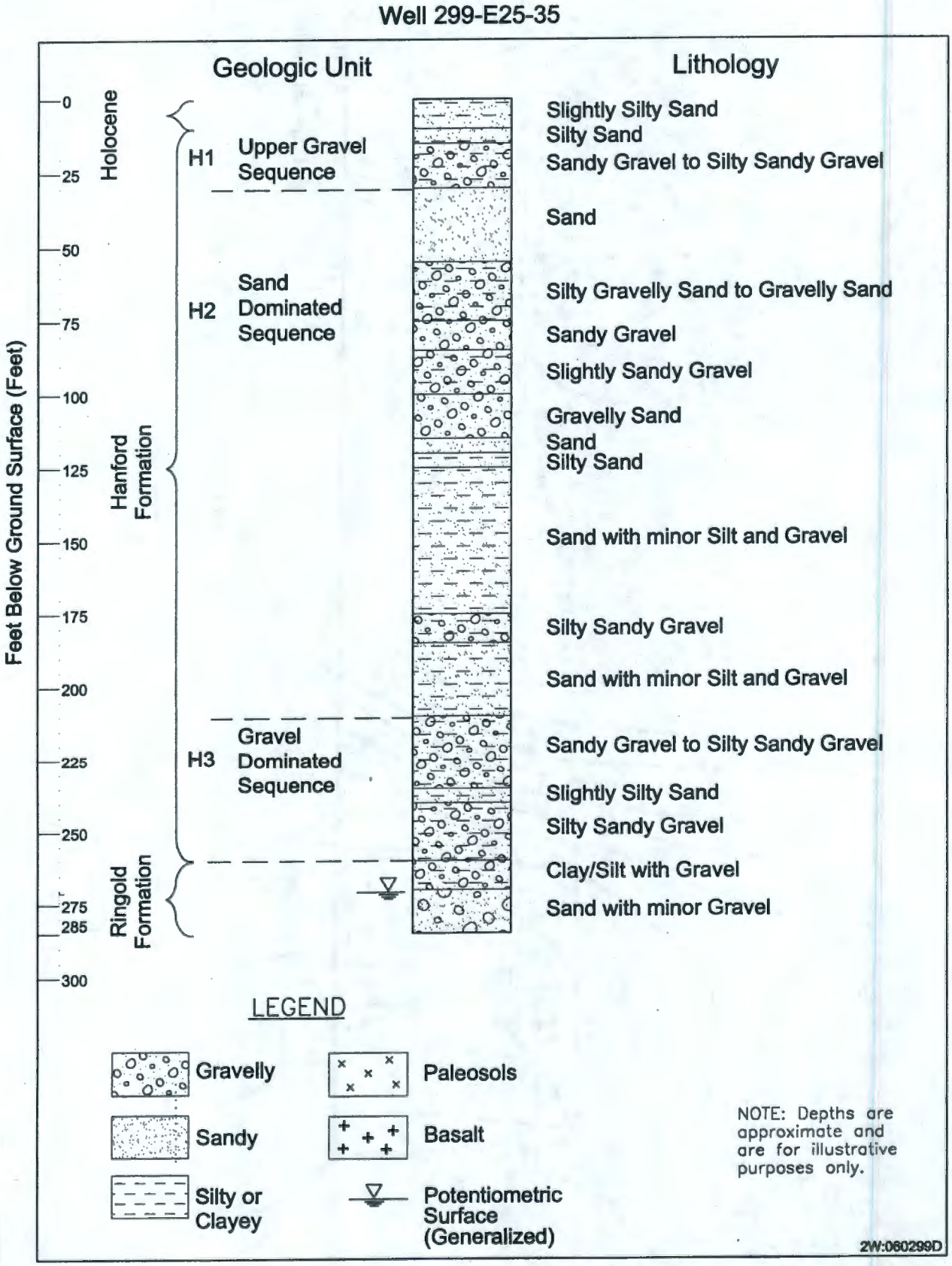


Figure 2-9. Representative Stratigraphy Beneath the 216-B-63 Trench.

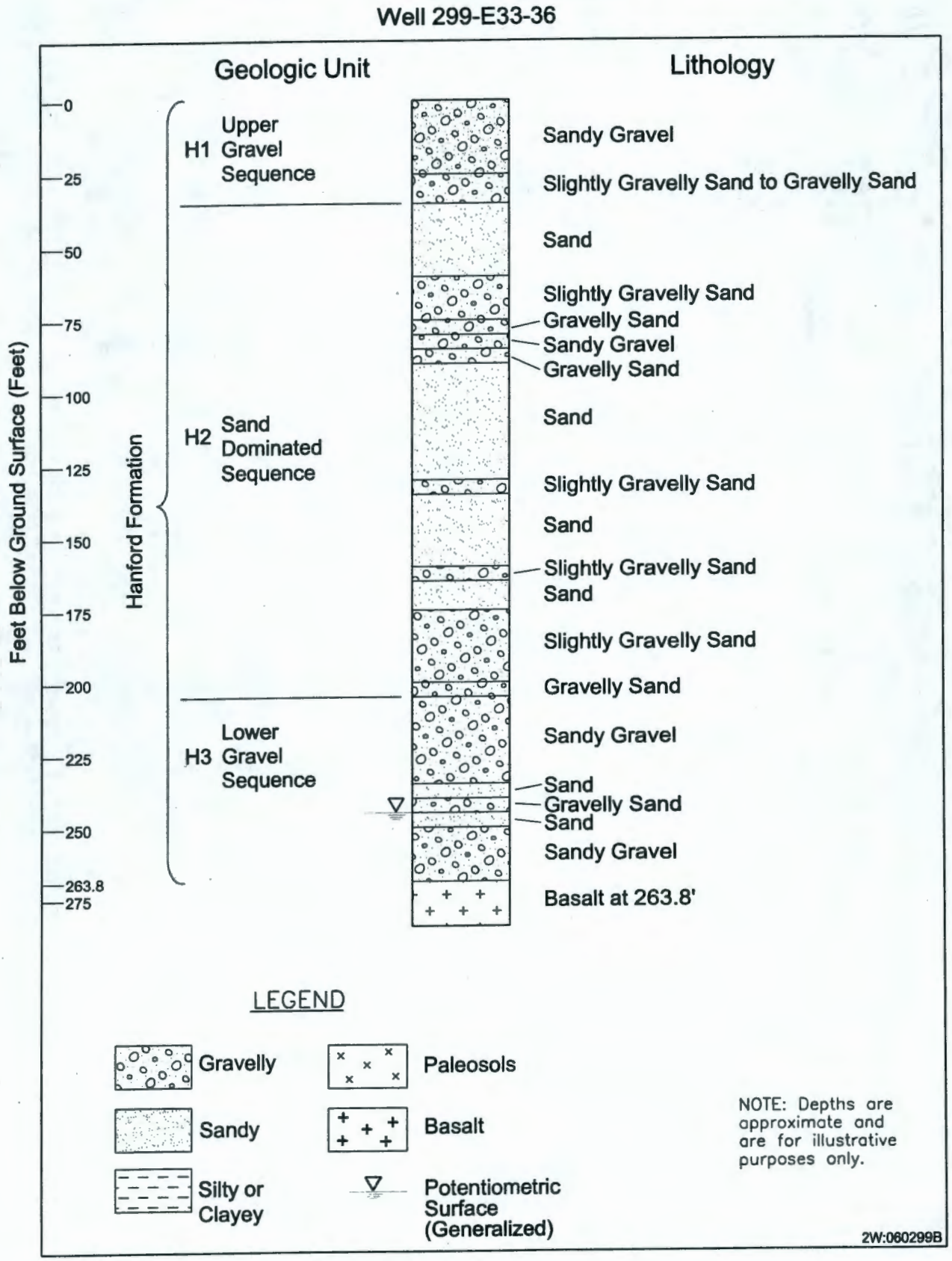


Figure 2-10. Representative Stratigraphy Beneath the 216-S-10 Ditch.

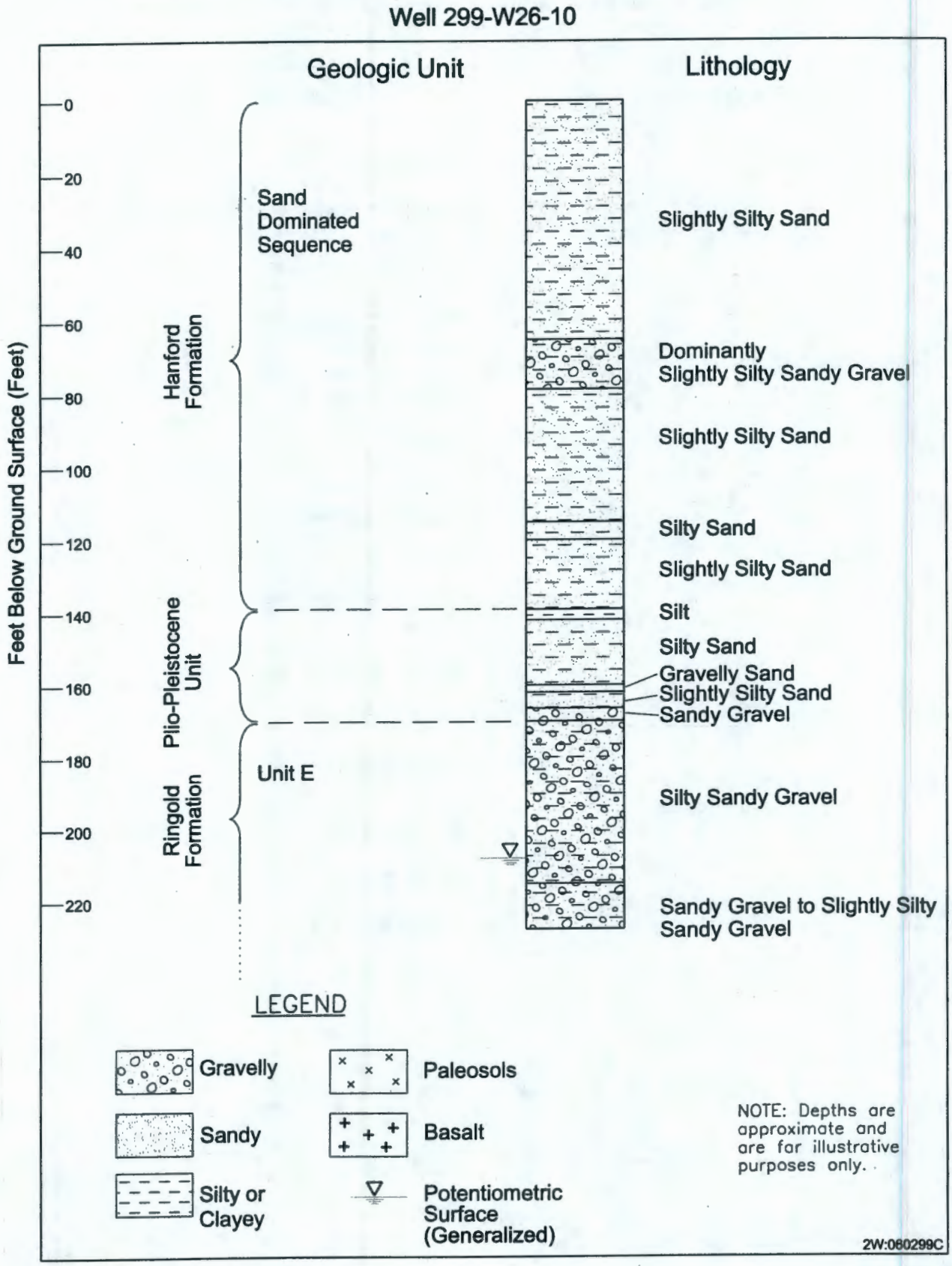


Figure 2-11. Representative Stratigraphy Beneath the 216-S-10 Pond.

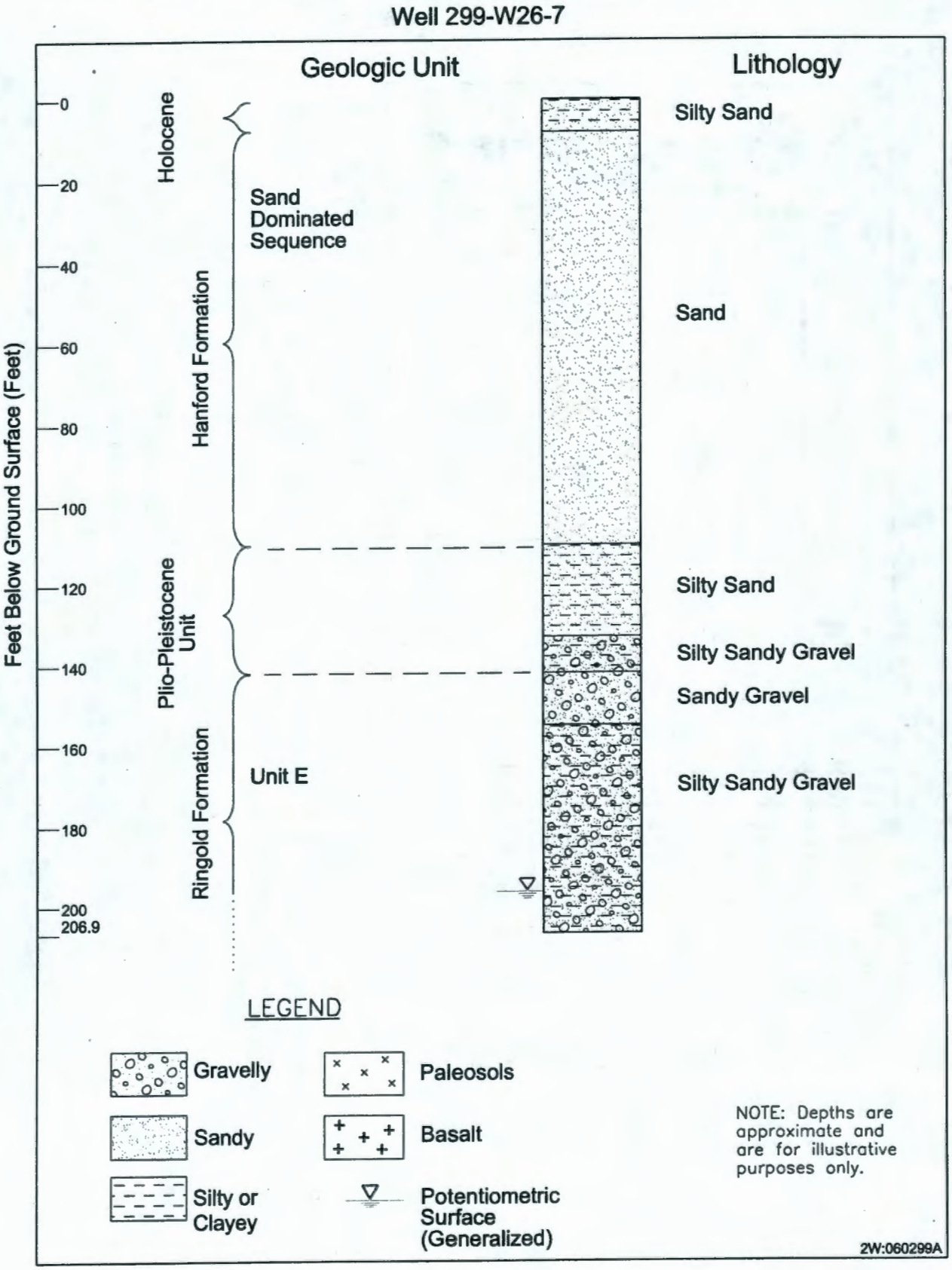
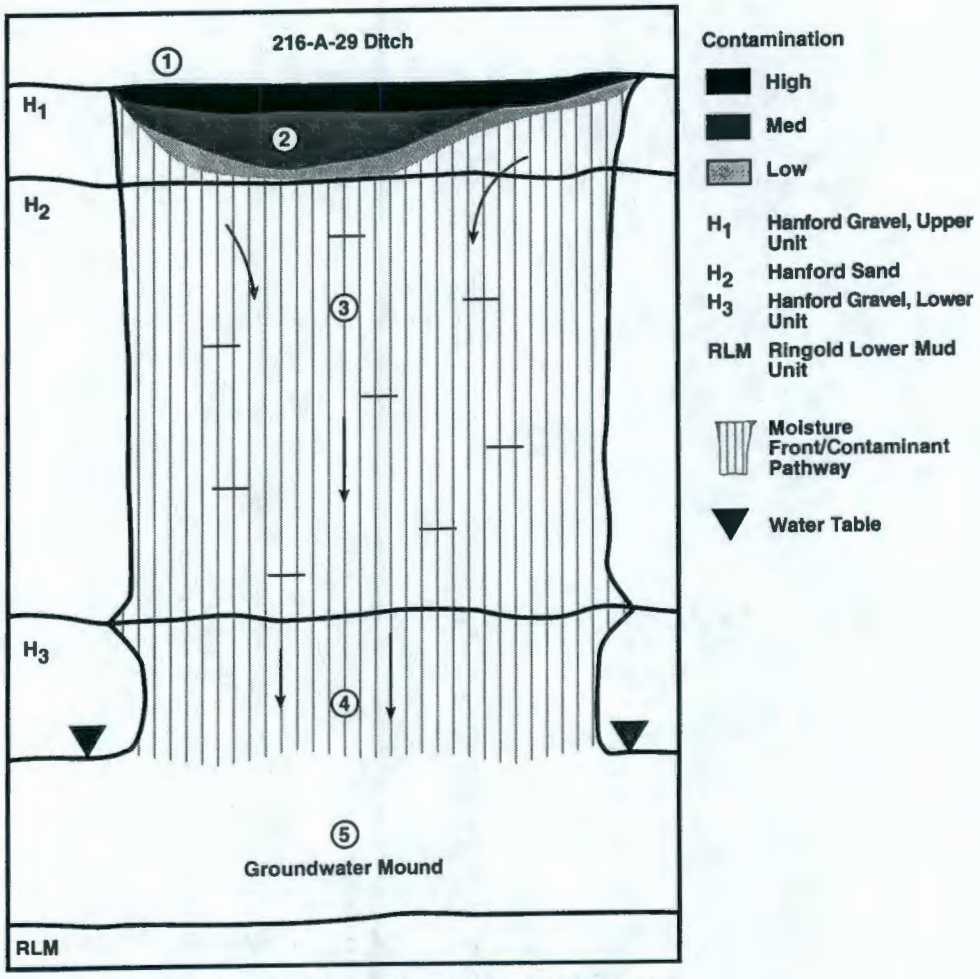


Figure 2-12. 216-A-29 Ditch Conceptual Contaminant Distribution Model (During Discharge).



1. Large volumes of low salt, low organic solutions containing minor quantities of Uranium, Pu-239/240, Cs-137, Sr-90, and nitrates were routinely discharged to the sediment column. Routine serial discharges of sulfuric acid and sodium hydroxide occurred. Occasional high concentration spills caused major contamination events including a spill of 15 kg cadmium nitrate and 141 kg of hydrazine.

2. Particulates (e.g. Pu-239/240) settle out at the bottom of the ditch. Cs-137, Pu-234/240, Uranium, and Sr-90 sorb to sediment in the bottom of the ditch. The highest concentrations should be within 2 meters of the ditch bottom and decrease with depth and distance from the point of discharge. Some Uranium complexes with carbonates and moves with the moisture front.

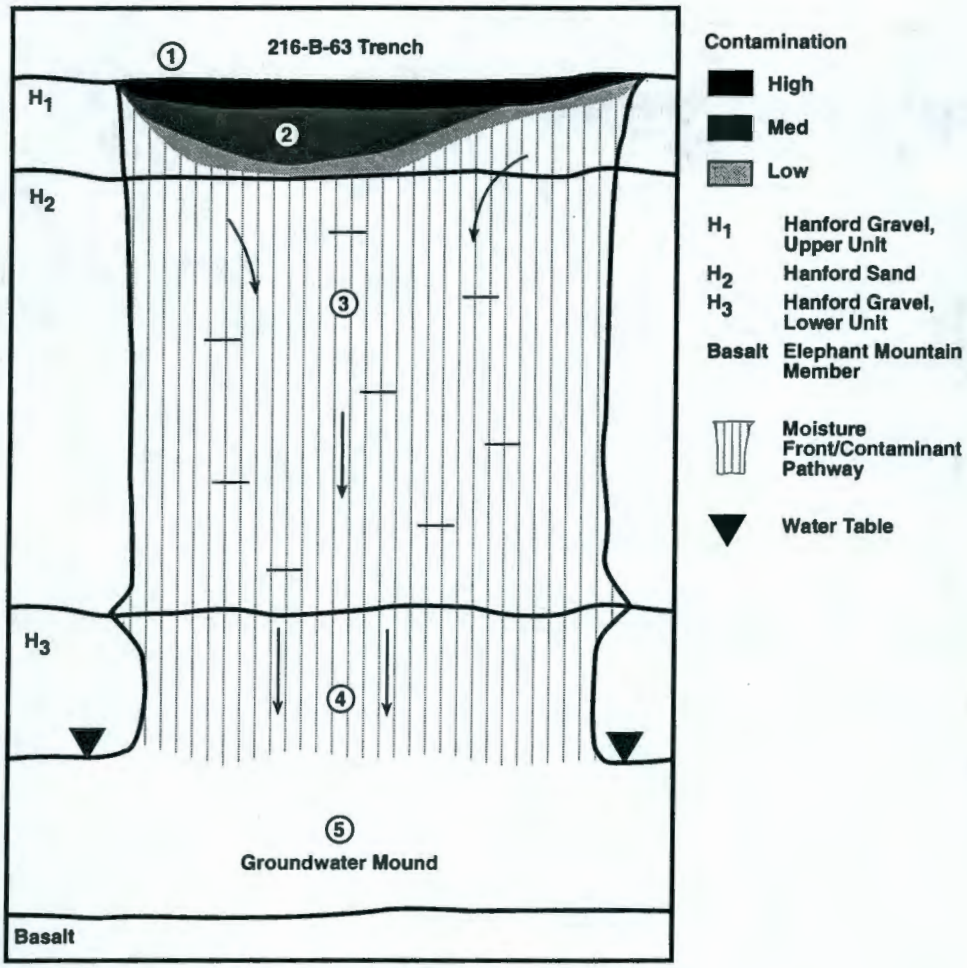
3. The wetting front and mobile contaminants (e.g. Uranium and Tc-99) with some Sr-90 move vertically downward through H_1 with minor spreading occurring on top of H_2 and along silt stringers.

4. Mobile contaminants enter groundwater since soil pore volume was exceeded during active discharge.

5. Minor groundwater mounding occurs beneath the ditch.

E9902048.1

Figure 2-13. 216-B-63 Trench Conceptual Contaminant Distribution Model (During Discharge).



1. Large volumes of low salt, low organic solutions containing minor quantities of Uranium, Pu-239/240, Cs-137, Sr-90, and nitrates were routinely discharged to the sediment column. Routine serial discharges of sulfuric acid and sodium hydroxide occurred. Occasional high concentration spills caused major contamination events.

2. Particulates (e.g. Pu-239/240) settle out at the bottom of the trench. Cs-137, Pu-234/240, Uranium, and Sr-90 sorb to sediment in the bottom of the trench. The highest concentrations should be within 2 meters of the trench bottom and decrease with depth and distance from the point of discharge. Some Uranium complexes with carbonates and moves with the moisture front.

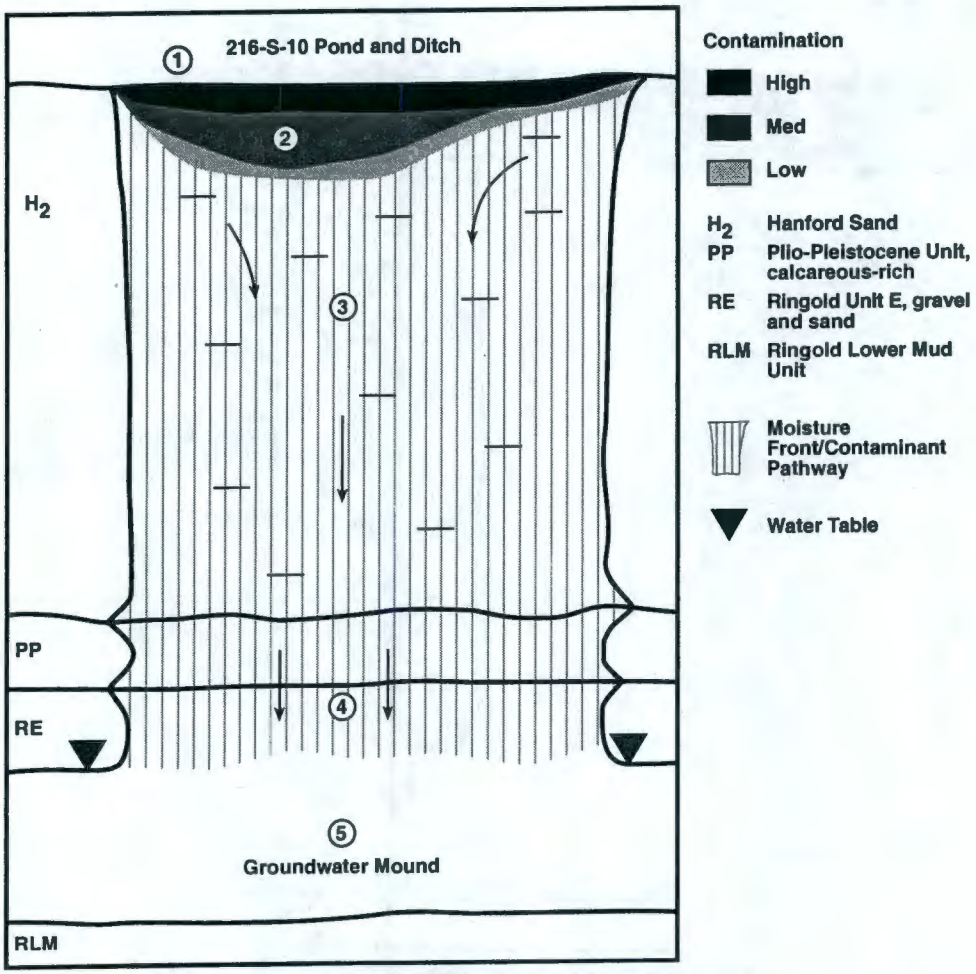
3. The wetting front and mobile contaminants (e.g. Uranium and Tc-99) with some Sr-90 move vertically downward through H_1 with minor spreading occurring on top of H_2 and along silt stringers.

4. Mobile contaminants enter groundwater since soil pore volume was exceeded during active discharge.

5. Minor groundwater mounding and mixing occurs beneath the trench.

E9902048.5

Figure 2-14. 216-S-10 Pond and Ditch Conceptual Contaminant Distribution Model (During Discharge).



1. Large volumes of low salt, low organic solutions containing minor quantities of Pu-239/240, Cs-137, Sr-90, and nitrates were routinely discharged to the sediment column. Occasional high concentration spills including 215 kg of Uranium in 1954 caused major contamination events.

2. Particulates (e.g. Pu-239/240) settle out at the bottom of the pond. Cs-137, Pu-234/240, Uranium, and Sr-90 sorb to sediment in the bottom of the pond. The highest concentrations should be within 2 meters of the pond bottom and decrease with depth and distance from the point of discharge. Some Uranium complexes with carbonates and moves with the moisture front.

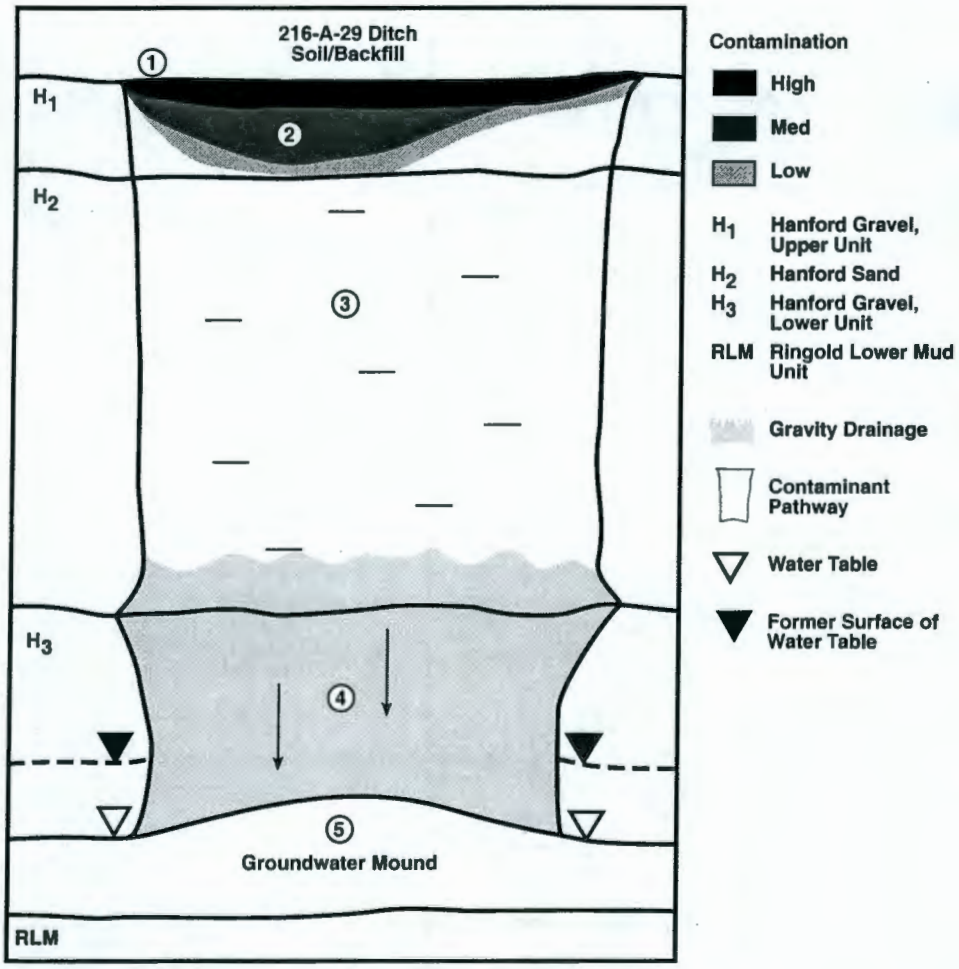
3. The wetting front and mobile contaminants (e.g. Uranium and Tc-99) with some Sr-90 move vertically downward through H_2 with minor spreading along silt stringers and at the PP boundary.

4. Mobile contaminants enter groundwater since soil pore volume was exceeded during active discharge.

5. Groundwater mounding occurs beneath large percolation ponds.

E9902048.3

Figure 2-15. 216-A-29 Ditch Conceptual Contaminant Distribution Model (After Cessation).



① 216-A-29 Ditch no longer receives effluent. Site has been backfilled/ stabilized with a combination of clean soil and contaminated soil from side slopes.

② Particulates (e.g. Pu-239/240) have settled out at the bottom of the ditch. Cs-137, Pu-234/240, Uranium, and Sr-90 sorbed to sediment in the bottom of the ditch. The highest concentrations should be within 2 meters of the ditch bottom and decrease with depth and distance from the point of discharge. Some Uranium complexed with carbonates and moved with the moisture front.

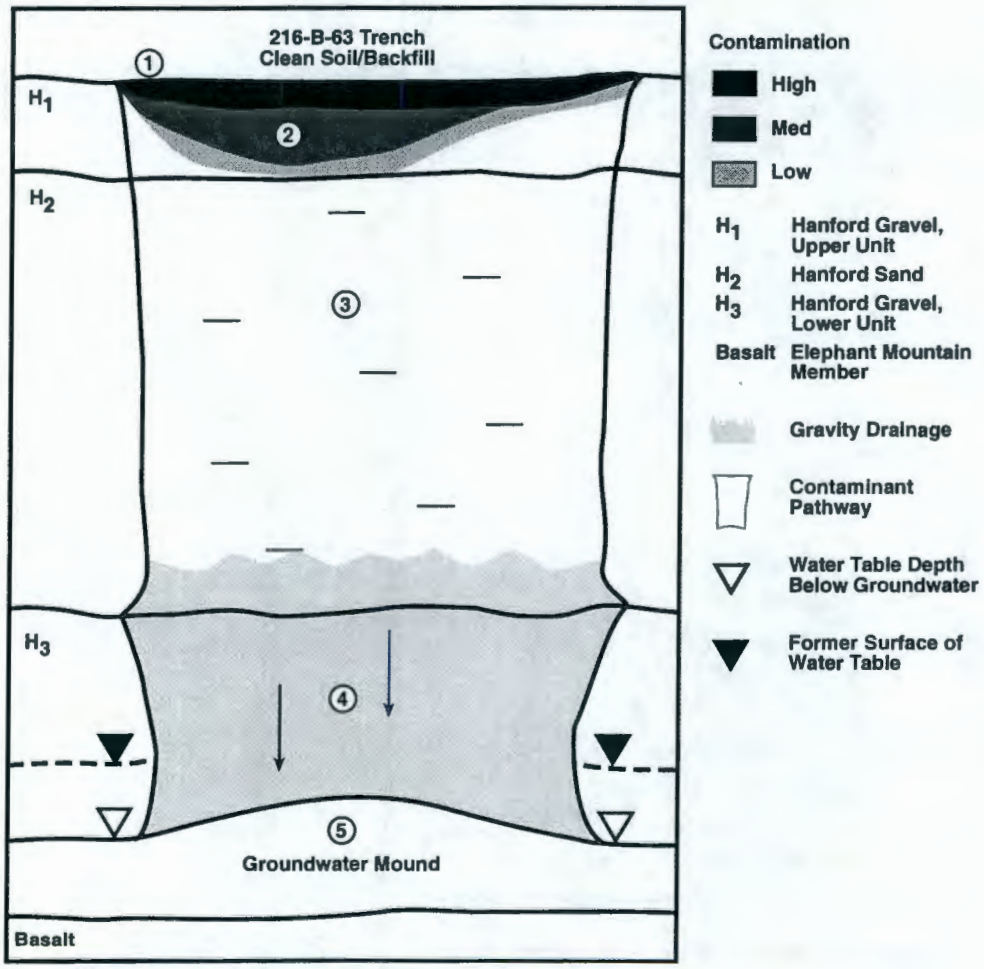
③ Zone of residual contamination. Residual concentrations are less than or equal to background. However slightly higher concentrations may be detected associated with fine grain stringers. Trace amount of Uranium and Sr-90 may be detected in the zone. Sampling results from 1988 and 1998 did not show contaminants in this zone.

④ Saturated/Near Saturated zone. Contaminants in the zone may be impacting groundwater. After gravity drainage of the zone is complete residual contamination may remain in the vadose zone. Contaminates may include Tritium, Sr-90, Uranium, Nitrate, and Tc-99.

⑤ The surface of the water table is dropping because of cessation of untreated discharge in the 200 Area and no discharge to 216-A-29 Ditch.

E9902048.2

Figure 2-16. 216-B-63 Trench Conceptual Contaminant Distribution Model (After Cessation).



① 216-B-63 Trench no longer receives effluent. Site has been backfilled/ stabilization with clean soil.

② Particulates (e.g. Pu-239/240) have settled out at the bottom of the trench. Cs-137, Pu-234/240, Uranium, and Sr-90 sorbed to sediment in the bottom of the trench. The highest concentrations should be within 2 meters of the trench bottom and decrease with depth and distance from the point of discharge. Some Uranium complexed with carbonates and moved with the moisture front.

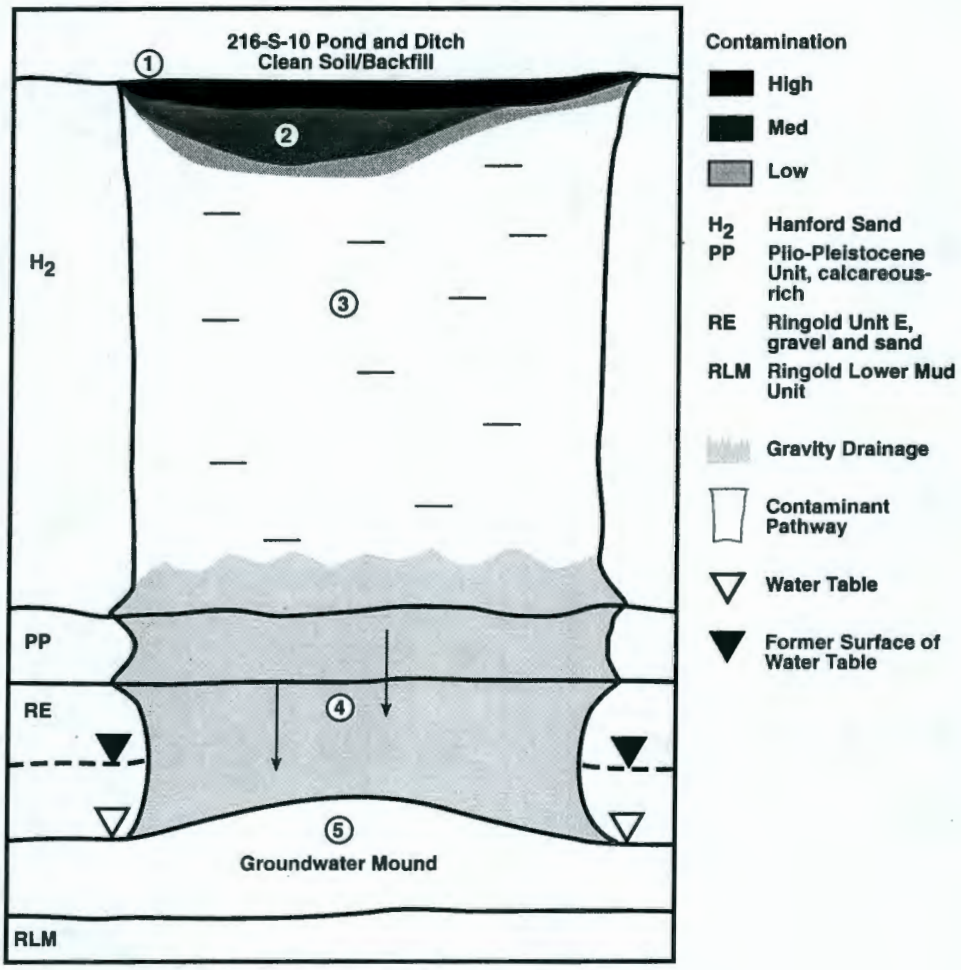
③ Zone of residual contamination. Residual concentrations are less than or equal to background. However slightly higher concentrations may be detected associated with fine grain stringers. Trace amount of Uranium and Sr-90 may be detected in the zone.

④ Saturated/Near Saturated zone. Contaminants in the zone may be impacting groundwater. After gravity drainage of the zone is complete residual contamination may remain in the vadose zone. Contaminates may include Tritium, Sr-90, Uranium, Nitrate, and Tc-99.

⑤ The surface of the water table is dropping because of cessation of untreated discharge in the 200 Area and no discharge to 216-B-63 Trench.

E9902048.6

Figure 2-17. 216-S-10 Pond and Ditch Conceptual Contaminant Distribution Model (After Cessation).



1. The pond and ditch waste sites no longer receives effluent. Site has been backfilled/stabilized with clean soil.

2. Particulates (e.g. Pu-239/240) have settled out at the bottom of the pond. Cs-137, Pu-234/240, Uranium, and Sr-90 sorbed to sediment in the bottom of the pond. The highest concentrations should be within 2 meters of the pond bottom and decrease with depth and distance from the point of discharge. Some Uranium complexed with carbonates and moved with the moisture front.

3. Zone of residual contamination. Residual concentrations are less than or equal to background. However slightly higher concentrations may be detected associated with fine grain stringers. Trace amount of Uranium and Sr-90 may be detected in the zone.

4. Saturated/Near Saturated zone. Contaminants in the zone may be impacting groundwater. After gravity drainage of the zone is complete residual contamination may remain in the vadose zone. Contaminates may include Tritium, Sr-90, Uranium, Nitrate, and Tc-99.

5. The surface of the water table is dropping because of cessation of discharge in the 200 Area.

E9902048.4

Table 2-1. Representative and TSD Waste Sites in the 200-CS-1 Operable Unit.

Site Name	Dates of Operation	Depth	Dimensions	General Description & Status	Unit Category	Source Facility
216-A-29	Nov. 1955 – July 1991	.6 m – 4.6 m (2 ft – 15 ft)	1219.2 m x 1.8 m (4,000 ft x 6 ft)	**Description:** Uncovered unlined ditch that followed the natural contour. Approximately 75% of the ditch is outside the 200 East Area fence. The chemical sewer line included diversion capabilities (i.e., diversion to 216-A-42) based on the continuous monitoring of radioactivity and pH limits. The ditch itself contained two dikes to allow capabilities for regulating flow. It is assumed that much of the effluent entering the ditch infiltrated the soil column prior to reaching 216-B-3-3. **Status:** Site backfilled and the surface stabilized in 1991.	TSD	PUREX
216-B-63	Mar. 1970 – Feb. 1992	3 m (10 ft)	426.7 m x 1.2 m (1,400 ft x 4 ft)	**Description:** Open, unlined, man-made earthen trench that is closed at one end (i.e., does not convey effluent to any other facility.) The trench is entirely within the 200 East Area perimeter fence. **Status:** Site backfilled and the surface stabilized in January 1995.	TSD	B Plant
216-S-10D	Feb. 1954 – 1991	1.8 m (6 ft)	685.8 m x 1.8 m (2,250 ft x 6 ft)	**Description:** Open, unlined, man-made ditch connecting the REDOX complex wastewater to the 216-S-10 Pond and 216-S-11 Pond. The ditch and ponds were designed to dispose liquids through percolation into the soil column. **Status:** Two-thirds of ditch backfilled and stabilized in October 1984. Site isolated in June 1994.	TSD	REDOX
216-S-10P	Feb. 1954 – Oct. 1984	2.4 m (8 ft)	20,234.3 m^2	**Description:** Irregular shaped, man-made pond that covered 5 acres and included 4 finger-leach trenches. The 216-S-10 Ditch fed the pond. Both ditch and pond were designed to dispose liquids through percolation into the soil column. **Status:** Decommissioned, backfilled, and stabilized in October 1984.	TSD	REDOX
216-S-11	May 1954 – 1965	3.1 m (10 ft)	152.4 m x 61 m (500 ft x 200 ft)	**Description:** Irregular shaped, man-made pond connected to the 216-S-10 Ditch. **Status:** South end backfilled and stabilized in 1965. Remaining portion of pond backfilled and stabilized in 1984.	RPP	REDOX
UPR-200-W-34	1955	N/A	≅ 1 Acre	Overflow of the 216-S-10 Ditch during 1955. Assumed to have covered approximately 1 acre.	RPP	REDOX
216-W-LWC	1981 – 1994	8 m	126.5 m x 65.8 m (415 ft x 216 ft)	Two independent crib structures (i.e., drain fields) each consisting of a central distribution pipe and drain lines with rock fill beneath. A 2.1 m (7 ft) layer of gravel fill was backfilled over to grade.	RPP	Laundry Facility

N/A = not applicable
RPP = RCRA past-practice
TSD = treatment, storage, and disposal

3.0 INITIAL EVALUATION OF REPRESENTATIVE AND TREATMENT, STORAGE, AND DISPOSAL SITES

The purpose of this section is to present the results of previous characterization efforts at representative and TSD sites in the 200-CS-1 OU. The contaminant inventory, effluent volume, available soil and groundwater data, and current understanding of the distribution of contamination are also discussed for these sites.

Certain subsections of this section contain information that will be used for portions of the RCRA TSD closure plan. Section 3.1 describes the nature and extent of contamination that corresponds to the closure plan facility description. Section 3.2 contains a historical description of the RCRA interim status groundwater monitoring system and the results of this monitoring.

3.1 NATURE AND EXTENT OF CONTAMINATION

This section uses previously published data to describe the contamination associated with the representative sites. Waste characteristic information that satisfies Section 4.0 of a RCRA closure/post-closure plan is also presented. The majority of the information provided in this section is germane to the waste sites from a historical perspective and is presented in support of technical direction, and health and safety planning for the characterization effort. However, some of the data is considered to be of high quality and representative of current conditions (i.e., 1998 216-A-29 Ditch sampling). An evaluation of the high quality data with regards to the *Model Toxics Control Act* (MTCA) cleanup levels is provided where appropriate.

Waste inventories for the 200-CS-1 OU waste sites are not well documented because there were no known requirements for sampling of nonradioactive contaminants. Table 3-1 contains inventory information for the following important radionuclides: total plutonium and uranium, americium-241, cesium-137, and strontium-90 (DOE-RL 1997). Very low levels of fission products, plutonium, and small quantities of uranium are known to exist at these sites, other than at the 216-S-10/11 sites, where more than 215 kg of uranium were reportedly discharged (UPR-200-W-34).

3.1.1 216-A-29 Ditch

3.1.1.1 Sources of Waste Contributions. Four mechanisms existed for the discharge of dangerous waste into the 216-A-29 Ditch:

- **Overflow of condensate from the acid fractionator** – Sporadic overflow of the acid fractionator may have resulted in an acidic waste (D002) discharge to the chemical sewer.

- **Effluent discharges from regeneration of the demineralizers** – Serial discharges of sulfuric acid and sodium hydroxide (both D002) routinely resulted in the discharge of effluent below a pH of 2 and above a pH of 12.5 to the chemical sewer. This practice

continued until 1989, when a catch tank was placed in service to hold the regeneration effluents.

- **Disposal of out-of-tolerance chemical makeups** – Various chemicals, including hydrazine (U133) and state-only toxic mixtures (WT02), were discharged to the chemical sewer when adjustments to chemicals used in the PUREX Plant became out of compliance with required plant specifications.

- **Accidental spills** – Equipment failures, misvalvings, and overflowing tanks resulted in accidental spills to the chemical sewer. The most significant spill was unplanned release UPR-200-E-51, which occurred in May 1977 and released 15 kg of cadmium nitrate (D006) to the chemical sewer. Other releases included hydrazine (U133), and various acidic and basic solutions (D002).

Table 3-2 contains a list of chemicals released to the PUREX Plant chemical sewer from mid-1983 to 1987. Before 1983, detailed release records were not maintained. The quantities identified represent the amount discharged at the point the sewer line entered the 216-A-29 Ditch. Chemicals and associated state dangerous waste designation codes identified in Table 3-2 are the same as those identified in the Part A Permit application for the 216-A-29 Ditch. Dangerous waste releases to the 216-A-29 Ditch ceased in 1986.

3.1.1.2 Maximum Inventory of Waste Managed. During operations, approximately 22,700,000 L/day (6,000,000 gal/day) of liquid wastewater reached the 216-A-29 Ditch. Accurate records are not available concerning the total volume of waste disposed in this unit. The ditch was equipped with a meter for measuring flow rate. Flow rates varied from approximately 378 to 5,290 L/min (100 to 1,400 gal/min), depending on the operating conditions of the PUREX Plant. The average flow was about 3,760 L/min (970 gal/min).

3.1.1.3 Historical Sampling and Analysis. Results from effluent stream sampling from 1976 to 1988 and from October 1989 to March 1990 are contained in the *PUREX Plant Chemical Sewer Stream-Specific Report* (WHC 1990d). This report contains data that were obtained after controls were placed to preclude the addition of dangerous waste such as corrosive demineralizer effluent. The report concluded that these effluents did not designate as dangerous waste.

Radionuclide inventory and effluent volume information for 216-A-29 Ditch are summarized in Table 3-1.

Annual environmental surveillance reports include radiological information on ditch sediments and vegetation collected at the head end of the 216-A-29 Ditch. Values ranged from less than detection limits to a high value of 127 pCi/g in sediments for cesium-137. Sediment samples collected in 1991 indicated uranium at 1.1E-06 g/g, cesium-137 at 3.3 pCi/g, strontium-90 at 0.65 pCi/g, and plutonium below the detection limit.

In 1982, a radiological survey was conducted on the upper end of 216-A-29 Ditch to estimate the extent of contamination requiring removal prior to construction activities in the area. Auger borings were drilled to a depth of 3.7 m (12 ft) and sediments were sampled for gamma-emitting

radionuclides. All radionuclides other than cesium-137 were determined to be at background levels. The highest value for cesium-137 was found in the top (i.e., uppermost) sample from the ditch core samples, with a maximum observed value of 90 pCi/g.

A 1989 radiation survey found contamination at 2,000 cpm. Dose rates from penetrating radiation were measured annually between 1985 and 1989 at 40 locations within or adjacent to the PUREX Plant aggregate area. An average total of 86 mrem/yr was found at 216-A-29 Ditch, and a separate reading of 96 mrem/yr was found at the east end of the ditch. The results of external radiation monitoring in 1990 showed a maximum of 104 mrem/yr at the ditch.

Data for water quality in the 216-A-29 Ditch were obtained between 1985 and 1990 before the ditch was stabilized. The samples were taken weekly, composited, and analyzed monthly for total beta, total alpha, cesium-137, and strontium-90. The results are presented in Table 3-3 in the form of maximum and minimum recorded levels. Data indicate that at the maximum concentrations (as the minimum levels were generally below detection), radioactivity appeared to be trending downward.

In 1991, vegetation samples were collected at the head end of the 216-A-29 Ditch. The maximum uranium concentrations were 0.15 pCi/g of uranium-234, 0.005 pCi/g of uranium-235, 0.04 pCi/g of uranium-238, or 0.2 pCi/g of total uranium. This total concentration was six times greater than reported in the previous year. Aquatic vegetation samples collected in 1991 indicated the presence of uranium at 2.9E-07 g/g and strontium-90 at 0.44 pCi/g.

In early spring 1991, soil and tree samples were taken to determine possible radionuclide uptake. Samples were collected of the surrounding surface soils, new growth limbs and leaves, and cores taken from the trunks of trees. Six sample points were chosen, three from each side: two sample points at the north end of the ditch, two sample points at the midsection, and two sample points at the south end. The sampled soil had a maximum value of 2.3 pCi/g of cesium-137, <0.28 pCi/g of plutonium-239/240, 0.65 pCi/g of strontium-90, and 5.5E-07 g/g of uranium. No radionuclides were found above background levels in any of the vegetative samples (WHC 1992e).

Recent sampling and analysis of the 216-A-29 Ditch provide relevant information on the potential nature and extent of contamination at the TSD units. Sampling was performed in July 1998 to evaluate the presence of contamination beneath a proposed roadway and utilities crossing that was built to support the Tank Waste Remediation Systems (TWRS) privatization effort. Results of the sampling effort were documented in the 216-A-29 letter report (BHI 1998b). Analytical results were compared to a previous 1988 sampling effort (RFS 1997), which was performed in support of a RCRA closure plan.

The results for both the 1988 and 1998 sampling efforts showed that the average values for all but one of the analytes measured were below background concentrations (computed as the 90th percentile of the background population, per Ecology guidance [Ecology 1992]) and that all analytes were below MTCA (WAC 173-340) Method B cleanup levels. Lead was found above the background value of 10.2 mg/kg in 1988 and 1998. In the 1998 sampling effort, a maximum lead value of 98.2 mg/kg was found in a sample collected 4 m (13 ft) beneath the surface of the

historical ditch, at the location of a the proposed road and utility corridor. A maximum lead value of 262 mg/kg was obtained during the 1988 sampling effort, which was located in the ditch 150 m (492 ft) upstream from the proposed road/utility corridor location. The maximum lead value is below the U.S. Environmental Protection Agency's (EPA's) *Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children* (EPA 1994) calculated level of 353 mg/kg, which has been established as the MTCA cleanup standard for lead in soil for previous Hanford Site remedial actions. For radionuclides, the 1988 data reported that the cesium-137 values demonstrated the greatest amount of variability, with the highest reported value of 140 pCi/g.

Nonradiological groundwater analytical results are described in Section 3.2. Radiological groundwater data have been collected at the 216-A-29 wells as part of the RCRA interim status groundwater monitoring program. Iodine-129 exceeds drinking water standards (8.5 pCi/L) in both upgradient and downgradient wells and, therefore, is not attributable to contamination at this site.

3.1.1.4 Hydrazine as a Listed Dangerous Waste. Hydrazine product (U133) entered the 216-A-29 Ditch from the PUREX Plant aqueous makeup unit tanks. As such, all environmental media and debris generated as waste during the characterization and remediation of these TSD units would be identified as listed hydrazine dangerous waste in accordance with WAC 173-303-081(3). This presents a problem from the context of storage, treatment, and disposal of soils and other debris generated from remediation of these units. All substantive dangerous waste management standards will apply to generated soils and debris because they are defined as listed waste. Should environmental media only be regulated due to the hydrazine waste code, this requirement could unduly burden cleanup activities. Particularly problematic requirements are those associated with land disposal restrictions; U133 wastes must undergo treatment using one of the technologies prescribed in 40 *Code of Federal Regulations* (CFR) 268 table entitled, "Treatment Standards for Hazardous Wastes." These technologies encompass mostly thermal or chemical destruction or extraction technologies and would be required prior to disposal of any waste, soils, and/or debris generated at B Pond and the 216-B-3-3 Ditch.

To avoid unnecessary treatment of characterization and remediation waste from the cleanup of the 216-A-29 Ditch, the U.S. Department of Energy (DOE) will be submitting a contained-in request under separate documentation to Ecology in accordance with their contained-in policy for environmental media (Ecology 1993) and EPA's contained-in requirements for debris (40 CFR 261.3[f]). Limited sampling to support this request is defined in the sampling and analysis plan (SAP) (Appendix B). With approval of a contained-in request, the listed waste code can be removed from debris and media if levels of the compound for which the waste was listed are determined to be below risk-based action levels. The chemical hydrazine rapidly oxidizes to form nontoxic nitrogen and water in the environment. Therefore, hydrazine could not be present in the B Pond system above detection or risk-based action levels.

3.1.2 216-B-63 Trench

3.1.2.1 Sources of Waste Contributions. The major sources of waste contributions to the 216-B-63 Trench were the 2902-B high tank (potable sanitary water), cooling water from B Plant

and Waste Encapsulation Storage Facility air-compressor aftercoolers, some of the 221-B steam condensate, and the demineralizer effluent. Minor contributions came from chemical makeup overflow systems (e.g., sodium hydroxide and sodium nitrite), air conditioning units, and space heaters. These minor contributions were determined to be controlled to levels below dangerous waste designation limits.

The only documented hazardous effluent discharged in the past consisted of regeneration solutions from the B Plant demineralizers (271-B Building). These effluents were routine corrosive discharges (D002) of aqueous sulfuric acid and sodium hydroxide solutions. The corrosive discharges occurred from 1970 until October 1985. After 1985, the cation column effluent was treated with sodium carbonate and the anion column effluent was treated with monosodium phosphate to maintain a combined pH between 4 and 10. As of 1987, the waste discharged to the 216-B-63 Trench was no longer considered to be dangerous waste.

3.1.2.2 Maximum Inventory of Waste Managed. The approximate average flow rate of wastewater discharged to the 216-B-63 Trench varied from 378,000 to 1,408,000 L/day (100,000 to 400,000 gal/day). Approximately 68,100,000 kg/yr (or 473,000 L/day [125,000 gal/day]) of corrosive wastes were managed in the 216-B-63 Trench for the period from 1970 to 1992.

3.1.2.3 Historical Sampling and Analysis. After corrosive waste discharge to the 216-B-63 Trench ceased, analytical data from the trench's effluent stream (downstream of all contributing waste streams) was obtained from October 1989 through March 1990. Data were collected to determine if other contaminants (other than corrosive waste) in the waste stream may be designated as dangerous waste. The results of this sampling effort concluded that the effluent stream to the trench was not a designated dangerous waste. Very low levels of radionuclides were also reported. Statistical data for this effluent are contained in the *B Plant Chemical Sewer Stream-Specific Report* (WHC 1990a).

In August 1970, the 216-B-63 Trench was dredged. The dredgings read approximately 3,000 cpm of beta/gamma activity and were removed and disposed to the Low-Level Burial Grounds (RHO 1979).

Surface water, vegetation, and sediment samples have been routinely analyzed and reported. The 1990 survey results for the 216-B-63 Trench indicated that radionuclide concentrations in the surface water were below detection limits. Sediment samples showed 13 pCi/g of plutonium, 6.6 E-06 g/g of uranium, 81 pCi/g of cesium-136, and 42.2 pCi/g of strontium-90. A 1978 sample of aquatic vegetation at the 216-B-63 Trench revealed relatively high concentrations of strontium-90 (218 pCi/g) and plutonium (89.1 pCi/g) (RHO 1980b).

An external radiation survey completed in August 1990 did not reveal any detectable beta contamination at the 216-B-63 Trench. A thermoluminescent dosimeter located at the 216-B-63 Trench reported a maximum of 128 mrem/yr, which is considered an above-average site in the area around B Plant.

Nonradiological groundwater analytical results are described in Section 3.2. Radiological groundwater data have been collected at wells in the vicinity of the 216-B-63 Trench as part of the RCRA interim status groundwater monitoring program. Iodine-129 exceeds drinking water standards (8.5 pCi/L) in upgradient and downgradient wells and, therefore, is not attributable to contamination at this site.

3.1.3 216-S-10 Ditch and Pond

3.1.3.1 Sources of Waste Contributions. The 216-S-10 Ditch and Pond both routinely received large quantities of nondangerous, low-level radioactive liquid effluent from the 202-S REDOX Facility chemical sewer and the Chemical Engineering Laboratory. The waste stream was comprised of cooling water, steam condensate, water tower overflow, and drain effluent. The effluent to the chemical sewer was comprised of approximately 60% REDOX Facility raw water, 20% sanitary water, and 20% steam condensate. This effluent was characterized from October 1989 to March 1990 in sufficient detail in the *S Plant Wastewater Stream-Specific Report* (WHC 1990e) to support a dangerous waste designation in accordance with WAC 173-303. The data were also compared against drinking water standards and derived concentration guidelines (DCGs) for radionuclides. This sampling effort concluded that the REDOX Facility effluent was not a designated dangerous waste, nor did it exceed drinking water standards or DCGs.

A documented hazardous waste discharge to the site occurred in September 1983. This discharge occurred during the pilot-scale evaporation crystallizer run at the Chemical Engineering Laboratory, which is located next to the REDOX Facility. The primary objective of this run was to simulate recovery of double-shell slurry (DSS) from a waste tank. A synthetic DSS was produced and 420 L (110 gal) of this product were sewered to the 216-S-10 Ditch and Pond. Samples of the synthetic DSS were taken from two feed tanks, TK-505 and TK-509, prior to discharge and were analyzed (WHC 1990e). The chemical compounds comprising the slurry are those identified in the Part A Permit application for the 216-S-10 Pond and Ditch. These components included sodium nitrate (46%), sodium hydroxide (41%), and small quantities of sodium phosphate, sodium fluoride, sodium chloride, and potassium chromate. The DSS was regulated due to ignitability (D001), corrosivity (D002), chromium (D007), and toxic state-only waste (WT01, WT02). In addition to the September 1983 discharge, an unknown quantity of aluminum nitrate nonahydrate (i.e., nonregulated chemical waste) was discharged in 1954.

In May 1954, a 4,049 m^3 (1-acre) overflow occurred from the ditch in the southeast dike of the 216-S-11 Pond (UPR-200-W-34) (GE 1956). A follow-up survey indicated the trench to be contaminated up to 800 mrads/hr, at 500 mrem/hr in some areas with lower contamination, up to 80,000 cpm in an overflow area approximately 4,049 m^3 (1 acre) in area, which resulted from a breakthrough on the east trench earth fill. Some decontamination of the area occurred after the release. Records have indicated that a considerable amount of surface contamination could be found along the ditch banks and the pond bottom (RHO 1979).

3.1.3.2 Maximum Inventory of Waste Managed. During operations, the maximum volume of wastewater discharged daily to the 216-S-10 Pond and Ditch was approximately 568,000 L/day

(150,000 gal/day). The annual volume of effluent discharged was approximately 1.9×10^8 L (5.0×10^7 gal).

3.1.3.3 Historical Sampling and Analysis. Specific chemical and radionuclide inventory data for the 216-S-10 Pond are not available; however, the 216-S-10 Pond received waste via the 216-S-10 Ditch.

Results from effluent stream sampling from 1976 to 1988 and from October 1989 to March 1990 are contained in the *S Plant Wastewater Stream-Specific Report* (WHC 1990e). The report concluded that the routine effluent stream entering the 216-S-10 Ditch and Pond does not designate as dangerous waste. Radionuclide inventory information is summarized in Table 3-1.

A radiation and dose rate survey was conducted in July 1991 at the 216-S-10 Pond. Contamination was not detected during this survey. A 1988 aerial radiation survey identified cesium-137 as the only radionuclide that could be identified from spectra information collected over the 216-S-17 Pond; 216-S-10 Pond; S Plant Complex; 241-S, 241-SX, and 241-SY tank farms; and 216-S-10 Ditch. However, the aerial radiation survey data should only be used as a qualitative tool for identifying more highly contaminated areas within the survey boundaries. In addition, the gamma counts noted in the survey probably resulted from both surface and shallow, buried radionuclides and are, thus, not entirely indicative of surface contamination.

Data exist on the water quality in the 216-S-10 Ditch. The samples were taken weekly, composited, and analyzed monthly for total beta, total alpha, cesium-137, and strontium-90, pH, and nitrates. The results are presented in Table 3-4 and 3-5 in the form of maximum and minimum recorded levels. Judging from the maximum concentrations (as the minimum levels were generally below detection), the radioactivity and nitrate concentrations appear to be trending downward to below detection limits.

A number of excavations by backhoe across the 216-S-10 Ditch in 1971 showed the ditch to be free of contamination (RHO 1979). In addition, semi-annual surface radionuclide monitoring had indicated that no surface contamination exists at the pond or ditch (DOE-RL 1992b). Weekly water samples and annual sediment and vegetation samples taken at the ditch have also found no contamination. Gross gamma-ray logs are available for four wells around the 216-S-10 Ditch and Pond. These logs indicate that no elevated gamma activity is present in the subsurface area surrounding this unit (DOE-RL 1992b).

Nonradiological groundwater analytical results are described in Section 3.2. Radiological groundwater data have been collected at wells in the vicinity of the 216-S-10 Ditch and Pond as part of the RCRA interim status groundwater monitoring program. No radionuclides have been found above drinking water standards.

3.2 RCRA TREATMENT, STORAGE, AND DISPOSAL INTERIM STATUS GROUNDWATER MONITORING

This section presents descriptions and results of interim status groundwater monitoring at the 216-A-29 Ditch, 216-B-63 Trench, and 216-S-10 Ditch and Pond. The purpose of this section is to present interim status groundwater monitoring information to be included in a RCRA closure/ post-closure plan. This information will be used by reference or will be inserted into the closure/post-closure plan that will form the basis for the modification to the Permit. This section will not include the proposed final status groundwater monitoring program; this information will be provided in the future in the closure/post-closure plan.

The current interim status groundwater monitoring plans (as required by WAC 173-303-400 and 40 CFR 265, Subpart F) are contained in three separate documents: *Groundwater Monitoring Plan for the 216-A-29 Ditch* (WHC 1992d), *Interim-Status Groundwater Monitoring Plan for the 216-B-63 Trench* (WHC 1995a), and *Interim-Status Groundwater Monitoring Plan for the 216-S-10 Pond and Ditch* (WHC 1990c). These documents contain further details regarding the geology, hydrology, and current groundwater monitoring programs for the RCRA TSD sites. Excerpts from *Hanford Site Groundwater Monitoring for Fiscal Year 1997* (PNNL 1998) are presented below for the current monitoring network and groundwater conditions.

Quarterly RCRA groundwater compliance monitoring reports were first published in 1986 on the Hanford Site. In addition to quarterly reports, annual reports commenced in 1988. The RCRA-compliant monitoring networks were implemented at different times for the various facilities. Sample collection and analyses for the RCRA groundwater monitoring program on the Hanford Site was halted on June 1, 1990, when Pacific Northwest Laboratory cancelled the United States Testing, Inc. analytical support services contract. The sampling program was reinstated on June 6, 1991, under an interim contract with International Technology Corporation (DOE-RL 1992a). Annual reports for the RCRA groundwater monitoring program have been included in the Hanford Site groundwater monitoring report since 1997 (PNNL 1997, 1998).

3.2.1 216-A-29 Ditch

3.2.1.1 History of RCRA Groundwater Monitoring. The RCRA groundwater monitoring of the 216-A-29 Ditch began in November 1988 with an interim status indicator parameter evaluation (detection level) program (DOE-RL 1992a). The wells were sampled quarterly for one year to establish background levels. Background sampling was completed in August 1989. The program was elevated to an assessment-level program in 1990 because of elevated specific conductance beyond the critical mean in one downgradient well (WHC 1990b). The results of the groundwater quality assessment, which concluded in 1995, are reported in *Results of the Groundwater Quality Assessment Program at the 216-A-29 Ditch* (WHC 1995b) and are summarized in Section 3.2.1.4. The program then reverted to indicator evaluation monitoring in October 1996.

3.2.1.2 Aquifer Identification. The uppermost or unconfined aquifer beneath the 216-A-29 Ditch is approximately 2- to 24-m (7- to 79-ft) thick and is contained within sediments of the Hanford and Ringold Formations. The aquifer extends from the water table to the top of

the basalt, or in some areas, the lower mud unit of the Ringold Formation. Groundwater flow is to the southwest due to the 216-B-3 Pond mound. Groundwater flow velocities range from 0.009 m/day (0.030 ft/day) under the head end of the ditch to 0.063 m/day (0.207 ft/day) under the intersection with the 216-B-3-3 Ditch. The water table beneath the ditch has declined significantly since the discharges to the 216-B-3 Pond system decreased.

3.2.1.3 Well Location and Design. The current monitoring well network (Figure 2-2) consists of 10 wells. There are two upgradient wells (699-43-43 and 699-43-45) and eight downgradient wells. The downgradient wells (prefixed by 299-) are E25-26, E25-28, E25-32P, E25-34, E25-35, E25-48, E26-12, and E26-13. All of the wells are sampled semi-annually with dedicated sampling pumps.

Construction of wells followed RCRA standard well construction specifications (WHC 1992c). The standards in WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells," were used to set the basic design requirements. The interim status groundwater monitoring network for the 216-A-29 Ditch includes 10 wells constructed from 1985 through 1992. The locations of the monitoring wells are identified in Figure 2-2. Nine of the wells are constructed with screens at the water table, and the remaining well is screened above the top of the basalt. Construction summaries and details of drilling and design specifications for all wells in the interim status groundwater monitoring system are contained in several reports (e.g., WHC 1992a, 1992b, 1993a). Two upgradient wells (699-43-43 and 699-43-45) were selected to determine the background groundwater chemistry (well 699-43-45 is located beyond the area depicted in Figure 2-2, to the east).

3.2.1.4 Results of RCRA Interim Status Groundwater Monitoring Data. The RCRA indicator parameters are specific conductance, pH, total organic carbon, and total organic halides. Groundwater quality parameters are chloride, iron (filtered), manganese (filtered), phenols, sodium (filtered), and sulfate. The 216-A-29 Ditch was placed into an assessment-level groundwater monitoring program in 1990 due to elevated specific conductance beyond the critical mean in one downgradient well (WHC 1990b). From that time until 1995, comprehensive sampling and analysis were performed to determine the cause of this anomaly. The assessment report (WHC 1995b) concluded that elevated specific conductance was due to high concentrations of sulfate, sodium, and calcium in the groundwater from the 216-A-29 Ditch. Sulfate, sodium, and calcium are not regulated as hazardous wastes. The facility reverted to an indicator parameter evaluation program. In fiscal year (FY) 1997, specific conductance increased slightly in nearly all of the network wells.

The groundwater in the vicinity of the 216-A-29 Ditch contains iodine-129 and pH at levels above interim drinking water standards but are not considered attributable to the unit. Unfiltered chromium and iron have historically exceeded drinking water standards in several wells. These concentrations have been attributed to well construction and oxidizing conditions in the aquifer.

3.2.2 216-B-63 Trench

3.2.2.1 History of RCRA Groundwater Monitoring. Quarterly RCRA groundwater sampling of the 216-B-63 Trench monitoring network was started in the third quarter of 1988 with an

interim status indicator parameter evaluation (detection level) program (WHC 1995a). The wells were sampled quarterly through calendar year 1993, and then semi-annual sampling for indicator parameters evaluation was initiated.

3.2.2.2 Aquifer Identification. The uppermost or unconfined aquifer beneath the 216-B-63 Trench is 3.4- to 6.1-m (11.2- to 20.0-ft) thick and is contained within the sediments of the Hanford formation. The aquifer extends from the water table to the top of the basalt. The Ringold Formation is absent beneath the trench. Groundwater flow is generally east to west due to the 216-B-3 Pond mound. Groundwater flow velocities range from 0.01 to 0.04 m/day (0.033 to 0.13 ft/day). The water table is nearly flat beneath the ditch and has been declining since the discharges to the 216-B-3 Pond system have decreased.

3.2.2.3 Well Location and Design. The current monitoring well network (Figure 2-3) consists of 12 wells. These wells include five upgradient wells (i.e., 299-E27-8, 299-E27-9, 299-E27-11, 299-E27 -17, and 299-E34-10) and seven downgradient wells (i.e., 299-E27-16, 299-E27-18, 299-E27-19, 299-E33-33, 299-E33-36, 299-E33-37, and 299-E34-8). All of the wells are sampled semi-annually with dedicated sampling pumps.

Construction of wells followed RCRA standard well construction specifications (WHC 1992c). The standards provided in WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells," were used to set the basic design requirements. The interim status groundwater monitoring network for the 216-B-63 Trench includes 12 wells constructed from 1987 through 1992. The locations of the monitoring wells are identified in Figure 2-3. All of the wells are constructed with screens at the water table. Construction summaries and details of drilling and design specifications for all of the wells in the interim status groundwater monitoring system are contained in *Interim-Status Groundwater Monitoring Plan for the 216-B-63 Trench* (WHC 1995a). Five upgradient wells (i.e., 299-E27-8, 299-E27-9, 299-E27-11, 299-E27-17, and 299-E34-10) were selected to determine the background groundwater chemistry.

3.2.2.4 Results of RCRA Interim Status Groundwater Monitoring Data. The RCRA indicator parameters are specific conductance, pH, total organic carbon, and total organic halides. Groundwater quality parameters are chloride, iron (filtered), manganese (filtered), phenols, sodium (filtered), and sulfate. The 216-B-63 Trench has been in an interim status indicator parameter evaluation (detection level) program since 1988. There are no significant detections that could be attributed to this trench, and there are no exceedances in the RCRA indicator parameters.

The groundwater in the vicinity of 216-B-63 Trench contains iodine-129 and pH at levels above interim drinking water standards but are not considered attributable to the unit. Unfiltered chromium and iron have historically exceeded drinking water standards in several wells. These concentrations have been attributed to well construction and oxidizing conditions in the aquifer.

3.2.3 216-S-10 Ditch and Pond

3.2.3.1 History of RCRA Groundwater Monitoring. RCRA groundwater monitoring of the 216-S-10 Ditch began in the third quarter of 1991 with an interim status indicator parameter

evaluation (detection-level) program (DOE-RL 1992a). The wells were sampled quarterly for one year to establish background levels. Semi-annual sampling for indicator parameters evaluation was instituted in 1992. Upgradient wells were sampled quarterly in 1997 to re-establish critical mean for total organic halides, and the wells were sampled semi-annually thereafter (PNNL 1998). The cause of the upgradient total organic halides is likely the upgradient carbon tetrachloride plume.

3.2.3.2 Aquifer Identification. The uppermost or unconfined aquifer beneath the 216-S-10 Pond and Ditch is about 61-m (200-ft) thick and is contained within sediments of the upper unit of the Ringold Formation and the Ringold Unit E. The aquifer extends from the water table to the lower mud unit of the Ringold Formation. Groundwater flow is to the east-southeast between 0.007 to 0.3 m/day (0.023 to 0.98 ft/day). The water table beneath the pond and ditch has declined significantly since the discharges to the U Pond system ceased in 1984.

3.2.3.3 Well Location and Design. The current monitoring well network (Figure 2-4) consists of five wells. These wells included one upgradient well (299-W26-7 [well 299-W26-8 was operational, but went dry]), and four downgradient wells (299-W26-9, 299-W26-10, 299-W26-12, and 299-W27-2). Well 299-W26-9 is also going dry and is expected to be replaced with a new well in early 2000. The proposed location for this well is identified in Figure 2-4. This well will be integrated with the borehole characterization effort described in this work plan. All of the wells are sampled semi-annually with dedicated sampling pumps.

Construction of wells followed RCRA standard well construction specifications (WHC 1992c). The standards in WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells," were used to set the basic design requirements. The interim status groundwater monitoring network for the 216-S-10 Pond and Ditch includes six wells constructed from 1990 through 1992. The locations of the monitoring wells are identified in Figure 2-4. Five of the wells are constructed with screens at the water table. The remaining well is screened above the top of the lower mud of the Ringold Formation. Construction summaries and details of drilling and design specifications for all of the wells in the interim status groundwater monitoring system are contained in several reports (e.g., WHC 1990c, 1992b, 1993b). Two upgradient wells (299-W26-7 and 299-W26-8) were selected to determine the background groundwater chemistry.

3.2.3.4 Results of RCRA Interim Status Groundwater Monitoring Data. The RCRA indicator parameters are specific conductance, pH, total organic carbon, and total organic halides. Groundwater quality parameters are chloride, iron (filtered), manganese (filtered), phenols, sodium (filtered), and sulfate. The RCRA interim status indicator parameter evaluation (detection level) program groundwater monitoring of the 216-S-10 facility began in 1991. In FY 1996 and FY 1997, total organic halides were detected in upgradient wells. Quarterly sampling of the upgradient wells occurred for one year to re-establish critical mean for total organic halides, and then the wells were sampled semi-annually. The cause of the upgradient total organic halides is probably the upgradient carbon tetrachloride plume. Chromium has also been found in an upgradient well. The source of this contamination is currently under investigation, but the source is likely attributable to the upgradient 216-S-17 Pond.

Two of the downgradient wells produced increasingly turbid samples, potentially affecting some analytical results. Turbidity increased to over 180 nephelometric units (NTUs) during FY 1996. Measures were taken to collect less-turbid samples (e.g., lowering the pump). The turbidity during FY 1997 ranged from 11 to 5 NTUs.

The groundwater in the vicinity of 216-S-10 Pond and Ditch contains aluminum and pH at levels above interim drinking water standards. Unfiltered chromium and iron have historically exceeded drinking water standards in several wells. These concentrations have been attributed to well construction and oxidizing conditions in the aquifer.

Historically, perched water has been discovered beneath the 216-S-9 Crib and the 216-S-10 Ditch. Well 299-W26-11 went dry in October 1991.

3.3 POTENTIAL IMPACTS TO HUMAN HEALTH AND THE ENVIRONMENT

This section presents and discusses the conceptual exposure model developed to identify potential impacts to human health and the environment from waste sites in the 200-CS-1 OU. Information pertaining to contaminant sources, release mechanisms, transport media, exposure routes, 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 in the RI and FS documents for the 200-CS-1 OU.

3.3.1 Contaminant Sources and Release Mechanisms

The primary sources of contamination at waste sites in this OU were major facilities (e.g., PUREX Plant, B Plant, and REDOX Facility) in the 200 East and 200 West Areas. Facilities in these areas routinely discharged low-level contaminated chemical sewer wastewater to unlined ponds and ditches where the wastewater infiltrated into the soil and where periodic unplanned releases occurred (e.g., wastewater leaks outside the ponds/ditches).

Releases to the environment from primary sources have resulted in secondary contaminant sources. The secondary sources include the contaminated soils and sediments beneath the stabilized waste sites and unplanned release sites in this OU. Secondary releases can occur through infiltration (continued movement of wastewater through the soil), resuspension of contaminated soil (erosion or mechanical disturbances), volatilization (movement of organic chemicals through the soil and into the air), biotic uptake (plant uptake or animal ingestion), leaching (contaminant release from rain or snowmelt exposure), and external radiation (gamma). The dominant mechanism of 200-CS-1 contaminant transport is from infiltration and leaching with rainwater or snowmelt as driving forces. Residual effluent contamination at the waste sites has the potential to impact groundwater.

3.3.2 Potential Receptors

Potential receptors (i.e., human and ecological) may be exposed to the affected media through several exposure pathways, including:

- ingestion of contaminated soils (including dust inhalation), sediments, or biota,
- dermal contact with contaminated soils or sediments, and
- direct exposure to external gamma radiation in site soils and sediments.

Potential human receptors include site workers (current and future) and site visitors (occasional users). Site worker and visitor exposure pathways would primarily involve incidental soil/sediment ingestion (including dust inhalation), dermal contact with contaminated soils/sediments, and external gamma radiation. Potential ecological receptors include terrestrial plants and animals using the sites. Site biota exposures would primarily involve incidental soil/sediment ingestion, biota ingestion (e.g., coyotes eating prey that live on the site or deer consuming plants growing on the site), dermal contact with contaminated soils/sediments, and external gamma radiation. The conceptual exposure model for the 200-CS-1 OU is shown in Figure 3-1.

3.3.3 Potential Impacts

Potential contaminant exposures and health impacts to humans are largely dependent on land use. The land use for the 200 Areas selected by DOE through the NEPA process (DOE 1999) and documented in a record of decision (64 FR 61615) is industrial (exclusive). Outside the 200 Areas boundary, the selected land use is conservation (limited mining and grazing by permit only). The 200-CS-1 sites, with the exception of the 200-S-10 Pond, are located within the 200 Areas boundary. Therefore, based on the land use decision for the 200 Areas, potential impacts from the waste site contaminants within the 200 Area would be to current and future site workers, and to terrestrial biota using the sites. At the 200-S-10 Pond, which is outside the 200 Area boundary, potential health impacts to occasional users (consistent with a conservation land use) could occur in addition to site workers (current and future) and terrestrial biota using the site.

3.4 DEVELOPMENT OF CONTAMINANTS OF CONCERN

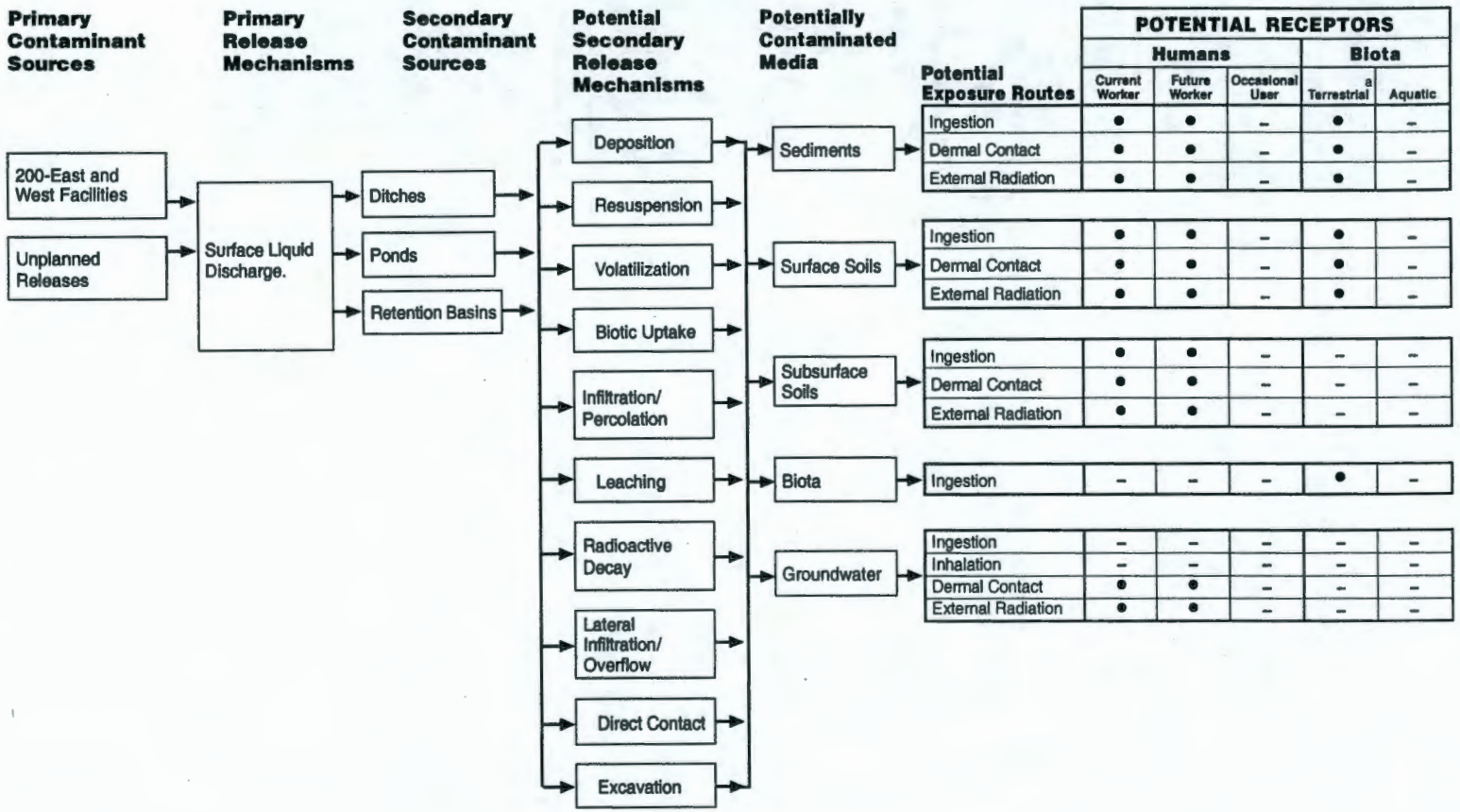
The development of a list of contaminants of potential concern (COPCs) and the refinement of the list of the potential contaminants of concern (COCs) were among the main objectives of the data quality objective (DQO) process for characterization of the 200-CS-1 OU representative sites and TSD units. 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 chemical sewer OU waste sites from the facilities discussed in Section 2.2. This master list of COPCs was evaluated against a set of exclusion criteria to develop a final potential COC list. Chemical characteristics such as toxicity, persistence, and chemical behavior in the environment were considered. The criteria for exclusion of certain constituents, as detailed in the DQO report (BHI 1999), are as follows:

- Short-lived radionuclides were excluded (half-lives of less than 3 years)

- Radionuclides that constitute less than 1% of the fission product inventory and for which historical sampling indicates nondetection
- Naturally occurring isotopes that were not created as a result of Hanford Site operations
- Constituents with an atomic mass greater than 242 that represent less than 1% of the actinide activities
- Progeny radionuclides that build insignificant activities within 50 years and/or for which a parent/progeny relationship exists that permit progeny estimation
- Chemicals that have no known carcinogenic or toxic effect (inert)
- Constituents that have been diluted, neutralized, and/or decomposed by the high volumes of water discharged and/or the presence of acids and bases
- Chemicals that are not persistent in the environment

The exclusion process resulted in a final list of the potential COCs for the 200-CS-1 OU, which is presented in Table 3-6. The preliminary list of COPCs and the excluded analytes and rationale for exclusion are presented in Table 1-6 of the DQO summary report (BHI 1999). Additional information regarding the potential COCs is presented in the DQO summary report and Section 4.0 of this work plan.

Figure 3-1. Conceptual Exposure Model for the 200-CS-1 Waste Sites.



a) The head-end of the 216-S-10 ditch has not been stabilized. There is a higher potential for terrestial plant and wildlife exposure to sediment and surface soil contaminate along this unstabilized segment.

Table 3-1. Inventory of Known and Suspected Contamination for Sites in the 200-CS-1 OU, and Effluent Volume Received – Radionuclides Decayed to January 1999 (from DOE-RL 1997).

Site	Site Name	Total U (kg)	Total Pu (g)	Am-241 (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	Effluent Volume (m^3)
216-A-29	216-A-29 Ditch	--	--	--	--	--	10,400,312
216-B-63	216-B-63 Trench	21.2	0.57	0.035	0.51	1.94	7,200,000
216-S-10	216-S-10 Ditch	199	0.10	0.015	1.00	0.86	4,340,000
216-S-10	216-S-10 Pond						4,120,000
216-S-11	216-S-11 Pond	208	0.31		0.67	0.65	2,230,000
216-W-LWC	200 West Area laundry waste crib	--	--	--	--	--	1,200,000
UPR-200-W-34	UPR-200-W-34	--	--	--	--	--	--

Table 3-2. Chemical Releases into the PUREX Plant Chemical Sewer Line from Mid-1983 to 1987 (modified from DOE-RL 1990). (2 pages)

Date	Chemical	Pounds	Waste Designation
May 20, 1983	Aluminum nitrate nonahydrate	17,725	None
October 17, 1983	Potassium permanganate Sodium carbonate	10,700 1,412	None
February 9, 1984	Potassium hydroxide	83,000	D002
February 26, 1984	Sodium hydroxide	3,700	D002, WT02
May 16, 1984	Cadmium nitrate	25 to 50	D006, WT01
June 6, 1984	Hydrazine Hydroxylamine nitrate	332 90	U133
August 22, 1984	Nitric acid	9,000	D002
October 2, 1984	Hydrazine Hydroxylamine nitrate	280 407	U133, WT02
November 1, 1984	Sulfuric acid	3,482	None
November 27, 1984	Nitric acid Ferrous sulfamate Sulfamic acid	349 43 68	None
December 2, 1984	Potassium hydroxide	150	D002
December 2, 1984	Potassium hydroxide	62,683	D002, WT02
January 10, 1985	Hydroxylamine nitrate Hydrazine Nitric acid	100 21 66	U133
January 18, 1985	Nitric acid	6,236	D002, WT02
February 8, 1985	Sodium nitrate	160	None
April 4, 1985	Ferrous sulfamate Nitric acid Sulfamic acid	52 269 132	None
May 14, 1985	Nitric acid Hydroxylamine nitrate Hydrazine	190 98 0.4	U133
May 27, 1985	Nitric acid	223	None
June 25, 1985	Nitric acid	24,189	D002, WT02

Table 3-2. Chemical Releases into the PUREX Plant Chemical Sewer Line from Mid-1983 to 1987 (modified from DOE-RL 1990). (2 pages)

Date	Chemical	Pounds	Waste Designation
July 1, 1985	Ammonium fluoride Ammonium nitrate	5,368 1,016	WT01
August 6, 1985	Sodium hydroxide	42,440	D002, WT02
October 28, 1985	Nitric acid	1,181	D002
December 18, 1985	Cadmium nitrate	35	D006, WT01
December 28, 1985	Aluminum nitrate nonahydrate	650 to 730	None
February 12, 1986	Nitric acid Sulfuric acid	42 276	D002
February 13, 1986	Sulfuric acid	77	D002
February 19, 1986	Sodium hydroxide	<100	D002, WT02
February 21, 1986	Sulfuric acid	<100	D002
March 24, 1986	Sulfuric acid	<100	D002
June 28, 1986	Sulfuric acid	121	D002
July 7, 1986	Hydrazine	6	U133
April 25, 1987	Sodium nitrite	1,275	None

Table 3-3. Results of Surface Water Sampling (pCi/L) for the 216-A-29 Ditch.

Radionuclide	1985		1986		1987		1988		1989		1990	
	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error
Total beta												
Maximum	8.8E-02		1.24E-01		2.7E-02		<1.00E+02		<1.00E+02		<4.0E+01	
Minimum	1.7E-02		<1E-01		<1E-01		<1.00E+02		<1.00E+02		<4.0E+01	
Average	4.9E-02											
SD	5.1E-02											
Total alpha												
Maximum	1.2E-02		<1.0E-02		1.1E-02		5E+00		<1.00E+02		1.04E+02	
Minimum	1E-03		<1E-01		<1E-01		<1.00E+02		<1.00E+02		<4.0E+01	
Average	3E-03											
SD	6E-03											
Cesium-137												
Maximum	5.8E-02		<9.0E-02		1.27E-01		<1.00E+02		6.2E+01		<4.0E+01	
Minimum	4.2E-02		<1E-01		1E-01		<1.00E+02		<1.00E+02		<4.0E+01	
Average	4.7E-02											
SD	9E-03											
Strontium-90												
Maximum	4.0E-02		<8.3E-02		<3.0E-02		<1.00E+02		<4.0E+01			
Minimum	1.5E-02		<1E-01		<1E-01		<1.00E+02		<4.0E+01			
Average	2.7E-02											
SD	1.7E-02											

SD = standard deviation.

Table 3-4. Results of Surface Water Sampling (pCi/mL) for the 216-S-10D Ditch[a].

Radionuclide	1985		1986		1990		Detection Limit (DL)
	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	
Total beta	0.106	0.008	0.036	<DL	<DL	<DL	0.1
Total alpha	0.007	0.001	0.012	<DL	<DL	<DL	0.04
Cs-137	0.121	0.043	0.127	<DL	<DL	<DL	0.2
Sr-90r	0.030	0.020	0.040	<DL	<DL	<DL	0.1

[a] Sources: Elder et al. 1986, 1987, 1989; Schmidt et al. 1992.

Table 3-5. Nonradiological Parameters for Water in the 216-S-10 Ditch[a].

Year	Sample Number	Maximum pH	Minimum pH	Average pH	Maximum NO_3 ppm	Minimum NO_3 ppm	Average NO_3 ppm
1986	RM 28	8.6	7.1	7.9	<DL	<DL	<DL
1988	RM 28	9.6	7.0	7.8	<DL	<DL	<DL
1990	RM 28	9.21	7.56	8.15	<DL	<DL	<DL

Note: pH maximum and minimum are from weekly samples.
[a] Sources: Elder et al. 1987, 1989; Schmidt et al. 1992.
<DL = less than detection limit (1.2 parts per million).

Table 3-6. List of Potential Contaminants of Concern at the 200-CS-1 Operable Unit. (2 pages)

Radioactive Constituents	
Americium-241	Plutonium-238
Cesium-137	Plutonium-239/240
Cobalt-60	Radium-228
Europium-152	Strontium-90
Europium-154	Technetium-99[a]
Europium-155	Tritium[a]
Gross alpha	Thorium-232
Gross beta	Uranium-233/234[b]
Neptunium-237	Uranium-235/236[b]
Nickel-63[a]	Uranium-238[b]
Chemical Constituents – Metals	
Arsenic	Lead
Barium	Mercury
Beryllium	Nickel
Cadmium	Selenium
Chromium	Silver
Hexavalent chromium	Vanadium
Copper	Zinc
Chemical Constituents - Other Inorganics	
Ammonia	Phosphate
Chloride	Sulfate
Cyanide	Sulfide
Fluoride	Thiocyanate
Nitrate/nitrite	pH
Chemical Constituents - Volatile Organics	
Acetone	Halogenated hydrocarbons
1-butanol (butyl alcohol)	Methyl isobutyl ketone (MIBK)
2-butanone (MEK)	Propanol (isopropyl alcohol)
Carbon tetrachloride	Toluene
Chloroform (trichloromethane)	1,1,1 trichloroethane
Decane	1,1,2 trichloroethane
Dichloromethane (methylene chloride)	Xylene
Ethanol	
Semi-Volatile Organics	
Diesel fuel[c]	Polychlorinated biphenyls
Kerosene[c]	Shell E-2342 (napthalene and paraffin)[c]
Normal paraffin hydrocarbon[c]	Soltrol-170 ($C_{10}H_{22}$ to C_6H_{34}; purified kerosene)[c]
Paraffin hydrocarbons[c]	Tributyl phosphate

[a]These contaminants of potential concern (COPCs) are deep-zone sensitive only. No analyses are required for these COPCs in the shallow zone soils, as they are soft beta emitters in low abundance that have insignificant dose impact in the shallow zone.
[b]Uranium will be analyzed for total abundance in all samples; any samples with values significantly above background levels will be analyzed for these individual species.
[c]Analyzed as kerosene total petroleum hydrocarbons.

4.0 WORK PLAN APPROACH AND RATIONALE

4.1 SUMMARY OF DATA QUALITY OBJECTIVE PROCESS

The remedial investigation needs for the 200-CS-1 OU were developed in accordance with the DQO process (EPA 1993; BHI-EE-01, *Environmental Investigations Procedures*, Procedure 1.2, "Data Quality Objectives"). The DQO process is a seven-step planning approach that is 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 contaminant distribution model and to support remediation decisions.

The DQO process was implemented by a team of subject matter experts and key decision makers. Subject matter experts provided input on regulatory issues, the physical condition of the sites, and sampling and analysis methods. Key decision makers from DOE, EPA, and Ecology participated in the process and approved the characterization approach outlined in the DQO summary report (BHI 1999). 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 informational needs of the 200-CS-1 OU remedial investigation. Results of the DQO process for characterization of the representative sites and TSD units in the 200-CS-1 OU are presented in a DQO process summary report (BHI 1999).

4.1.1 Data Uses

Data generated during characterization of the representative sites and TSD units will consist mainly of soil contaminant data. The soil contaminant data will be used to define the nature and extent of radiological and chemical contamination; to support an evaluation of risks; and to assist in the evaluation, selection, and design of a remedial alternative. By defining the type and distribution of contamination, the site-specific conceptual model for contaminant distribution can be verified or rejected. Verification of the current model will direct the application of the analogous unit concept at 200-CS-1 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 (e.g., RESidual RADioactivity dose model [RESRAD] or other risk modeling, as required). Contaminant and soil property data will be obtained by sampling and analyzing soils at the four TSD sites, two of which are representative.

Borehole sampling at the 216-S-10 Pond will be integrated with the installation of a downgradient RCRA interim status groundwater monitoring well. Because this well will be located as close to the edge and influence of the waste site as possible, it will be representative of contamination found in deep soils and to groundwater. However, because it is not located in the pond proper, a test pit will be located at the pond influence in order to obtain shallow samples.

4.1.2 Data Needs

A considerable amount of background and historical information have been presented in Sections 2.0 and 3.0 regarding 200-CS-1 OU waste sites. Some of this information will be used to develop a site-specific conceptual model for the waste sites, and additional information is provided by reference. For most waste sites, information is available regarding location, design, major types of waste disposed, and radiological contaminants associated with the bottom of waste sites. However, the data needed to refine the site conceptual contaminant distribution model and to support remedial decision making are limited. As defined by the DQO process, the focus of the 200-CS-1 RI is to determine the nature and extent of contamination in the vadose zone. Specifically, determinations of the type, concentration (especially highest concentration), and vertical and lateral extent of radiological and chemical contaminants in the vadose zone are the major data needs. Data are also required to determine the physical properties of soils, which will provide additional input to support an evaluation of risk through the use of models for groundwater transport, direct exposure to radionuclides, etc.

4.1.3 Data Quality

Data quality was addressed during the DQO session by identifying potential COCs and establishing associated analytical performance criteria. The process of identifying potential COCs is summarized in Section 3.4. Analytical performance criteria were established by evaluating potential ARARs and preliminary remediation goals (PRGs), which are regulatory thresholds/standards or derived risk-based thresholds. These potential ARARs and PRGs represent chemical-, location-, and action-specific requirements that are protective of human health and the environment. Regulatory thresholds/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 using established specific policies and procedures for generating analytical data and field quality assurance/quality control requirements. These requirements are discussed in detail in the SAP (Appendix B). Analytical performance requirements are specified in Tables 3-7a and 3-7b of the DQO summary report (BHI 1999). Table 3-7a contains analytical requirements for shallow soils collected up to 4.6 m (0 to 15 ft) below ground surface (bgs), and Table 3-7b provides the analytical requirements for deeper soils (BHI 1999). The potential ARARs and PRGs for 200 Area waste sites are discussed in Sections 4.0 and 5.0 of the Implementation Plan (DOE-RL 1999).

4.1.4 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. Bias in 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. Biased sampling is the preferred sampling approach for the RI phase, as defined in Step 6 of the

DQO process summary report (BHI 1999) and Section 6.2.2 of the Implementation Plan (DOE-RL 1999). Using this approach, sampling locations can be selected that increase the chance of encountering the highest contamination in the local soil column.

Sample locations at representative sites and TSD units were selected based on the preliminary conceptual contaminant distribution model presented in the DQO summary report and applied to site-specific representative and TSD units in Section 2.4 of this work plan. Fourteen locations in the four waste sites were selected for sampling. The locations were selected with the goal of intersecting the highest area of contamination and determining the vertical and lateral extent of contamination within the historical boundary of the waste sites. From 20 to 34 samples will be collected from different depths at each of the sites to evaluate the extent of contamination. Additional 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 work.

4.2 CHARACTERIZATION APPROACH

This section provides an overview of characterization activities that are planned to collect the required data identified during the DQO process. These activities include drilling boreholes and excavating test pits (or auger boreholes) to collect and analyze soil samples. The sampling strategy is designed to provide access to potentially contaminated subsurface areas. Sample collection shall be guided by field screening efforts and a sampling scheme that identifies critical sampling depths.

The sample intervals are designed to support the remedial decision process and verify the conceptual site models. The tight sampling intervals at the 0- to 3.1-m (0- to 10-ft) below the pond/ditch sediment layer are intended to show that the highest concentrations of contaminants are historically sorbed or filtered on the bottom of the ponds and ditches, and significantly decrease with depth within this zone. The 4.6- and 7.6-m (15- to 25-ft) samples are intended to contain moderate concentrations of moderately mobile contaminants, while the deeper samples at 7.6-m to 15.2-m (25- to 50-ft) intervals are intended to contain low concentrations of mobile contaminants which also decrease with depth.

The historical high water table sample are intended to be representative of the deep contaminants originating from the waste site of interest, which have been isolated from other possible contaminant sources via groundwater transport. The sample above the water table is intended to represent deep contaminants in the vadose zone that could potentially impact groundwater. The sample intervals are also significant at the 4.6- and 7.6-m (15- and 25-ft) depth in order to define contamination profiles for remedial designs. For excavation and disposal sites, the decision-making depth is 4.6 m (15 ft), as directed by MTCA direct exposure requirements. For containment sites, models show that RCRA surface barriers become more cost effective than excavation in the 4.6- to 6.1-m (15- to 20-ft) depth range

4.2.1 Drilling and Sampling

The 216-A-29 borehole will be drilled and sampled to groundwater at a location near the inlet to 216-A-29 Ditch (Figure 4-1). The 216-S-10 Pond will be drilled and sampled to groundwater as close to the edge of the waste site as possible in order to integrate this sampling effort with the installation of a downgradient RCRA interim status groundwater monitoring well (Figure 4-2). The 216-S-10 Pond borehole will be installed prior to public review and final regulatory approval of this work plan. The drilling of this borehole is scheduled to begin in mid-November 1999. One borehole will be drilled and sampled to 30.5 m (100 ft) at 216-B-63 Trench (Figure 4-3). This borehole will not be drilled to the groundwater because sufficient information on deep zone soils is available through adjacent 216-B-2-2 borehole information obtained from the 1998 borehole summary report for this unit (BHI 1998a). The borehole for the 216-S-10 Ditch will be located at the beginning of the stabilized portion at the head end of the ditch (Figure 4-2) due to access concerns. These locations were chosen because the inlet areas (or as near the inlet as possible) are located where the highest levels of contamination are generally expected to exist. Therefore, the deep sediments that will be collected should provide a worst-case scenario for maximum contamination levels at depth.

The sample collection strategy has been designed to thoroughly characterize the unit sediments and the vadose zone materials beneath to the top of the groundwater table. Sampling will generally begin at the first sign of radiological contamination, as determined by field measurements. This contamination is expected to begin at the historic bottom of the unit (i.e., pond, ditch, and trench sediments), but if contamination is detected in backfill materials above the unit bottom, the backfill materials will also be sampled. Other than 216-S-10 Pond borehole that will begin at 15.3 m (50 ft) bgs, borehole samples will typically be collected at 0.76-m (2.5-ft) intervals for the first 3 m (10 ft) from the bottom of the unit, then at 1.5-m (5-ft) intervals to 7.6 m (25 ft) bgs, then at 15.3-m (50-ft) intervals to groundwater or, in the case of the 216-B-63 Trench, to 30.5 m (100 ft) bgs. Samples that were identified as critical during the DQO process will be collected at the sediment layer and at 4.6 m (15 ft) bgs. A 7.6-m (25-ft) bgs sample will also be identified as critical at 216-B-63 Trench and 216-S-10 Pond. The 7.6-m (25-ft) bgs depth is considered critical for determining the cost effectiveness of placing a barrier over a waste unit versus the excavation of contaminants. Containment was not considered cost effective for planning purposes at the 216-A-29 Ditch and 216-S-10 Ditch due to the long, narrow shapes of the ditches; therefore, the 7.6-m (25-ft) bgs depth will not be considered critical at these units.

In addition, one sample will be collected at the historic high groundwater table at the three boreholes that will be constructed to groundwater: 216-A-29 Ditch, 216-S-10 Pond, and 216- S-10 Ditch. These samples will be used to determine if residual contamination remains in the soil column that is attributable to past operation of liquid disposal units in the 200 Areas.

A sample will not be taken specifically below 3.1 m (10 ft) from the bottom of the unit (i.e., 4.6 m, 6.1 m, or 7.6 m [15 ft, 20 ft, or 25 ft] bgs) if this point falls within an already assigned 0.76-m (2.5-ft) interval sample or within 0.6 m (2 ft) of a sample. Additional samples may be collected at the discretion of the geologist/sampler based on field screening and geologic

information (e.g., changes in lithology). A detailed sample schedule for each borehole is presented in the SAP (Appendix B).

All drilling will be via a procedure approved by Bechtel Hanford, Inc. (BHI), and will conform to site-specific technical specifications for environmental drilling services. The drill rig generally will require a 23-m (75-ft)-square pad with a 5-m (16-ft)-wide access road leading to the drill rig. Cleaning and decontamination requirements will also be performed by BHI-approved procedures.

Likely drilling methods for this project include cable tool, sonic, and Becker hammer. The Becker hammer is a dual-string, reverse-air, circulation drilling method. The potential impacts of this drilling method include degraded sample quality and increased contaminant release potential. Because of the introduction of air to the sample media, affects on analytical results for volatile organics and increased potential for dust result from this technique. The drilling method must allow the use of a 13-cm (5-in.) outside-diameter split-spoon sampler. Use of a split-spoon sampler will necessitate composting the sample over at least 0.3 m (1 ft) to obtain enough sample for analysis. The drilling method must not use any system that circulates air or water. If a drilling method, other than cable tool drilling will be used, Ecology will be notified.

Three of four boreholes will be drilled to the top of the water table. The maximum total depth of the investigation below ground surface is approximately as follows: 216-A-29 Ditch will be 73 m (240 ft), 216-B-63 Trench will be 30.5 m (100 ft), 216-S-10 Ditch will be 70 m (230 ft), and 216-S-10 Pond will be 64 m (210 ft). In the boreholes to the groundwater, the presence of water-saturated soils will indicate the end of the borehole and will be determined by the site geologist. Up to three strings of casing may be telescoped to the proposed depth to minimize the transport of contaminants in the vadose zone from the drilling operations. The casing sizes will be of sufficient size to accommodate a split-spoon sampler to the bottom of the borehole. Downsizing of the casing will be commensurate with the expected decrease in contamination levels with depth. Actual conditions during drilling may warrant changes; the changes may be implemented after consultation with and the approval of the task lead and the subcontract technical representative. All casings will be removed from boreholes when drilling and sampling are completed. If required to support Hanford Site groundwater monitoring needs, boreholes may be completed as wells. Otherwise, the borehole shall be backfilled with bentonite or an appropriate alternative abandonment procedure in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells."

4.2.2 Test Pit Excavation/Auger Drilling and Sampling

Ten test pits and/or shallow auger borings shall be excavated and sampled at the representative sites and TSD units. The locations of these excavations are shown in Figures 4-1 through 4-3. Test pits will likely be used for excavating and sampling; however, a hollow-stem auger may be used as an alternative if it is determined to be more cost effective. The excavations will be used to determine vertical and lateral extent of contamination within the area historically defined as the waste site boundary.

If sampling from a test pit, the samples shall be collected at the bottom of the unit (either at the bottom of the pond, trench, or ditch), or upon the first detection of radiological contamination above background levels, whichever is encountered first. The sampling shall be at 0.75-m (2.5-ft) intervals to 3 m (10 ft), then at 1.5-m (5-ft) intervals to 4.6 m (15 ft) bgs at the 216-A-29 Ditch and 216-S-10 Ditch, and to 7.6 m (25 ft) bgs at 216-B-63 Trench and 216-S-10 Pond. Additional samples may be collected at the discretion of the geologist/sampler based on field screening information, and critical samples will be collected at 4.6 and 7.6 m (15 and 25 ft) bgs. A sample will not be taken specifically below 3 m (10 ft) from the bottom of the unit (i.e., 4.6 m, 6.1 m, or 7.6 m [15 ft, 20 ft, or 25 ft]) if this point falls within an already assigned 0.75 m (2.5 ft) below unit sediment interval sample or within 0.6 m (2 ft) of a sample. If contamination is observed during the excavation process via field screening equipment at the maximum sampling depth, an additional deeper sample will be attempted (depending on the limitations of the excavation equipment) for further resolution of the vertical contamination concentration profile. A detailed sample schedule for each test pit/auger borehole is presented in the SAP (Appendix B). Chemical and radiological analyses will be composite samples. Physical property testing will be performed on discreet samples.

Test pits will be excavated and sampled with an excavator, which will be large enough to collect samples from the maximum target depth of 7.6 m (25 ft). The samples shall be collected directly from the excavator bucket and handled in accordance with BHI-EE-01, *Environmental Investigations Procedures*.

Samples collected from hollow-stem augers will require use of a large-diameter split-spoon sampler, which necessitates compositing the sample through at least 0.3 m (1 ft) to obtain adequate sample size for analysis. In this case, samples will be collected at the intervals for drilling to 4.6 m (15 ft) bgs or 7.6 m (25 ft) bgs, as described above. As with test pits, critical samples will be collected at 4.6 and 7.6 m (15 and 25 ft) bgs; additional samples may be collected at the discretion of the geologist/sampler based on field screening information.

4.2.3 Field Screening

All samples and/or cuttings from the boreholes and test pits will be field screened for evidence of radionuclides by the radiological control technician. Radioactivity screening of the soils will assist in selecting the sample intervals. Field screening instrumentation will be maintained consistent with the manufacturer's specifications and other approved procedures. The site geologist will record all field screening results in the borehole log. Field screening methodology and instrumentation is described in detail in the SAP (Appendix B).

4.2.4 Analysis of Soil

Samples shall be collected for chemical and radionuclide analysis and to determine the physical properties of the soil. 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 waste sites. Development of this list of potential COCs is presented in Section 3.4 and Table 3-6. Tables B2-1 and B2-2 of the SAP list detailed descriptions of analytical methods, holding times, and quality assurance and quality control procedures for each

contaminant (Appendix B). A limited number of samples will also be analyzed to determine soil physical properties such as moisture content and particle size. All samples will be collected and controlled in accordance with BHI-EE-01, Procedure 4.0, "Soil and Sediment Sampling." A detailed sample schedule for all boreholes and test pits is included in the SAP (Appendix B).

4.3 GEOPHYSICAL LOGGING

The four boreholes (described in Section 4.2.1) will be logged with a high-resolution spectral gamma-ray logging (SGL) system to provide continuous vertical logs of gamma-emitting radionuclides and with a neutron moisture-logging system to identify moisture changes. In addition to the logging performed on the new borings, SGL is proposed in two existing wells near the 216-S-10 Pond and Ditch (wells 299-W26-6 and 699-32-77). The SGL of existing wells in the vicinity of a waste site can be a cost-effective method of providing supplemental data on the vertical and lateral distribution of gamma-emitting radionuclides, provided that the wells are located sufficiently close to the waste site and are appropriately constructed (e.g., single well casing in contact with the formation). Following an evaluation of the locations and designs of existing wells, wells 299-W26-6 and 699-32-77 were identified as suitable for logging. Other wells at the 216-S-10 Pond and Ditch, 216-B-63 Trench, and 216-A-29 Ditch are not suitable for logging because they have annular seals.

The SGL system uses standard laboratory high-purity germanium (HPGe) detector instrumentation to identify and quantify gamma-emitting radionuclides in wells as a function of depth. The HPGe detector is calibrated to National Institute of Standards and Testing requirements and includes corrections for environmental conditions that deviate from the standard calibration condition. The HPGe detector has been used to locate, identify, and monitor the distribution and movement of contaminants in more than 600 boreholes at the Hanford Site. The precision of this detector is such that movement of mobile constituents in the subsurface can be identified to as little as 0.07 m (0.25 ft) at depths of up to 167.6 m (550 ft). The detector requires constant cooling with liquid nitrogen and was designed to operate completely submerged in water. Venting of the nitrogen gas to the surface is accomplished with a specially designed logging cable.

The neutron moisture-logging system that measures moisture employs a weak radioactive americium-beryllium neutron source and neutron detector to provide a direct reading of hydrogen atom distribution in the soil surrounding the borehole. This detector will be used to measure continuous vertical moisture in the vadose zone.

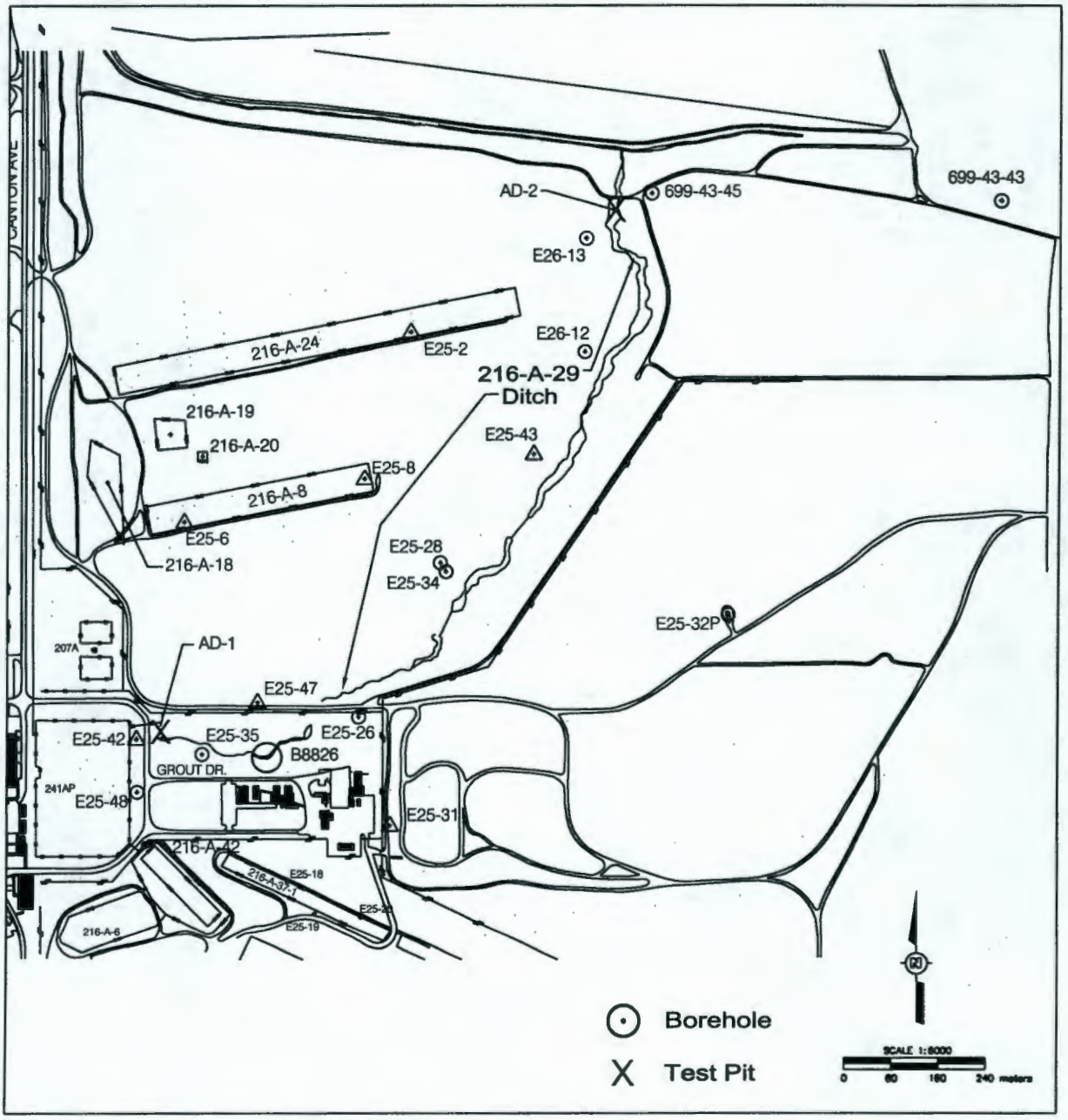
The SGL logs will be used to supplement the laboratory radionuclide data to determine the vertical distribution of radionuclides in the vadose zone beneath the units and aid in geological interpretation of subsurface stratigraphy. The deep boreholes will be logged through the casing prior to the addition of a new casing string and after the well has reached total depth. SGL equipment calibration is conducted annually, and the data acquired during the calibrations is used to derive factors that convert measured peak area count rate to radionuclide concentrations in pCi/g. Casing corrections are applied to the data to compensate for the gamma-ray attenuation by the casing.

Existing wells in the vicinity of representative sites and TSD units may be logged with the gamma-ray-logging tool. Logging will only be required in existing wells that have one casing string and lack annular seals. A list of wells to be logged is identified in the SAP (Appendix B).

All geophysical logging will be in accordance with Waste Management Northwest's procedure WMNW-CM-004, Section 17 ("Geophysical Logging"), and WMNW-CM-004, Section 18 ("Geophysical Logging Analysis") (WMNW 1998). Applicable detection limits, analytical methods, and accuracy and precision requirements are defined in the documents governing borehole logging. The site geologist will record the types of geophysical surveys and the depth intervals of initial and repeat runs in the Well Construction Summary Report form.

Logging runs will be made prior to changing casing sizes and at the total depth of the borehole. The downhole tools and cable will be subject to the same rules as the drill rig and equipment. The downhole tools and cable will be cleaned between boreholes. The upper part of each borehole will be the most contaminated and will be logged first.

Figure 4-1. Approximate Location of Test Pits and Borehole at 216-A-29 Ditch.



G:\Maps\042999K.DWG

Figure 4-2. Approximate Locations of Test Pits and Boreholes at 216-S-10 Ditch and Pond.

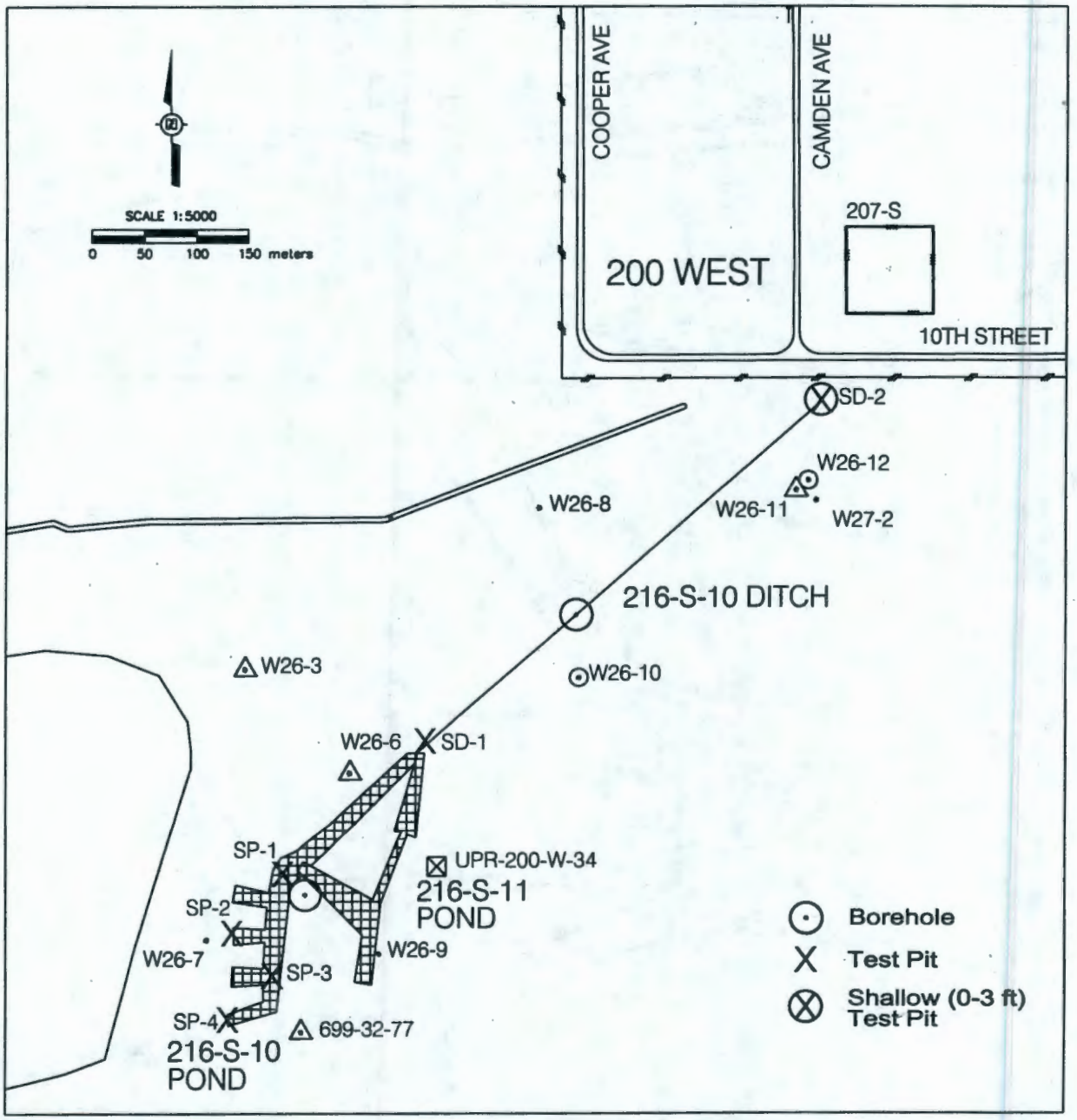


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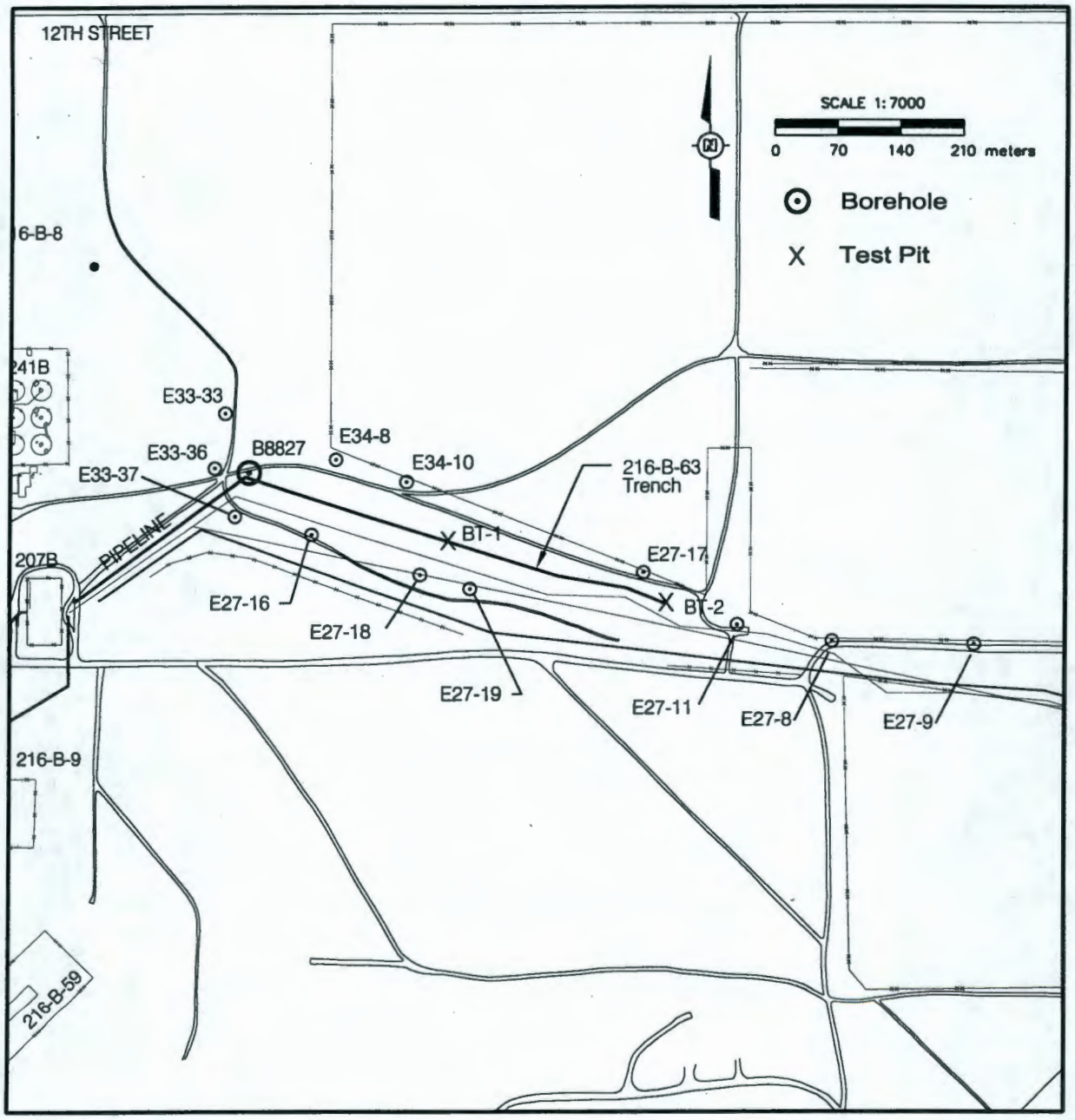
Figure 4-3. Approximate Locations of Test Pits and Boreholes at 216-B-63 Trench.



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5.0 REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROCESS

This section describes the RI/FS (assessment) process for the 200-CS-1 OU. The development of and rationale for this process are provided in the Implementation Plan (DOE-RL 1999) and are summarized in Figure 1-1. The process follows the CERCLA format with modifications to concurrently satisfy the requirements specific to RPP waste sites and RCRA TSD units undergoing closure. A summary of the integrated 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 Section 4.0), document the results of the RI, and manage the waste generated during field activities. The general purpose of the RI is to characterize the nature, extent, concentration, and potential transport of contaminants and to 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 B) and a waste control plan.

Tasks to be completed following the RI include a FS with a RCRA TSD unit closure plan (Section 5.3), and a proposed plan and proposed RCRA permit modification for RCRA TSD units, followed by a ROD and RCRA permit modification for RCRA TSD units (Section 5.4).

Project management occurs throughout the RI/FS process. Project management is used to direct and document project activities (so the objectives of the work plan are met) and to ensure 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 1999). 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 1999) provides the overall quality assurance framework that was used to prepare an OU-specific quality assurance project plan for the 200-CS-1 RI (Appendix A, Section A2.0). Appendix C of the Implementation Plan reviews data management activities that are applicable to the 200-CS-1 OU RI/FS and describes the process for the collection/control of data, records, documents, correspondence, and other information associated with OU activities.

5.1 INTEGRATED REGULATORY PROCESS

The RCRA closure and corrective action authorities have clear jurisdiction over waste with chemical constituents (in particular, dangerous waste and dangerous waste constituents), and mixed wastes (i.e., mixtures of dangerous waste and radiological contaminants), but not jurisdiction over waste with radiological contaminants only. By applying CERCLA authority concurrently with RCRA closure and corrective action requirements through integration, cleanup

will be addressing all regulatory and environmental obligations at this OU as effectively and efficiently as possible. Also, by applying CERCLA authority jointly with that of RCRA, additional options for disposal of closure, corrective action, and remedial action wastes at the Environmental Restoration Disposal Facility are possible. By allowing flexibility in final disposal options, DOE, Ecology, and EPA intend to minimize disposal costs as much as possible while remaining fully protective of human health and the environment.

The integrated process for characterization of the 200-CS-1 OU uses this RI/FS work plan in combination with the Implementation Plan (DOE-RL 1999) to satisfy the requirements for both an RI/FS work plan and a RCRA facility investigation/corrective measures study (RFI/CMS) 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. This work plan also provides RCRA TSD unit closure plan information on facility description, location, and process information (Sections 2.1 and 2.2), waste characteristics (Section 3.1), and groundwater monitoring (Section 3.2). Following the completion of the work plan, a RI will be performed that will satisfy the requirements for a RFI and will provide the data needed to support the selection of a closure strategy for RCRA TSD units. The RI will be limited to the concurrent investigation of representative waste sites and RCRA TSD units undergoing closure. A report summarizing the results of the RI will then be prepared that will satisfy the requirements for a RFI report. The report will also contain the characterization information required in a RCRA TSD unit closure plan.

After the RI is complete, remedial alternatives/closure strategies will be developed and evaluated against performance standards and evaluation criteria. The integration process for the evaluation of remedial alternatives includes the preparation of a FS/closure plan that will satisfy the requirements for a CMS report and RCRA TSD unit closure plans. Both documents are required to include identification and development of corrective measure/remedial alternatives and an evaluation of those alternatives. The CMS generally also includes a recommended alternative, which is typically the purpose of the proposed plan under CERCLA. The FS will include a section that provides corrective action recommendations for RPPs. The closure plans will address the RCRA TSD unit in the OU and will be included in the FS as an appendix.

The RCRA closure options (i.e., landfill, modified, and clean closure as defined in Condition II.K. of the Hanford Facility RCRA Permit) will be determined based upon the alternative selected and the amount of cleanup that can be attained by the alternative. Landfill closure under RCRA will include the construction of an engineered barrier over the unit and equates to what is typically termed as a "containment alternative" under CERCLA. A modified closure option includes alternatives that leave contaminants in place above MTCA Method B cleanup standards in soil, debris, or groundwater. A clean closure option requires that all contaminated material and media be removed and decontaminated to levels below MTCA Method B.

The decision-making process for the 200-CS-1 OU will be based on the use of a proposed plan, ROD, and Hanford Facility RCRA Permit modification. Based on the FS/closure plan, a proposed plan will be prepared that identifies the preferred remedial alternative for waste sites within the OU. The proposed plan will include a draft permit modification with unit-specific

permit conditions for RPP waste sites and the RCRA TSD units within the OU for incorporation into the Hanford Facility RCRA Permit. The CERCLA ROD will document the RCRA TSD unit closure and RCRA corrective action decisions for these units. The lead regulatory agency (Ecology) will prepare the CERCLA ROD following completion of the public involvement process for the proposed plan, which, after signature by the Tri-Parties, will authorize the selected remedial action. The remedy selected under CERCLA will be incorporated into the Hanford Facility RCRA Permit as the RCRA closure/corrective action after issuance of the public notice and the comment process.

The technical and procedural elements of RCRA and CERCLA are each addressed in full in this process. The CERCLA public involvement, including public notice and opportunity to comment, will be enhanced, as necessary, to concurrently satisfy the public involvement requirements for the RCRA closure and RPP processes. The public will be given an opportunity to review and comment on the CMS, closure plans (which are appended to the CMS), and the proposed permit conditions that will be contained in the proposed plan. The proposed plan with a draft permit modification will be issued for a minimum 45-day public review and comment period. Supporting documents, including the FS/closure plan, will also be made available to the public for review at this time. A combined public meeting/public hearing may be held during the comment period to provide information on the proposed action and permit modification and to solicit public comment.

5.2 REMEDIAL INVESTIGATION ACTIVITIES

This section summarizes the planned tasks that will be performed during the RI phase for the 200-CS-1 OU, including the following:

- Planning
- Field investigation
- Management of investigation-derived waste (IDW)
- Laboratory analysis and data validation
- Remedial investigation report.

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

5.2.1 Planning

The planning subtask includes activities and documentation that need to be completed before field activities can begin. These include the preparation of an activity hazard analysis and site-specific health and safety plan (HASP), radiation work permits, excavation permits and supporting surveys (e.g., cultural, radiological, wildlife, and utilities), work instructions, personnel training, and the procurement of materials and services (e.g., drilling and geophysical logging services). In addition, borehole and test pit locations identified in Figures 4-1 through 4-3 will be located using a global positioning satellite system.

Appendix B of the Implementation Plan (DOE-RL 1999) provides a general HASP that outlines health and safety requirements for RI activities. Site-specific HASPs will be prepared for test pit excavation and drilling following the requirements of the general HASP. Initial surface radiological surveys will be performed to document any radiological surface contamination and the 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 is detailed in the SAP (Appendix B). The scope includes soil/sediment sampling and analysis to characterize the vadose zone at the two representative TSD waste sites (216-A-29 Ditch and 216-S-10 Ditch) and the other RCRA TSD units (216-B-63 Trench and 216-S-10 Pond). Major subtasks associated with the field investigation include the following:

- Test pit excavation and sampling
- Borehole drilling and sampling and associated geophysical logging
- Preparation of field reports.

5.2.2.1 Test Pit Excavation and Sampling. This subtask involves the excavation of test pits for the purpose of collecting soil and sediment samples and characterizing the geology of the upper vadose zone. Samples will be collected from 10 test pits to a maximum depth of 7.6 m (25 ft) using an excavator. Samples will be collected from the bucket of the excavator and will be packaged for shipment to an offsite laboratory. At the completion of sampling, the test pit will be backfilled and initial site conditions will be re-established. Alternatively, a hollow-stem auger drill (using split-spoon sampling) may be used instead of test pits if this technique is found to be more cost effective. Other activities include work zone setup, mobilization/demobilization of equipment, equipment decontamination, and field analyses. Planned field analyses include radiological field screening and pH.

In addition to the soil sampled for laboratory analyses, all sample material and excavated soil will be analyzed in the field using field screening techniques for radionuclides to provide additional characterization data, to assist in the selection of sample intervals (e.g., hot spots), to control the work (e.g., separation of contaminated and clean spoil), and to ensure the health and safety of workers.

5.2.2.2 Borehole Drilling and Sampling. This subtask involves drilling boreholes for the purpose of collecting soil and sediment samples and creating a geophysical log of the borehole. Three boreholes are planned to collect samples at a depth to the top of the groundwater table of the 216-A-29 Ditch, 216-S-10 Ditch, and 216-S-10 Pond. One borehole is planned to collect samples to 30.5 m (100 ft) at the 216-B-63 Trench. Samples will be collected with split-spoon samplers and packaged for shipment to an offsite laboratory. At the completion of sampling, the boreholes will be abandoned and initial site conditions will be re-established. Alternatively, the borehole may be completed as a groundwater monitoring well, if needed by the Hanford Site groundwater monitoring program. Other activities include work zone setup,

mobilization/demobilization of equipment, equipment decontamination, and field analyses. Planned field analyses include radiological field screening, pH, bulk density, and geophysical logging.

All samples and drill cuttings will be field screened (i.e., additional field screening analyses) for radionuclides to provide additional characterization data, to assist in the selection of sample intervals (e.g., hot spots), to assist in establishing radiation control measures, and for worker health and safety. Monitoring of volatile organic compounds may be also performed at the borehole casing for worker health and safety.

Geophysical logging will be used to gather in situ radiological, water saturation, and physical data from boreholes and from several existing wells. Spectral gamma-ray logging will be performed on planned boreholes and is proposed at two existing wells near 216-S-10 Pond and Ditch (299-W26-6 and 699-32-77) to assess the distribution and type of gamma-emitting radionuclides, and neutron logging will be performed for saturation distribution over the borehole or well interval.

5.2.2.3 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. The report will include survey data for test pit and borehole locations, the number and types of samples collected and associated Hanford Environmental Information System database numbers, inventory of IDW waste containers, geological logs, field screening results, and geophysical logging results.

5.2.3 Management of Investigation-Derived Waste

Waste generated during the RI will be managed in accordance with a waste control plan. Appendix E of the Implementation Plan (DOE-RL 1999) provides general waste management processes and requirements for the IDW and forms the basis for activity-specific waste control plans. A waste control plan will be prepared that addresses the handling, storage, and disposal of IDW generated during the RI phase. Furthermore, the plan identifies governing Environmental Restoration Contractor (ERC) procedures and discusses the 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.

5.2.4 Laboratory Analysis and Data Validation

Soil and sediment samples collected via test pits and boreholes 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 (Appendix B). The list of analytes, methods, and associated target detection limits are provided in Tables B2-1 and B2-2 of the SAP (Appendix B). This task includes the laboratory analysis of samples, the compilation of laboratory results in 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 a RI report. The primary activities include 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 the RI report preparation task.

5.2.5.1 Data Quality Assessment. A DQA will be performed on the analytical data to determine if the data are the right type, quality, and quantity to support the intended use. The DQA completes the data life cycle of planning, implementation, and assessment that began with the DQO process. For this task, the data will be examined to determine if they meet the analytical quality criteria outlined in the DQO and to determine if the data are adequate to evaluate the decision rules in the DQO.

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 the test pits and boreholes 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 each test pit and borehole.

- Stratifying the data and computing basic statistical parameters such as mean and standard deviation for individual levels. This will provide an indication of lateral and vertical contaminant distribution.

- Constructing contour diagrams and variograms to evaluate spatial correlations within each stratum, which will indicate if contamination is concentrated in a particular area (e.g., near the influent end for the units, or at the head end of the ditches).

- Performing analyses on the data to evaluate the presence or absence of contamination. There are many facets to this step, including determining data distribution 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 (e.g., MTCA tests) or more complex comparisons such as nonparametric hypothesis tests (e.g., Wilcoxon Rank Sum Test). These tests may also compare the data to appropriate cleanup levels.

All of these statistical evaluations will aid in refining the conceptual model for this OU and selecting the remedial alternative.

Data on the soil physical properties will be used to determine the sediment type, which will assist in choosing the proper unsaturated hydraulic conductivity/moisture retention curve. Knowing

the soil type and soil moisture will allow the determination of unsaturated hydraulic conductivity, which will be used in modeling flow and transport (see Section 5.2.5.3).

The chemical, physical, and geophysical data will be used for correlating subsurface data, for further refinement of the conceptual model, and as input to a QRA.

5.2.5.3 Qualitative Risk Assessment. For the 200-CS-1 OU, a QRA will be prepared to evaluate risk to human receptors from potential exposure to contaminants in accessible surface sediments and shallow subsurface soils. The QRA will also evaluate the impact to groundwater that may result from contaminants migrating to the water table through the vadose zone underlying wastes sites in the 200-CS-1 OU.

The application of risk assessment in the characterization and remediation of the 200 Areas will follow a graded approach as described in Section 5.5 of the Implementation Plan (DOE-RL 1999). A QRA will be performed as part of the RI report and FS. When additional data are available for all the sites in an OU, a more quantitative risk assessment may be performed. A quantitative, cumulative risk assessment will be used to evaluate remedial actions and close out the sites in the 200 Areas.

The computer program, RESRAD, will be used to model radionuclide dose. Other contaminant fate and transport models may be used to assess impact to the groundwater from chemicals and radionuclides in the vadose zone. The chemical and physical characterization data obtained in this study will be used in the RESRAD modeling, as well as input parameters appropriate for the land use. As waste sites within the 200-CS-1 OU are both inside and outside the 200 Areas boundary, separate QRAs will be performed for both commercial/industrial and rural-residential land use. The input parameters recommended by the Washington State Department of Health (WDOH 1997) may be considered for this effort. Section 5.5 of the Implementation Plan (DOE-RL 1999) contains additional information on the application of the risk assessment process to the OU.

5.3 FEASIBILITY STUDY AND RCRA TREATMENT, STORAGE, AND DISPOSAL UNIT CLOSURE PLAN

After the RI is complete, remedial alternatives/closure strategies will be developed and evaluated against performance standards and evaluation criteria in the FS and appended RCRA TSD unit closure plans. The FS process consists of several steps:

1. Defining RAO and RCRA closure and RCRA corrective action performance standards.

2. Identifying general response actions (GRAs) to satisfy RAOs.

3. Identifying potential technologies and process options associated with each GRA.

4. Screening process options to select a representative process for each type of technology based on their effectiveness, implementability, and cost.

5. Assembling viable technologies or process options into alternatives representing a range of treatment and containment plus no action.

6. Evaluating alternatives and presenting information needed to support remedy selection and RCRA closure of the unit as a landfill or under modified or clean closure pursuant to Hanford Facility RCRA Permit Condition II.K.

Appendix D of the Implementation Plan (DOE-RL 1999) identifies the following remedial action alternatives as potentially applicable to the 200-CS-1 OU:

- Engineered surface barriers with or without vertical barriers
- Excavation and disposal with or without soil treatment
- In situ grouting or stabilization
- In situ vitrification
- Monitored natural attenuation.

Engineered surface barriers with or without vertical barriers could be used on sites where contaminants may be leached or mobilized by the infiltration of precipitation or if surface/near-surface contamination exists. However, the cost to construct a surface barrier over a very long, narrow area of contamination (as is the case with the 216-A-29 Ditch and the 216-S-10 Ditch), as well as the unlikely potential for very low levels of deep contaminants to exist, may likely preclude applicability of this alternative. The 216-B-63 Trench is also relatively long and narrow; however, surface barriers should be retained for this unit because of its close proximity with other contaminated waste sites (e.g., 216-B-2-2 Ditch) where construction of an aggregate surface barrier may be cost effective.

Excavation and disposal with or without soil treatment could be used at most waste sites that contain shallow contamination including radionuclides, heavy metals, other inorganics compounds, semi-volatile organic compounds, and volatile organic compounds. This alternative is applicable to the 200-CS-1 OU waste sites.

In situ grouting or stabilization could be used on waste sites that contain high concentrations of heavy metals, radionuclides, and/or other inorganic compounds. In situ grouting could also be effective in filling voids for subsidence control. Information known about the 200-CS-1 OU waste sites indicates that high concentrations of these potential COCs are not anticipated, and void spaces are not anticipated. Therefore, this alternative will be screened out from the preliminary list of remedial alternatives applicable to these sites.

In situ vitrification could be used at most waste sites although, like in situ grouting, this alternative is considered to be most applicable to sites that contain high concentrations of contamination in a small, relatively shallow-depth area. This alternative will also be screened out of the preliminary list of remedial alternatives applicable to these sites.

Monitored natural attenuation is considered to be applicable to most sites as a remedial alternative to consider, primarily due to radioactive decay; however, it will rarely be considered

as a sole alternative for remediation. Typically, use of monitored natural attenuation will be considered in combination with other remedial alternatives for the waste group.

The list of potentially applicable remedial alternatives for the 200-CS-1 OU is as follows:

- Engineered surface barriers with or without vertical barriers (for 216-B-63 Trench and 216-S-10 Pond only).
- Excavation and disposal with or without soil treatment.
- Monitored natural attenuation.
- Remedial action alternatives will be reassessed as part of the final FS to develop a final list of alternatives. Remedial alternatives are expected to require refinements or modifications in the final FS based on site characterization data collected during the RI. The development of new or emerging technologies will also be considered in the final FS.

Along with the CERCLA requirement to evaluate a no action alternative, this list of potential remedial alternatives satisfies the requirements for the screening phase (Steps 1 through 6) of the FS process unless information gathered during the remedial investigation phase conflicts with this preliminary evaluation or new technologies are developed. The preliminary RAOs, PRGs, 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 (DOE-RL 1999), the FS report will focus on the final phase of the FS, which consists of developing final RAOs and PRGs, and refining and analyzing (in detail) a limited number of alternatives identified in the screening phase.

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 criteria, community acceptance, will be applied following the FS at the proposed plan and ROD phase.

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

The RCRA closure performance standards (WAC 173-303-610[2]) will also be used to evaluate the ability of alternatives to comply with RCRA closure requirements. These standards require the closure of TSD units in a manner that achieves the following:

- Minimizes the need for further maintenance
- Controls, minimizes, or eliminates, to the extent necessary to protect human health and the environment, post-closure escape of dangerous waste, dangerous waste constituents, leachate, contaminated run-off, or dangerous waste decomposition products to the ground, surface water, groundwater, or the atmosphere
- Returns the land to the appearance and use of surrounding land areas to the degree possible given the nature of the previous dangerous waste activity.

In addition, RCRA corrective action performance standards (WAC 173-303-646[2]) will be used to evaluate alternative compliance with RCRA corrective action requirements. These standards state that corrective action must achieve the following:

- Protect human health and the environment for all releases of dangerous wastes and dangerous constituents, including releases from all solid waste management units at the facility
- Occur regardless of the time at which waste was managed at the facility or placed in such units, and regardless of whether such facilities or unit were intended for the management of solid or dangerous waste
- Be implemented by the owner/operator beyond the facility boundary where necessary to protect human health and the environment.

The FS will also include supporting information needed to complete the detailed analysis and meet regulatory integration needs, 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 may need to be addressed by remedial action.
- Provide a detailed evaluation of ARARs, beginning with potential ARARs identified in the Implementation Plan (Section 4.0, DOE-RL 1999).
- Refine potential RAOs and PRGs identified in the Implementation Plan (Section 5.0, DOE-RL 1999) 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 1999) and in this section, based on the RI.

- Provide corrective action recommendations for RPPs to fulfill the requirements for a CMS report.

- Include closure plans to address RCRA TSD units in the OU as appendices. The closure plans will incorporate, by reference, specific sections of the work plan or RI report containing specific closure plan information. The closure plans will include closure performance standards, a closure strategy, general closure activities including verification sampling, and a general post-closure plan.

Additional RCRA integration guidance for preparing a FS/closure plan is provided in Section 2.4 of the Implementation Plan (DOE-RL 1999).

5.4 PROPOSED PLAN AND PROPOSED RCRA PERMIT MODIFICATION

The decision-making process for the 200-CS-1 OU will be based on the use of a proposed plan, ROD, and modification to the Hanford Facility RCRA Permit. Following the completion of the FS/closure plan, a proposed plan will be prepared that identifies the preferred remedial alternative for the OU (which will include RCRA closure and corrective action requirements). In addition to identifying the preferred alternative, the proposed plan will also serve the following purposes:

- Provide a summary of the completed RI/FS.

- Provide criteria by which analogous waste sites within the OU 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. Contingencies to move a waste site to a more appropriate waste group will also be developed.

- Identify performance standards and ARARs applicable to the OU.

The proposed plan will also include a draft permit modification with unit-specific permit conditions for RPPs and the RCRA TSD unit for incorporation into the Hanford Facility RCRA Permit. After the public review process is complete, Ecology (as the lead regulatory agency) will make a final decision on the remedial action to be taken, which is documented in a ROD. The Hanford Facility RCRA Permit will subsequently be modified by Ecology to incorporate the ROD (and subsequent amendments) by reference, authorizing the RCRA actions.

5.5 POST-RECORD OF DECISION ACTIVITIES

After the ROD and modification to the Hanford Facility RCRA Permit have been issued, a remedial design report (RDR) and remedial action work plan (RAWP) will be prepared to detail the scope of the remedial action (which will include RCRA closure and corrective action requirements). As part of this activity, DQOs will be established and SAPs will be prepared to direct confirmatory and verification sampling and analysis efforts. Prior to beginning remediation, 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 OU, 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 1999).

The RDR/RAWP will include an integrated schedule of remediation activities for the OU, including the schedule for RCRA TSD unit closure, and will satisfy the requirements for a RPP corrective measures implementation work plan and corrective measure design report. Following the completion of the remediation effort, closeout activities will be performed as specified in the ROD, RDR/RAWP, and the Permit.

The RCRA closure activities and schedules will be defined in the closure plan and will be consistent with those identified in the RDR/RAWP. Enforceable sections of the closure plan will be stated in the modification to the Hanford Facility RCRA Permit. Certification of closure in accordance with WAC 173-303-610(6) will be performed after completion of cleanup actions. The site will be restored as appropriate for future land use. If clean closure is not attained at a TSD unit, post-closure care requirements will be met. These requirements will include final status groundwater monitoring, maintenance and monitoring of institutional controls and/or surface barriers, and certification of post-closure at the completion of the post-closure period.

6.0 PROJECT SCHEDULE

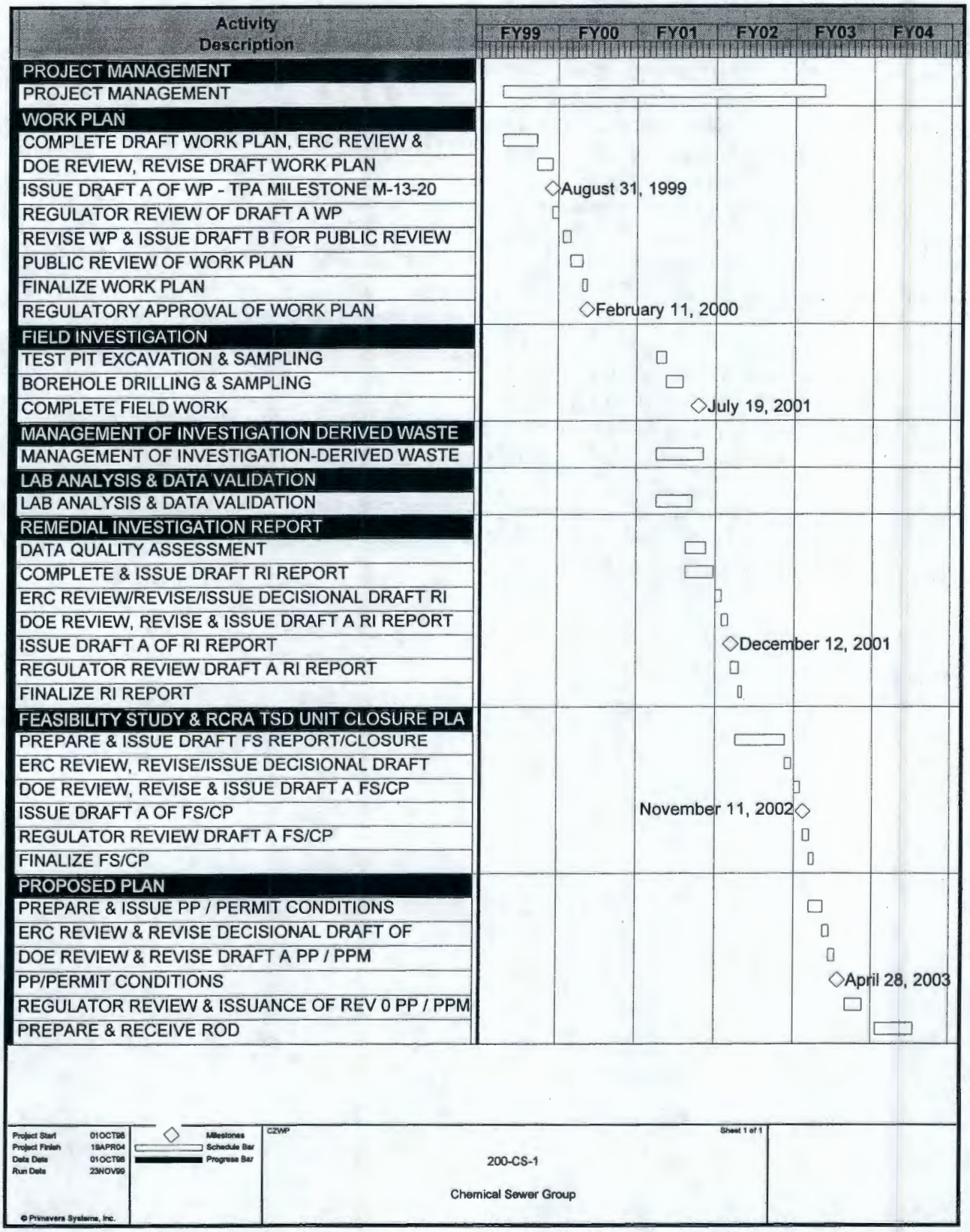
The project schedule for activities discussed in this work plan is shown in Figure 6-1. This schedule will serve as the baseline for the work planning process and will be used to measure the progress of implementing this work plan. The schedule for preparation, review, and issuance of the RI report and FS/closure plan is also shown in Figure 6-1. The schedule concludes with the preparation of a ROD. Modification of the Hanford Facility RCRA Permit will occur after issuance of the ROD, during Ecology's annual modification process.

The portions of the schedule most germane to this work plan and the SAP (Appendix B) are FY 1999 through FY 2000. One Tri-Party Agreement milestone that is associated with this project involves completing Draft A of the work plan by August 31, 1999, for transmittal to the regulators (Milestone M-13-21). The following are project milestone completion dates for key activities:

- Complete field activities – July 19, 2001
- Submit Draft A RI report for regulatory review – December 12, 2001
- Submit Draft A FS/closure plan for regulator review – November 11, 2002
- Submit Draft A proposed plan/permit modification for regulator review – April 28, 2003.

Interim milestones to be designated under the Tri-Party Agreement will be established through negotiations between the Tri-Parties. A Class II change form will be submitted to Ecology and EPA to request the addition of any interim milestones.

Figure 6-1. Project Schedule for the 200-CS-1 Operable Unit.



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WHC, 1992b, *Borehole Completion Data Package for the 216-S-10 Facility, CY 1991,* WHC-SD-EN-DP-045, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC, 1992c, *Generic Specifications – Groundwater Monitoring Wells*, WHC-S-014, Rev. 7, Westinghouse Hanford Company, Richland, Washington.

WHC, 1992d, *Ground Water Monitoring Plan for the 216-A-29 Ditch*, WHC-SD-EN-AP-045, Rev. 0-A, Westinghouse Hanford Company, Richland, Washington.

WHC, 1992e, *216-A-29 Ditch Interim Stabilization Final Report,* WHC-SD-DD-TI-060, Rev. 0A, Westinghouse Hanford Company, Richland, Washington.

WHC, 1993a, *Borehole Completion Data Package for the 216-A-29 RCRA Facility Monitoring Wells 299-E25-47 and 299-E25-48*, WHC-SD-EN-DP-054, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC, 1993b, *Borehole Completion Data Package for the 216-S-10 Facility, CY 1992*, WHC-SD-EN-DP052, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC, 1994, *Geologic Setting of the Low-Level Burial Grounds*, WHC-SD-EN-TI-290, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC, 1995a, *Interim-Status Groundwater Monitoring Plan for the 216-B-63 Trench*, WHC-SD-EN-AP-165, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

WHC, 1995b, *Results of the Groundwater Quality Assessment Program at the 216-A-29 Ditch*, WHC-SD-EN-EV-032, Rev. 0, Westinghouse Hanford Company, Richland, Washington

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

WMNW, 1998, Section 17, "Geophysical Logging," and Section 18, "Geophysical Logging Analysis," WMNW-CM-004, Waste Management Northwest, Richland, Washington.

Zimmerman, D. A., A. E. Reisenauer, G. D. Black, and M. A. Young, 1986, *Hanford Site Water Table Changes 1950 through 1980, Data Observation and Evaluatio*n, PNL-5506, Pacific Northwest Laboratory, Richland, Washington.

APPENDIX A

PART A PERMIT APPLICATIONS

A-1
PART A, FORM 3 PERMIT APPLICATION
FOR
216-A-29 DITCH

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Please print or type in the unshaded areas only
(fill-in areas are spaced for elite type, i.e., 12 character/inch).

FORM 3

DANGEROUS WASTE PERMIT APPLICATION

1. EPA/STATE I.D. NUMBER: W A 7 8 9 0 0 0 8 8 6 7

FOR OFFICIAL USE ONLY

APPLICATION APPROVED	DATE RECEIVED *(mo., day, & yr.)*	COMMENTS

II. FIRST OR REVISED APPLICATION

Place an "X" in the appropriate box in A or B below (mark one box only) to indicate whether this is the first application you are submitting for your facility or a revised application. If this is your first application and you already know your facility's EPA/STATE I.D. Number, or if this is a revised application, enter your facility's EPA/STATE I.D. Number in Section I above.

A. FIRST APPLICATION *(place an "X" below and provide the appropriate date)*

☐ 1. EXISTING FACILITY *(See instructions for definition of "existing" facility. Complete item below.)*

MO.	DAY	YR.
1 1		5 6

FOR EXISTING FACILITIES, PROVIDE THE DATE *(mo., day, & yr.)* OPERATION BEGAN OR THE DATE CONSTRUCTION COMMENCED *(use the boxes to the left)*

☐ 2. NEW FACILITY *(Complete item below)*

MO.	DAY	YR.

FOR NEW FACILITIES, PROVIDE THE DATE *(mo., day, & yr)* OPERATION BEGAN OR IS EXPECTED TO BEGIN

B. REVISED APPLICATION *(place an "X" below and complete Section I above)*

☒ 1. FACILITY HAS AN INTERIM STATUS PERMIT

☐ 2. FACILITY HAS A FINAL PERMIT

III. PROCESSES - CODES AND CAPACITIES

A. PROCESS CODE - Enter the code from the list of process codes below that best describes each process to be used at the facility. Ten lines are provided for entering codes. If more lines are needed, enter the code(s) in the space provided. If a process will be used that is not included in the list of codes below, then describe the process *(including its design capacity)* in the space provided on the *(Section III-C)*.

B. PROCESS DESIGN CAPACITY - For each code entered in column A enter the capacity of the process.

1. AMOUNT - Enter the amount.

2. UNIT OF MEASURE - For each amount entered in column B(1), enter the code from the list of unit measure codes below that describes the unit of measure used. Only the units of measure that are listed below should be used.

PROCESS	PROCESS CODE	APPROPRIATE UNITS OF MEASURE FOR PROCESS DESIGN CAPACITY
orage:		
CONTAINER (barrel, drum, etc)	S01	GALLONS OR LITERS
TANK	S02	GALLONS OR LITERS
WASTE PILE	S03	CUBIC YARDS OR CUBIC METERS
SURFACE IMPOUNDMENT	S04	GALLONS OR LITERS
Disposal:		
INJECTION WELL	D80	GALLONS OR LITERS
LANDFILL	D81	ACRE-FEET *(the volume that would cover one acre to a depth of one foot)* OR HECTARE-METER
LAND APPLICATION	D82	*ACRES OR HECTARES*
OCEAN DISPOSAL	D83	GALLONS PER DAY OR LITERS PER DAY
SURFACE IMPOUNDMENT	D84	GALLONS OR LITERS

PROCESS	PROCESS CODE	APPROPRIATE UNITS OF MEASURE FOR PROCESS DESIGN CAPACITY
Treatment:		
TANK	T01	GALLONS PER DAY OR LITERS PER DAY
SURFACE IMPOUNDMENT	T02	GALLONS PER DAY OR LITERS PER DAY
INCINERATOR	T03	TONS PER HOUR OR METRIC TONS PER HOUR; GALLONS PER HOUR OR LITERS PER HOUR
OTHER (Use for physical, chemical, thermal or biological treatment processes not occurring in tanks, surface impoundments or incinerators. Describe the processes in the space provided; Section III-C.)	T04	GALLONS PER DAY OR LITERS PER DAY

UNIT OF MEASURE	UNIT OF MEASURE CODE
GALLONS	G
LITERS	L
CUBIC YARDS	Y
CUBIC METERS	C
GALLONS PER DAY	U
LITERS PER DAY	V
TONS PER HOUR	D
METRIC TONS PER HOUR	W
GALLONS PER HOUR	E
LITERS PER HOUR	H
ACRE-FEET	A
HECTARE-METER	F
ACRES	B
HECTARES	Q

EXAMPLE FOR COMPLETING SECTION III *(shown in line numbers X-1 and X-2 below): A facility has two storage tanks, one tank can hold 200 gallons and the other can hold 400 gallons.* The facility also has an incinerator that can burn up to 20 gallons per hour.

LINE NUMBER	A. PROCESS CODE *(from list above)*	B. PROCESS DESIGN CAPACITY 1. AMOUNT *(specify)*	B. 2. UNIT OF MEASURE *(enter code)*	FOR OFFICIAL USE ONLY
X-1	S 0 2	600	G	
X-2	T 0 3	20	E	
	D 8 4	6,000,000	G	
2	T 0 4	6,000,000	U	
3				
4				

LINE NUMBER	A. PROCESS CODE *(from list above)*	B. PROCESS DESIGN CAPACITY 1. AMOUNT *(specify)*	B. 2. UNIT OF MEASURE *(enter code)*	FOR OFFICIAL USE ONLY
5				
6				
7				
8				
9				
10				

Continued from the front.

III. PROCESSES (continued)

SPACE FOR ADDITIONAL PROCESS CODES OR FOR DESCRIBING OTHER PROCESS (code "T04"). FOR EACH PROCESS ENTERED HERE INCLUDE DESIGN CAPACITY.

T04, D84

The 216-A-29 Ditch received nonregulated process and cooling water from the Plutonium-Uranium Extraction (PUREX) Plant, and also received corrosive dangerous waste from regeneration of demineralizer columns in the PUREX Plant. The ditch also received spills from the PUREX Plant. Treatment of this waste occurred by the successive addition of acidic and caustic waste, which served to neutralize the waste in the ditch. Any acidic and caustic waste that did reach the soil were subsequently neutralized by the calcareous nature of the soil. Approximately 6,000,000 gallons (22,712,400 liters) a day of waste flow reached the ditch. No accurate records are available concerning the total volume of waste treated in this unit. The 216-A-29 Ditch has not received dangerous waste since February 1986 and will be closed under interim status. The process design capacity for this unit reflects the maximum volume of waste discharged to the unit daily rather than the physical design capacity.

IV. DESCRIPTION OF DANGEROUS WASTES

A. DANGEROUS WASTE NUMBER - Enter the four digit number from Chapter 173-303 WAC for each listed dangerous waste you will handle. If you handle dangerous wastes which are not listed in Chapter 173-303 WAC, enter the four digit number(s) that describes the characteristics and/or the toxic contaminants of those dangerous wastes.

B. ESTIMATED ANNUAL QUANTITY - For each listed waste entered in column A estimate the quantity of that waste that will be handled on an annual basis. For each characteristic or toxic contaminant entered in column A estimate the total annual quantity of all the non-listed waste(s) that will be handled which possess that characteristic or contaminant.

C. UNIT OF MEASURE - For each quantity entered in column B enter the unit of measure code. Units of measure which must be used and the appropriate codes are:

ENGLISH UNIT OF MEASURE	CODE	METRIC UNIT OF MEASURE	CODE
POUNDS	P	KILOGRAMS	K
TONS	T	METRIC TONS	M

If facility records use any other unit of measure for quantity, the units of measure must be converted into one of the required units of measure taking into account the appropriate density or specific gravity of the waste.

D. PROCESSES

1. PROCESS CODES:

For listed dangerous waste: For each listed dangerous waste entered in column A select the code(s) from the list of process codes contained in Section III to indicate how the waste will be stored, treated, and/or disposed of at the facility.

For non-listed dangerous wastes: For each characteristic or toxic contaminant entered in Column A, select the code(s) from the list of process codes contained in Section III to indicate all the processes that will be used to store, treat, and/or dispose of all the non-listed dangerous wastes that possess that characteristic or toxic contaminant.

Note: Four spaces are provided for entering process codes. If more are needed: (1) Enter the first three as described above; (2) Enter "000" in the extreme right box of Item IV-D(1); and (3) Enter in the space provided on page 4, the line number and the additional code(s).

2. PROCESS DESCRIPTION: If a code is not listed for a process that will be used, describe the process in the space provided on the form.

NOTE: DANGEROUS WASTES DESCRIBED BY MORE THAN ONE DANGEROUS WASTE NUMBER - Dangerous wastes that can be described by more than one Waste Number shall be described on the form as follows:

1. Select one of the Dangerous Waste Numbers and enter it in column A. On the same line complete columns B, C, and D by estimating the total annual quantity of the waste and describing all the processes to be used to treat, store, and/or dispose of the waste.
2. In column A of the next line enter the other Dangerous Waste Number that can be used to describe the waste. In column D(2) on that line enter "included with above" and make no other entries on that line.
3. Repeat step 2 for each other Dangerous Waste Number that can be used to describe the dangerous waste.

EXAMPLE FOR COMPLETING SECTION IV *(shown in line numbers X-1, X-2, X-3, and X-4 below)* - A facility will treat and dispose of an estimated 900 pounds per year of chrome shavings from leather tanning and finishing operation. In addition, the facility will treat and dispose of three non-listed wastes. Two wastes are corrosive only and there will be an estimated 200 pounds per year of each waste. The other waste is corrosive and ignitable and there will be an estimated 100 pounds per year of that waste. Treatment will be in an incinerator and disposal will be in a landfill.

LINE NO.	A. DANGEROUS WASTE NO. *(enter code)*	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE *(enter code)*	D. PROCESSES 1. PROCESS CODES *(enter)*	D. PROCESSES 2. PROCESS DESCRIPTION *(if a code is not entered in D(1))*
	K 0 5 4	900	P	T 0 3 D 8 0	
X-2	D 0 0 2	400	P	T 0 3 D 8 0	
X-3	D 0 0 1	100	P	T 0 3 D 8 0	
X-4	D 0 0 2			T 0 3 D 8 0	*included with above*

Continued from page 2.
NOTE: Photocopy this page before completing if you have more than 26 wastes to list.

.D. NUMBER *(entered from page 1)* WA7890008967

IV. DESCRIPTION OF DANGEROUS WASTES (continued)

LINE NO.	A. DANGEROUS WASTE NO. (enter code)	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE (enter code)	D. PROCESSES 1. PROCESS CODES (enter)				D. PROCESSES 2. PROCESS DESCRIPTION (If a code is not entered in D(1))
1	D002	3,300,000,000	P	T04	D84			Neutralization/Percolation
2	D006	35						
3	U133	310						
4	WT02	50,000						Included With Above
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								

ECL30 - 271 - ECY 030-31 Form 3 PAGE 3 _____ OF 5 CONTINUE ON REVERSE

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Continued from the front.

DESCRIPTION OF DANGEROUS WASTES (continued)

USE THIS SPACE TO LIST ADDITIONAL PROCESS CODES FROM SECTION D(1) ON PAGE 3.

The 216-A-29 Ditch received corrosive waste (D002) from the PUREX Plant. The discharges consisted of acidic and caustic backwashes from the regeneration of demineralizer columns in the PUREX Plant. The ditch also received spills from the PUREX Plant. The dangerous waste consists of toxicity characteristic waste (D006), acutely dangerous discarded chemical products (U133), and state-only waste (WT02).

V. FACILITY DRAWING

All existing facilities must include in the space provided on page 5 a scale drawing of the facility *(see instructions for more detail)*.

VI. PHOTOGRAPHS

All existing facilities must include photographs *(aerial or ground-level)* that clearly delineate all existing structures; existing storage, treatment and disposal areas; and sites of future storage, treatment or disposal areas *(see instructions for more detail)*.

VII. FACILITY GEOGRAPHIC LOCATION This information is provided on the attached drawings and photos.

LATITUDE *(degrees, minutes, & seconds)*	LONGITUDE *(degrees, minutes, & seconds)*

VIII. FACILITY OWNER

[x] A. If the facility owner is also the facility operator as listed in Section VII on Form 1, "General Information", place an "X" in the box to the left and skip to Section IX below.

B. If the facility owner is not the facility operator as listed in Section VII on Form 1, complete the following items:

1. NAME OF FACILITY'S LEGAL OWNER	2. PHONE NO. *(area code & no.)*

3. STREET OR P.O. BOX	4. CITY OR TOWN	5. ST.	6. ZIP CODE

IX. OWNER CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

NAME *(print or type)*	SIGNATURE	DATE SIGNED
John D. Wagoner, Manager U.S. Department of Energy Land Operations Office	John D. Wagoner	6/30/94

OPERATOR CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

NAME *(print or type)*	SIGNATURE	DATE SIGNED
SEE ATTACHMENT		

X. OPERATOR CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

John D. Wagoner

Owner/Operator
John D. Wagoner, Manager
U.S. Department of Energy
Richland Operations Office

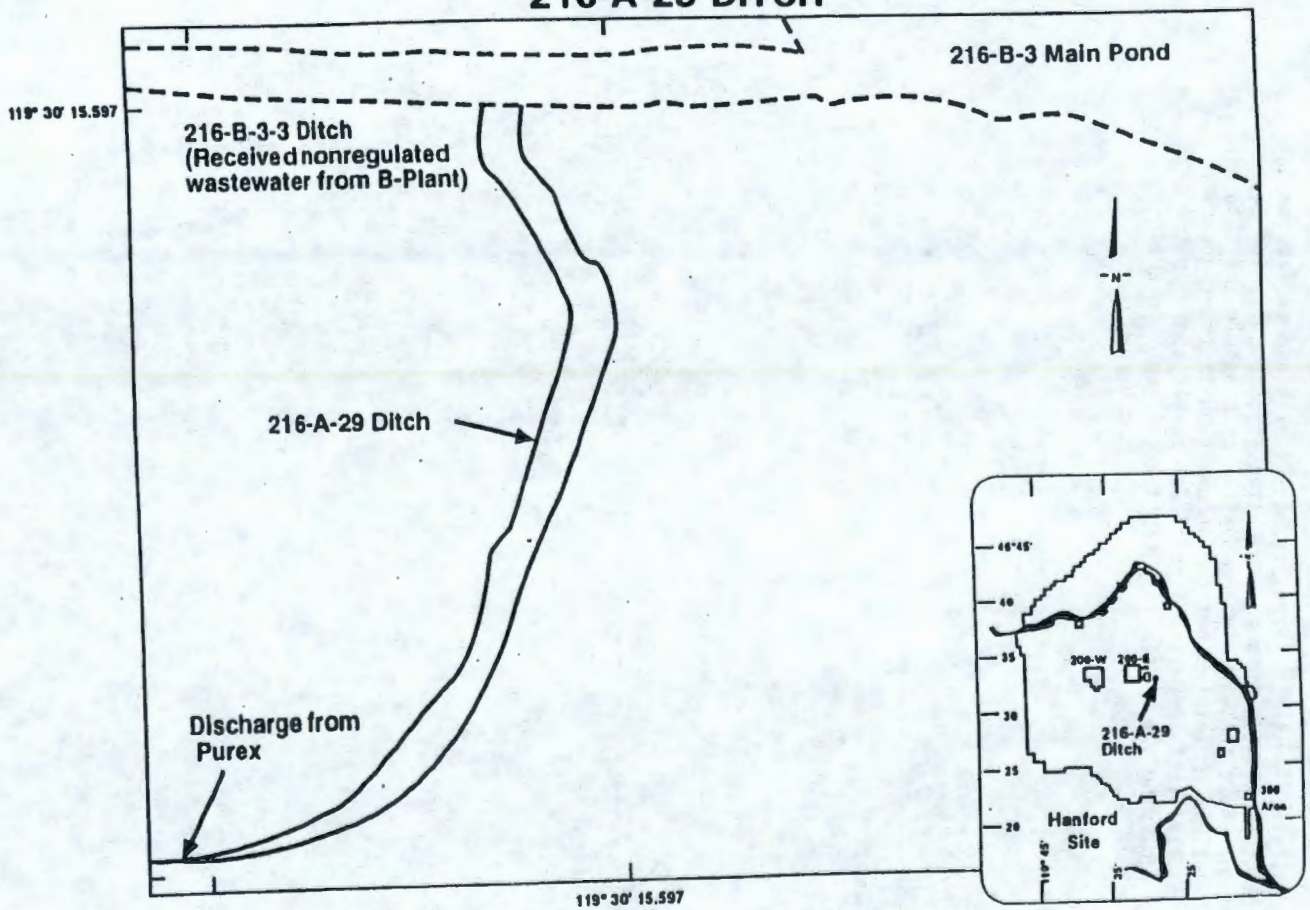
6/30/94
Date

Edward S. Keen

Co-operator
Edward S. Keen, President
Bechtel Hanford, Inc.

6/30/94
Date

216-A-29 DITCH



216-A-29 DITCH

46°33'07.301"
46°33'30.947"
119°33'11.592"
119°30'15.597"

93080116-34CN
(PHOTO TAKEN 1993)

A-2
PART A, FORM 3 PERMIT APPLICATION FOR 216-B-63 TRENCH

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FORM 3

DANGEROUS WASTE PERMIT APPLICATION

1. EPA/STATE I.D. NUMBER: W A 7 8 9 0 0 0 8 9 6 7

FOR OFFICIAL USE ONLY

APPLICATION APPROVED	DATE RECEIVED (mo., day, & yr.)	COMMENTS

II. FIRST OR REVISED APPLICATION

Place an "X" in the appropriate box in A or B below (mark one box only) to indicate whether this is the first application you are submitting for your facility or a revised application. If this is your first application and you already know your facility's EPA/STATE I.D. Number, or if this is a revised application, enter your facility's EPA/STATE I.D. Number in Section I above.

A. FIRST APPLICATION *(place an "X" below and provide the appropriate date)*

☐ 1. EXISTING FACILITY *(See instructions for definition of "existing" facility. Complete item below.)*

MO.	DAY	YR.
0 3	2 2	4 3

*FOR EXISTING FACILITIES, PROVIDE THE DATE *(mo., day, & yr.)* OPERATION BEGAN OR THE DATE CONSTRUCTION COMMENCED *(use the boxes to the left)*
*The date construction of the Hanford Facility commenced.

☐ 2. NEW FACILITY *(Complete item below)*

MO.	DAY	YR.

FOR NEW FACILITIES, PROVIDE THE DATE *(mo., day, & yr.)* OPERATION BEGAN OR IS EXPECTED TO BEGIN

B. REVISED APPLICATION *(place an "X" below and complete Section I above)*

☒ 1. FACILITY HAS AN INTERIM STATUS PERMIT

☒ 2. FACILITY HAS A FINAL PERMIT

III. PROCESSES - CODES AND CAPACITIES

A. PROCESS CODE - Enter the code from the list of process codes below that best describes each process to be used at the facility. Ten lines are provided for entering codes. If more lines are needed, enter the code(s) in the space provided. If a process will be used that is not included in the list of codes below, then describe the process *(including its design capacity)* in the space provided on the *(Section III-C)*.

B. PROCESS DESIGN CAPACITY - For each code entered in column A enter the capacity of the process.

1. AMOUNT - Enter the amount.

2. UNIT OF MEASURE - For each amount entered in column B(1), enter the code from the list of unit measure codes below that describes the unit of measure used. Only the units of measure that are listed below should be used.

PROCESS	PROCESS CODE	APPROPRIATE UNITS OF MEASURE FOR PROCESS DESIGN CAPACITY
Storage:		
CONTAINER (barrel, drum, etc)	S01	GALLONS OR LITERS
TANK	S02	GALLONS OR LITERS
WASTE PILE	S03	CUBIC YARDS OR CUBIC METERS
SURFACE IMPOUNDMENT	S04	GALLONS OR LITERS
Disposal:		
INJECTION WELL	D80	GALLONS OR LITERS
LANDFILL	D81	ACRE-FEET *(the volume that would cover one acre to a depth of one foot)* OR HECTARE-METER
LAND APPLICATION	D82	*ACRES OR HECTARES*
OCEAN DISPOSAL	D83	GALLONS PER DAY OR LITERS PER DAY
SURFACE IMPOUNDMENT	D84	GALLONS OR LITERS

PROCESS	PROCESS CODE	APPROPRIATE UNITS OF MEASURE FOR PROCESS DESIGN CAPACITY
Treatment:		
TANK	T01	GALLONS PER DAY OR LITERS PER DAY
SURFACE IMPOUNDMENT	T02	GALLONS PER DAY OR LITERS PER DAY
INCINERATOR	T03	TONS PER HOUR OR METRIC TONS PER HOUR; GALLONS PER HOUR OR LITERS PER HOUR
OTHER (Use for physical, chemical, thermal or biological treatment processes not occurring in tanks, surface impoundments or incinerators. Describe the processes in the space provided; Section III-C.)	T04	GALLONS PER DAY OR LITERS PER DAY

UNIT OF MEASURE	UNIT OF MEASURE CODE
GALLONS	G
LITERS	L
CUBIC YARDS	Y
CUBIC METERS	C
GALLONS PER DAY	U
LITERS PER DAY	V
TONS PER HOUR	D
METRIC TONS PER HOUR	W
GALLONS PER HOUR	E
LITERS PER HOUR	H
ACRE-FEET	A
HECTARE-METER	F
ACRES	B
HECTARES	Q

EXAMPLE FOR COMPLETING SECTION III *(shown in line numbers X-1 and X-2 below): A facility has two storage tanks, one tank can hold 200 gallons and the other can hold 400 gallons.* The facility also has an incinerator that can burn up to 20 gallons per hour.

LINE NUMBER	A. PROCESS CODE *(from list above)*	B. PROCESS DESIGN CAPACITY 1. AMOUNT *(specify)*	2. UNIT OF MEASURE *(enter code)*	FOR OFFICIAL USE ONLY
X-1	S 0 2	600	G	
X-2	T 0 3	20	E	
1	T 0 2	757,080	V	
2	D 8 4	757,080	L	
3				
4				

LINE NUMBER	A. PROCESS CODE *(from list above)*	B. PROCESS DESIGN CAPACITY 1. AMOUNT *(specify)*	2. UNIT OF MEASURE *(enter code)*	FOR OFFICIAL USE ONLY
5				
6				
7				
8				
9				
10				

II. PROCESSES (continued)

C. SPACE FOR ADDITIONAL PROCESS CODES OR FOR DESCRIBING OTHER PROCESS (code "T04"). FOR EACH PROCESS ENTERED HERE INCLUDE DESIGN CAPACITY.

T02, D84

The 216-B-63 Trench began waste management operations in March of 1970. The 216-B-63 Trench received nonregulated process water from the B Plant chemical sewer. The trench also received corrosive dangerous waste from the regeneration of demineralizer columns in B Plant. Treatment occurred by the successive addition to the trench of acidic and caustic waste, which served to neutralize the waste while in the trench. Approximately 473,175 liters (125,000 gallons) per day of total flow reached the trench. The corrosive discharges constituted a major part of this flow. This unit has not received dangerous waste since September 1985 and will close. The 216-B-63 Trench was stabilized in November 1994 and permanently isolated in December 1994. The process design capacity reflects the maximum volume of water discharged to the trench on a daily basis rather than the physical capacity of the unit.

IV. DESCRIPTION OF DANGEROUS WASTES

A. DANGEROUS WASTE NUMBER - Enter the four digit number from Chapter 173-303 WAC for each listed dangerous waste you will handle. If you handle dangerous wastes which are not listed in Chapter 173-303 WAC, enter the four digit number(s) that describes the characteristics and/or the toxic contaminants of those dangerous wastes.

B. ESTIMATED ANNUAL QUANTITY - For each listed waste entered in column A estimate the quantity of that waste that will be handled on an annual basis. For each characteristic or toxic contaminant entered in column A estimate the total annual quantity of all the non-listed waste(s) that will be handled which possess that characteristic or contaminant.

C. UNIT OF MEASURE - For each quantity entered in column B enter the unit of measure code. Units of measure which must be used and the appropriate codes are:

ENGLISH UNIT OF MEASURE	CODE	METRIC UNIT OF MEASURE	CODE
POUNDS	P	KILOGRAMS	K
TONS	T	METRIC TONS	M

If facility records use any other unit of measure for quantity, the units of measure must be converted into one of the required units of measure taking into account the appropriate density or specific gravity of the waste.

D. PROCESSES

1. PROCESS CODES:

For listed dangerous waste: For each listed dangerous waste entered in column A select the code(s) from the list of process codes contained in Section III to indicate how the waste will be stored, treated, and/or disposed of at the facility.

For non-listed dangerous wastes: For each characteristic or toxic contaminant entered in Column A, select the code(s) from the list of process codes contained in Section III to indicate all the processes that will be used to store, treat, and/or dispose of all the non-listed dangerous wastes that possess that characteristic or toxic contaminant.

Note: Four spaces are provided for entering process codes. If more are needed: (1) Enter the first three as described above; (2) Enter "000" in the extreme right box of Item IV-D(1); and (3) Enter in the space provided on page 4, the line number and the additional code(s).

2. PROCESS DESCRIPTION: If a code is not listed for a process that will be used, describe the process in the space provided on the form.

NOTE: DANGEROUS WASTES DESCRIBED BY MORE THAN ONE DANGEROUS WASTE NUMBER - Dangerous wastes that can be described by more than one Waste Number shall be described on the form as follows:

1. Select one of the Dangerous Waste Numbers and enter it in column A. On the same line complete columns B, C, and D by estimating the total annual quantity of the waste and describing all the processes to be used to treat, store, and/or dispose of the waste.
2. In column A of the next line enter the other Dangerous Waste Number that can be used to describe the waste. In column D(2) on that line enter "included with above" and make no other entries on that line.
3. Repeat step 2 for each other Dangerous Waste Number that can be used to describe the dangerous waste.

EXAMPLE FOR COMPLETING SECTION IV *(shown in line numbers X-1, X-2, X-3, and X-4 below)* - A facility will treat and dispose of an estimated 800 pounds per year of chrome shavings from leather tanning and finishing operation. In addition, the facility will treat and dispose of three non-listed wastes. Two wastes are corrosive only and there will be an estimated 200 pounds per year of each waste. The other waste is corrosive and ignitable and there will be an estimated 100 pounds per year of that waste. Treatment will be in an incinerator and disposal will be in a landfill.

LINE NO.	A. DANGEROUS WASTE NO. (enter code)	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE (enter code)	D. PROCESSES 1. PROCESS CODES (enter)	D. PROCESSES 2. PROCESS DESCRIPTION (If a code is not entered in D(1))
X-1	K 0 5 4	900	P	T 0 3 D 8 0	
X-2	D 0 0 2	400	P	T 0 3 D 8 0	
X-3	D 0 0 1	100	P	T 0 3 D 8 0	
X-4	D 0 0 2			T 0 3 D 8 0	Included with above

NUMBER (entered from page 1)

W A 7 8 9 0 0 0 8 9 8 7

V. DESCRIPTION OF DANGEROUS WASTES (continued)

No.	A. DANGEROUS WASTE NO. (enter code)	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE (enter code)	D. PROCESSES 1. PROCESS CODES (enter)				D. PROCESSES 2. PROCESS DESCRIPTION (If a code is not entered in D(1))
1	D002	68,038,856	K	T02	D84			Surface Impoundment(Neutralization)
2								/Surface Impoundment (Percolation)
3								
4								
5								
6								
7								
8								
9								
10								
12								
13								
14								
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5								
26								

ECL30 - 271 - ECY 030-31 Form 3

PAGE 3 ____ OF 5
(enter "A", "B", "C", etc. behind the "3" to identify photo copied pages)

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IV. DESCRIPTION OF DANGEROUS WASTES (continued)

E. USE THIS SPACE TO LIST ADDITIONAL PROCESS CODES FROM SECTION D(1) ON PAGE 3.

The 216-B-63 Trench received discharges of corrosive dangerous waste (D002) from B Plant. These discharges consisted of acidic and caustic backwashes from the regeneration of demineralizer columns in B Plant. Approximately 68,038,856 kilograms (150,000,000 pounds) of waste was managed in the trench on an annual basis.

V. FACILITY DRAWING Refer to attached drawing(s).

All existing facilities must include in the space provided on page 5 a scale drawing of the facility *(see instructions for more detail)*.

VI. PHOTOGRAPHS Refer to attached photograph(s).

All existing facilities must include photographs *(aerial or ground-level)* that clearly delineate all existing structures; existing storage, treatment and disposal areas; and sites of future storage, treatment or disposal areas *(see instructions for more detail)*.

VII. FACILITY GEOGRAPHIC LOCATION This information is provided on the attached drawing(s) and photograph(s).

LATITUDE *(degrees, minutes, & seconds)*	LONGITUDE *(degrees, minutes, & seconds)*

VIII. FACILITY OWNER

[X] A. If the facility owner is also the facility operator as listed in Section VII on Form 1, "General Information", place an "X" in the box to the left and skip to Section IX below.

B. If the facility owner is not the facility operator as listed in Section VII on Form 1, complete the following items:

1. NAME OF FACILITY'S LEGAL OWNER	2. PHONE NO. *(area code & no.)*

3. STREET OR P.O. BOX	4. CITY OR TOWN	5. ST.	6. ZIP CODE

IX. OWNER CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

NAME *(print or type)*	SIGNATURE	DATE SIGNED
John D. Wagoner, Manager U.S. Department of Energy Richland Operations Office	John D. Wagoner	9/26/96

X. OPERATOR CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

NAME *(print or type)*	SIGNATURE	DATE SIGNED
SEE ATTACHMENT		

X. OPERATOR CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

John D. Wagoner — 9/26/96

Owner/Operator
John D. Wagoner, Manager
U.S. Department of Energy
Richland Operations Office

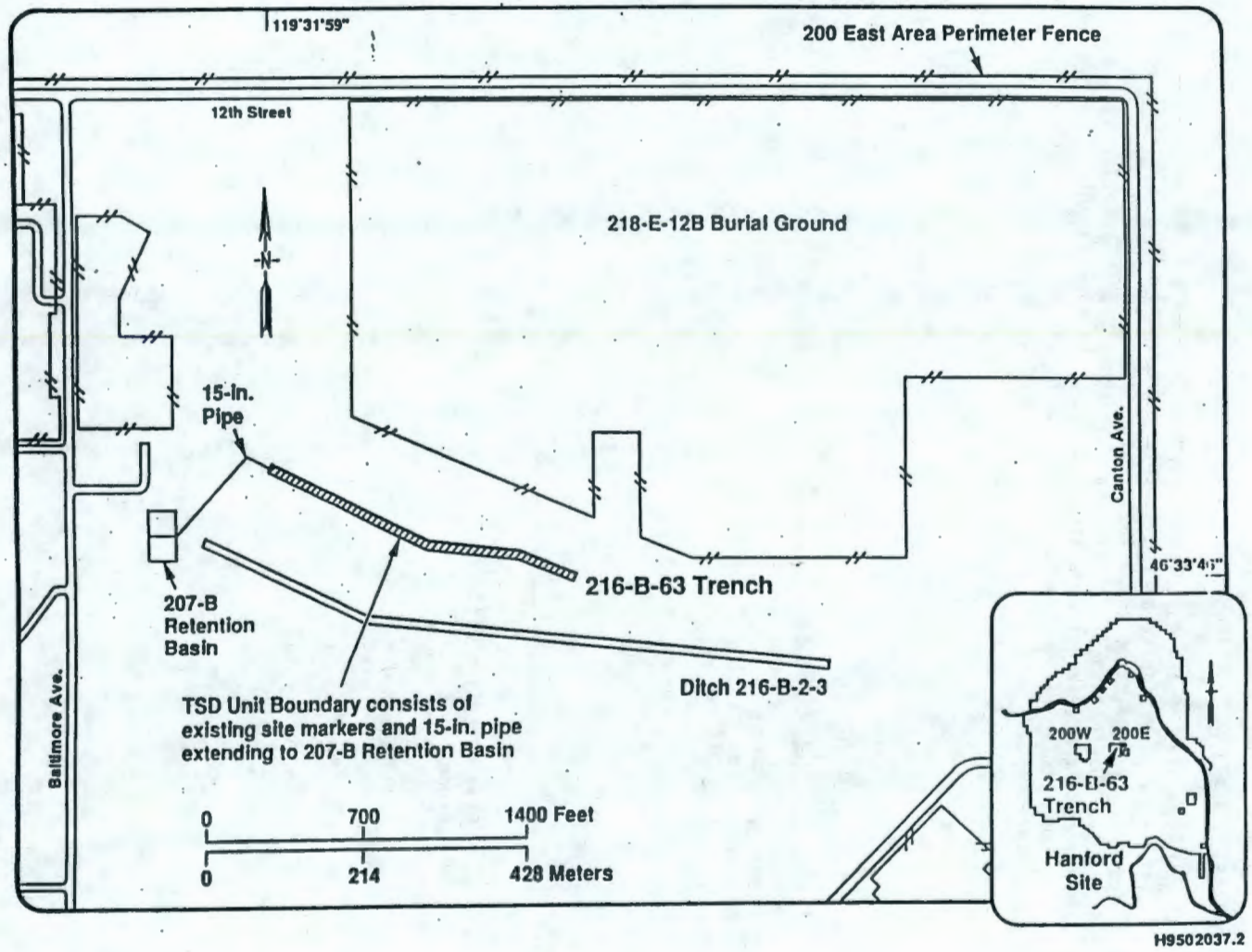
Date

9/13/96

Co-operator
H. J. Hatch,
President and Chief Executive Officer
Fluor Daniel Hanford, Inc.

Date

216-B-63 Trench Site Plan



216-B-63 TRENCH

46°33'46"
119°31'59"

95020800-6CN
(PHOTO TAKEN 1995)

A-3
PART A, FORM 3 PERMIT APPLICATION
FOR
216-S-10 POND AND DITCH

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Please print or type in the unshaded areas only
(fill-in areas are spaced for elite type, i.e., 12 character/inch).

FORM 3

DANGEROUS WASTE PERMIT APPLICATION

1. EPA/STATE I.D. NUMBER: W A 7 8 9 0 0 0 8 9 6 7

FOR OFFICIAL USE ONLY

APPLICATION APPROVED	DATE RECEIVED *(mo., day, & yr.)*	COMMENTS

II. FIRST OR REVISED APPLICATION

Place an "X" in the appropriate box in A or B below (mark one box only) to indicate whether this is the first application you are submitting for your facility or a revised application. If this is your first application and you already know your facility's EPA/STATE I.D. Number, or if this is a revised application, enter your facility's EPA/STATE I.D. Number in Section I above.

A. FIRST APPLICATION *(place an "X" below and provide the appropriate data)*

☐ 1. EXISTING FACILITY *(See instructions for definition of "existing" facility. Complete item below.)*

MO.	DAY	YR.
0 5	0 1	5 2

FOR EXISTING FACILITIES, PROVIDE THE DATE *(mo., day, & yr.)* OPERATION BEGAN OR THE DATE CONSTRUCTION COMMENCED *(use the boxes to the left)*

☐ 2. NEW FACILITY *(Complete item below)*

MO.	DAY	YR.

FOR NEW FACILITIES, PROVIDE THE DATE, *(mo., day, & yr)* OPERATION BEGAN OR IS EXPECTED TO BEGIN

B. REVISED APPLICATION *(place an "X" below and complete Section I above)*

☒ 1. FACILITY HAS AN INTERIM STATUS PERMIT

☐ 2. FACILITY HAS A FINAL PERMIT

III. PROCESSES - CODES AND CAPACITIES

A. PROCESS CODE - Enter the code from the list of process codes below that best describes each process to be used at the facility. Ten lines are provided for entering codes. If more lines are needed, enter the code(s) in the space provided. If a process will be used that is not included in the list of codes below, then describe the process *(including its design capacity)* in the space provided on the *(Section III-C)*.

B. PROCESS DESIGN CAPACITY - For each code entered in column A enter the capacity of the process.

1. AMOUNT - Enter the amount.

2. UNIT OF MEASURE - For each amount entered in column B(1), enter the code from the list of unit measure codes below that describes the unit of measure used. Only the units of measure that are listed below should be used.

PROCESS	PROCESS CODE	APPROPRIATE UNITS OF MEASURE FOR PROCESS DESIGN CAPACITY
Storage:		
CONTAINER (barrel, drum, etc)	S01	GALLONS OR LITERS
TANK	S02	GALLONS OR LITERS
WASTE PILE	S03	CUBIC YARDS OR CUBIC METERS
SURFACE IMPOUNDMENT	S04	GALLONS OR LITERS
Disposal:		
INJECTION WELL	D80	GALLONS OR LITERS
LANDFILL	D81	ACRE-FEET *(the volume that would cover one acre to a depth of one foot)* OR HECTARE-METER
LAND APPLICATION	D82	*ACRES OR HECTARES*
OCEAN DISPOSAL	D83	GALLONS PER DAY OR LITERS PER DAY
SURFACE IMPOUNDMENT	D84	GALLONS OR LITERS

PROCESS	PROCESS CODE	APPROPRIATE UNITS OF MEASURE FOR PROCESS DESIGN CAPACITY
Treatment:		
TANK	T01	GALLONS PER DAY OR LITERS PER DAY
SURFACE IMPOUNDMENT	T02	GALLONS PER DAY OR LITERS PER DAY
INCINERATOR	T03	TONS PER HOUR OR METRIC TONS PER HOUR; GALLONS PER HOUR OR LITERS PER HOUR
OTHER (Use for physical, chemical, thermal or biological treatment processes not occurring in tanks, surface impoundments or incinerators. Describe the processes in the space provided; Section III-C.)	T04	GALLONS PER DAY OR LITERS PER DAY

UNIT OF MEASURE	UNIT OF MEASURE CODE
GALLONS	G
LITERS	L
CUBIC YARDS	Y
CUBIC METERS	C
GALLONS PER DAY	U
LITERS PER DAY	V
TONS PER HOUR	D
METRIC TONS PER HOUR	W
GALLONS PER HOUR	E
LITERS PER HOUR	H
ACRE-FEET	A
HECTARE-METER	F
ACRES	B
HECTARES	Q

EXAMPLE FOR COMPLETING SECTION III *(shown in line numbers X-1 and X-2 below): A facility has two storage tanks, one tank can hold 200 gallons and the other can hold 400 gallons.* The facility also has an incinerator that can burn up to 20 gallons per hour.

NUMBER	A. PROCESS CODE *(from list above)*	B. PROCESS DESIGN CAPACITY 1. AMOUNT *(specify)*	B. PROCESS DESIGN CAPACITY 2. UNIT OF MEASURE *(enter code)*	FOR OFFICIAL USE ONLY	NUMBER	A. PROCESS CODE *(from list above)*	B. PROCESS DESIGN CAPACITY 1. AMOUNT *(specify)*	B. PROCESS DESIGN CAPACITY 2. UNIT OF MEASURE *(enter code)*	FOR OFFICIAL USE ONLY
X-1	S 0 2	600	G		6				
X-2	T 0 3	20	E		6				
	D 8 4	150,000	G		7				
2					8				
3					9				
4					10				

Continued from the front.

III. PROCESSES (continued)

SPACE FOR ADDITIONAL PROCESS CODES OR FOR DESCRIBING OTHER PROCESS (code "T04"). FOR EACH PROCESS ENTERED HERE INCLUDE DESIGN CAPACITY.

D84

The 216-S-10 Pond and Ditch received nonregulated waste water consisting of water tower overflow, cooling water, and rainwater. The unit was used as the disposal site for the Chemical Engineering Laboratory between 1980 and 1983. During that time, discharges of dangerous waste to the pond and ditch consisted of simulated double-shell tank slurry. This waste was discharged to the pond and ditch and allowed to percolate into the soil column underlying the unit. The unit was designed to percolate approximately 150,000 gallons (567,800 liters) of waste a day. The process design capacity reflects the maximum volume of water discharged daily rather than the physical capacity of the 216-S-10 Pond and Ditch. The 216-S-10 Pond has been decommissioned. The 216-S-10 Ditch last received a nonregulated waste water discharge in October 1991. The 216-S-10 Pond and Ditch no longer receives dangerous waste and will be closed under interim status.

IV. DESCRIPTION OF DANGEROUS WASTES

A. DANGEROUS WASTE NUMBER - Enter the four digit number from Chapter 173-303 WAC for each listed dangerous waste you will handle. If you handle dangerous wastes which are not listed in Chapter 173-303 WAC, enter the four digit number(s) that describes the characteristics and/or the toxic contaminants of those dangerous wastes.

B. ESTIMATED ANNUAL QUANTITY - For each listed waste entered in column A estimate the quantity of that waste that will be handled on an annual basis. For each characteristic or toxic contaminant entered in column A estimate the total annual quantity of all the non-listed waste(s) that will be handled which possess that characteristic or contaminant.

C. UNIT OF MEASURE - For each quantity entered in column B enter the unit of measure code. Units of measure which must be used and the appropriate codes are:

ENGLISH UNIT OF MEASURE	CODE	METRIC UNIT OF MEASURE	CODE
POUNDS	P	KILOGRAMS	K
TONS	T	METRIC TONS	M

If facility records use any other unit of measure for quantity, the units of measure must be converted into one of the required units of measure taking into account the appropriate density or specific gravity of the waste.

D. PROCESSES

1. PROCESS CODES:

For listed dangerous waste: For each listed dangerous waste entered in column A select the code(s) from the list of process codes contained in Section III to indicate how the waste will be stored, treated, and/or disposed of at the facility.

For non-listed dangerous wastes: For each characteristic or toxic contaminant entered in Column A, select the code(s) from the list of process codes contained in Section III to indicate all the processes that will be used to store, treat, and/or dispose of all the non-listed dangerous wastes that possess that characteristic or toxic contaminant.

Note: Four spaces are provided for entering process codes. If more are needed: (1) Enter the first three as described above; (2) Enter "000" in the extreme right box of Item IV-D(1); and (3) Enter in the space provided on page 4, the line number and the additional code(s).

2. PROCESS DESCRIPTION: If a code is not listed for a process that will be used, describe the process in the space provided on the form.

NOTE: DANGEROUS WASTES DESCRIBED BY MORE THAN ONE DANGEROUS WASTE NUMBER - Dangerous wastes that can be described by more than one Waste Number shall be described on the form as follows:

1. Select one of the Dangerous Waste Numbers and enter it in column A. On the same line complete columns B, C, and D by estimating the total annual quantity of the waste and describing all the processes to be used to treat, store, and/or dispose of the waste.
2. In column A of the next line enter the other Dangerous Waste Number that can be used to describe the waste. In column D(2) on that line enter "included with above" and make no other entries on that line.
3. Repeat step 2 for each other Dangerous Waste Number that can be used to describe the dangerous waste.

EXAMPLE FOR COMPLETING SECTION IV *(shown in line numbers X-1, X-2, X-3, and X-4 below)* - A facility will treat and dispose of an estimated 900 pounds per year of chrome shavings from leather tanning and finishing operation. In addition, the facility will treat and dispose of three non-listed wastes. Two wastes are corrosive only and there will be an estimated 200 pounds per year of each waste. The other waste is corrosive and ignitable and there will be an estimated 100 pounds per year of that waste. Treatment will be in an incinerator and disposal will be in a landfill.

LINE NO.	A. DANGEROUS WASTE NO. (enter code)	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE (enter code)	D. PROCESSES 1. PROCESS CODES (enter)	D. PROCESSES 2. PROCESS DESCRIPTION (If a code is not entered in D(1))
	K 0 5 4	900	P	T 0 3 D 8 0	
X-2	D 0 0 2	400	P	T 0 3 D 8 0	
X-3	D 0 0 1	100	P	T 0 3 D 8 0	
X-4	D 0 0 2			T 0 3 D 8 0	included with above

ECL30 - 271 - ECY 030-31 Form 3

Continued from page 2.
NOTE: Photocopy this page before completing if you have more than 26 wastes to list.

I.D. NUMBER *(entered from page 1)*: A 7 8 9 0 0 0 8 9 6 7

IV. DESCRIPTION OF DANGEROUS WASTES (continued)

LINE NO.	A. DANGEROUS WASTE NO. *(enter code)*	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE *(enter code)*	D. PROCESSES 1. PROCESS CODES *(enter)*	D. PROCESSES 2. PROCESS DESCRIPTION *(if a code is not entered in D(1))*
1	D001	1,000	P	D84	Percolation
2	D002				
3	D007				
4	WT01				
5	WT02				Included With Above
6					
7					
8					
9					
10					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
25					
26					

ECL30 - 271 - ECY 030-31 Form 3 PAGE 3 ____ OF 5 CONTINUE ON REVERSE
(enter "A", "B", "C", etc. behind the "3" to identify photo copied pages)

Continued from the front.

DESCRIPTION OF DANGEROUS WASTES (continued)

USE THIS SPACE TO LIST ADDITIONAL PROCESS CODES FROM SECTION D(1) ON PAGE 3.

The 216-S-10 Pond and Ditch received one documented discharge of dangerous waste. This discharge consisted of simulated double-shell tank slurry, which exhibited the dangerous waste characteristics of ignitability (D001), corrosivity (D002), characteristic waste (D007), and toxic state-only waste (WT01, WT02). Approximately 1,000 pounds (450 kilograms) of dangerous waste were discharged to the unit.

V. FACILITY DRAWING

All existing facilities must include in the space provided on page 5 a scale drawing of the facility *(see instructions for more detail)*.

VI. PHOTOGRAPHS

All existing facilities must include photographs *(aerial or ground-level)* that clearly delineate all existing structures; existing storage, treatment and disposal areas; and sites of future storage, treatment or disposal areas *(see instructions for more detail)*.

VII. FACILITY GEOGRAPHIC LOCATION This information is provided on the attached drawings and photos.

LATITUDE *(degrees, minutes, & seconds)*	LONGITUDE *(degrees, minutes, & seconds)*

VIII. FACILITY OWNER

[x] A. If the facility owner is also the facility operator as listed in Section VII on Form 1, "General Information", place an "X" in the box to the left and skip to Section IX below.

B. If the facility owner is not the facility operator as listed in Section VII on Form 1, complete the following items:

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3. STREET OR P.O. BOX	4. CITY OR TOWN	5. ST.	6. ZIP CODE

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NAME *(print or type)*	SIGNATURE	DATE SIGNED
John D. Wagoner, Manager U.S. Department of Energy Richland Operations Office	John D. Wagoner	6/30/94

X. OPERATOR CERTIFICATION

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NAME *(print or type)*	SIGNATURE	DATE SIGNED
SEE ATTACHMENT		

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John D. Wagoner — 6/30/94

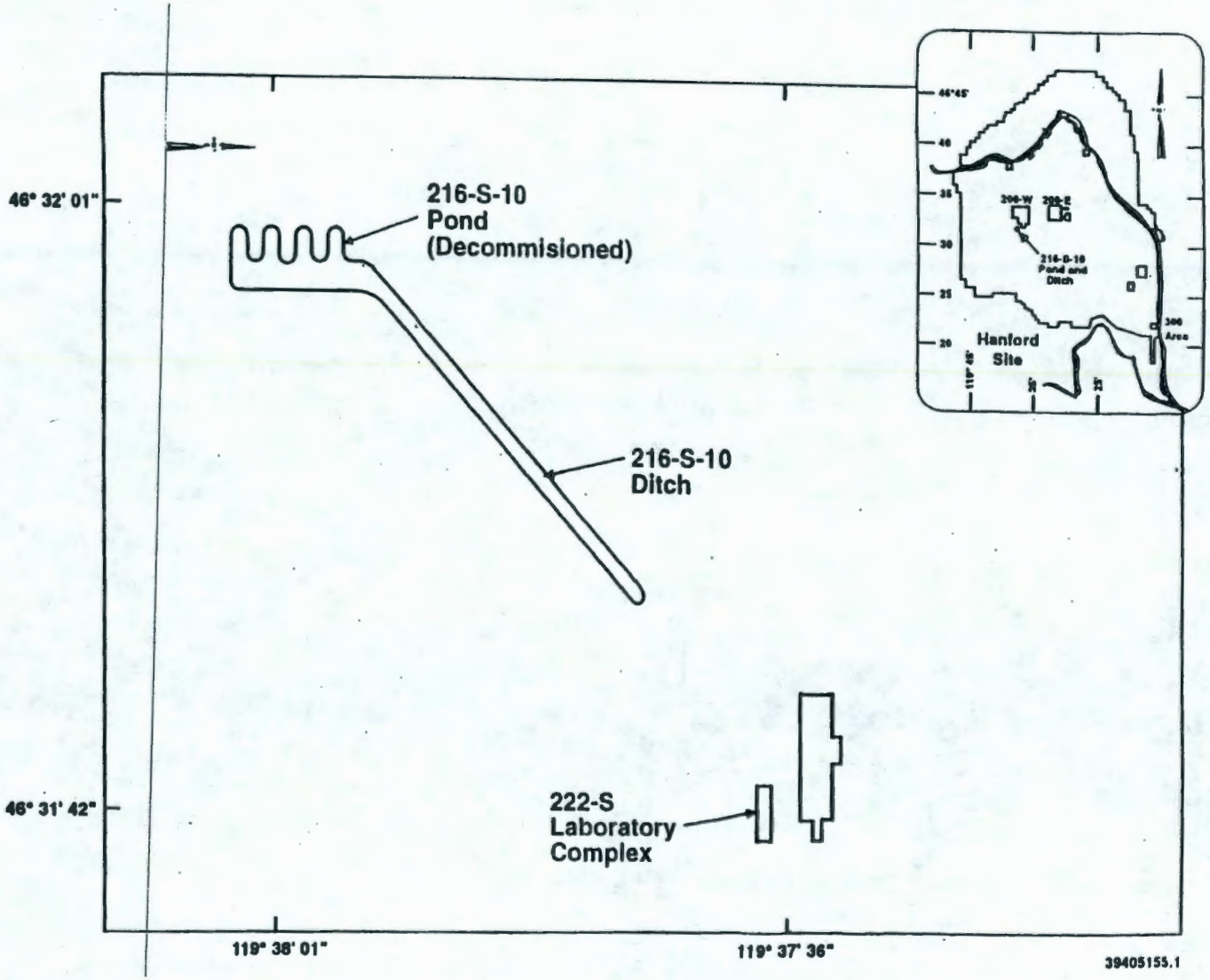
Owner/Operator
John D. Wagoner, Manager
U.S. Department of Energy
Richland Operations Office

Date

Edward S. Keen — 6/30/94

Co-operator
Edward S. Keen, President
Bechtel Hanford, Inc.

Date


46° 32' 01"
46° 31' 42"
119° 38' 01"
119° 37' 36"
216-S-10
Pond
(Decommisioned)
216-S-10
Ditch
222-S
Laboratory
Complex
Hanford
Site
39405155.1

216-S-10 DITCH

46°32'01"
46°31'39"
119°37'36"
119°38'02"

94051304-9CN
(PHOTO TAKEN 1994)

216-S-10 POND (Decommissioned)

46°31'42"
119°38'01"

8704191-7CN
(PHOTO TAKEN 1987)

APPENDIX B

SAMPLING AND ANALYSIS PLAN

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ACRONYMNS

ASTM	American Society for Testing and Materials
BHI	Bechtel Hanford, Inc.
bgs	below ground surface
CFR	*Code of Federal Regulations*
COC	contaminant of concern
COPC	contaminant of potential concern
DOE	U.S. Department of Energy
dpm	disintegrations per minute
DQO	data quality objective
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ERC	Environmental Restoration Contractor
FSP	field sampling plan
HASQARD	*Hanford Analytical Services Quality Assurance Requirements Documents*
HEIS	Hanford Environmental Information System
IDW	investigation-derived waste
IMO	information management overview
MTCA	*Model Toxics Control Act*
OU	operable unit
ppm	parts per million
PUREX	Plutonium/Uranium Extraction (Facility)
QAPjP	quality assurance project plan
QC	quality control
RCF	Radiological Counting Facility
RCRA	*Resource Conservation and Recovery Act of 1976*
RCT	radiological control technician
REDOX	Reduction-Oxidation (Facility)
RESRAD	RESidual RADioactivity dose model
SAP	sampling and analysis plan
SGL	spectral gamma-ray logging
TSD	treatment, storage, and disposal
WAC	*Washington Administrative Code*

B1.0 INTRODUCTION

This sampling and analysis plan (SAP) directs the sampling and analysis activities that will be performed to characterize the vadose zone at four waste sites: the 216-A-29 Ditch, the 216-B-63 Trench, the 216-S-10 Ditch, and the 216-S-10 Pond. These waste sites are part of the 200-CS-1 Chemical Sewer Operable Unit (OU) in the Hanford Site's 200 Areas. The sampling and analysis will be performed to provide soil/sediment data that will be used to support remedial decision making (i.e., remedial investigation), to refine and/or validate the site conceptual contaminant distribution model, and to support an assessment of risk for waste sites in this OU. Characterization activities described in this plan are based on the implementation of the data quality objective (DQO) process, as documented in the *200-CS-1 Chemical Sewer Operable Unit DQO Process Summary Report* (BHI 1999).

The scope of activities described in this SAP involves the excavation of 10 test pits, trenches, and/or shallow auger boreholes and the drilling of four boreholes. Soil samples will be collected and analyzed for radiological and chemical contaminants of concern (COCs) and select physical properties. Boreholes will be geophysically logged to obtain additional information on the distribution of contamination and soil moisture.

Borehole sampling at the 216-S-10 Pond will be integrated with the installation of a downgradient *Resource Conservation and Recovery Act of 1976* (RCRA) interim status groundwater monitoring well. Because this well will be located as close to the edge and influence of the waste site as possible, it will be representative of contamination found in deep soils and the groundwater. However, because the well is not located in the pond proper, a test pit will be located at the pond influence to obtain shallow samples.

B1.1 BACKGROUND

The ditches, pond, and trench to be characterized received wastewater conveyed by pipelines from the Plutonium-Uranium Extraction (PUREX) Plant, B Plant, and the Reduction-Oxidation (REDOX) Facility. The majority of the releases to the waste sites were greatly diluted and dispersed by large volumes of water, but the total volume of water discharged to the chemical sewer OU sites exceeded 20 billion L (more than 5 billion gal) of water. Consequently, the vadose zone under some of these waste sites became saturated during the years of operation. After the water discharges ceased, portions of the vadose zone remained at or near saturation for an extended period of time. Although the groundwater mounds are declining, recharge from historical wastewater discharges from some of these facilities to the groundwater may still be occurring.

The four waste sites that will be investigated in this OU will be characterized to determine the nature and extent of contamination. These sites were chosen because they are treatment, storage, and disposal (TSD) units and because one of the sites represents the worst-case scenario (i.e., 216-S-10 Ditch), and the other represents the typical scenario (i.e., 216-A-29 Ditch), as discussed in Section 2.2.2 of the work plan. Knowledge gained from characterizing these sites will be used to refine the conceptual model and will facilitate the use of the analogous site approach in

reaching remedial action decisions for the OU. The use of the analogous site approach is fundamental to streamlining in the 200 Areas due to the large number of waste sites (DOE-RL 1999).

B1.2 200-CS-1 WASTE SITE LOCATIONS

The 200-CS-1 waste sites are located on the Hanford Site in southeastern Washington State, in the vicinity of the 200 Areas. Figure B1-1 shows the general locations of waste sites in the 200-CS-1 OU with respect to the general Hanford Site.

B1.3 SITE DESCRIPTION AND HISTORY

The following subsections provide brief descriptions of the four waste sites that will be investigated. Additional detail is provided in Section 2.2 of the work plan. Section 3.1 of the work plan contains information on the nature and extent of contamination and previous investigations.

B1.3.1 216-A-29 Ditch

The 216-A-29 Ditch became operational in 1945 with the startup of the 284-E Powerhouse and water treatment system. The 216-A-29 Ditch, an open unlined ditch, ran east across 200 East Area, then entered an underground pipeline and discharged to a land depression east of the 200 East Area boundary. In February 1955, the powerhouse wastewater was routed to the 216-B-3-1 Ditch. From November 1955 to December 1957, the head end of the 216-A-29 Ditch received PUREX Plant chemical sewer and cooling water (raw Columbia River water) from separate pipelines. In December 1957, the cooling water was routed to Gable Mountain and B Ponds. There is no process knowledge that breaks down the percentage contribution from the various waste streams. The amount of wastewater discharged to the 216-A-29 Ditch is difficult to estimate because the flows from the ditches leading to B Pond were not differentiated. Dangerous waste releases to the 216-A-29 Ditch ceased in 1986 and all liquid discharge ceased in 1991. The 216-A-29 Ditch was backfilled and surface stabilized in 1991.

B1.3.2 216-B-63 Trench

The 216-B-63 Trench began receiving effluent from the B Plant chemical sewer in May 1970. The major sources of waste contributions to the 216-B-63 Trench were the 2902-B high tank (potable sanitary water), cooling water from B Plant and the Waste Encapsulation and Storage Facility air compressor aftercoolers, some of the 221-B steam condensate, and B Plant demineralizer effluent. Minor waste contributions came from chemical makeup overflow systems (e.g., sodium hydroxide and sodium nitrite), air-conditioning units, and space heaters. In August 1970, the 216-B-63 Trench was dredged (reading about 3,000 counts per minute beta/gamma activity) and the dredgings were buried in the 218-E-12B burial ground. The only documented hazardous effluent discharged in the past consisted of regeneration solutions from the B Plant demineralizers. These effluents were routine corrosive discharges (D002) of aqueous sulfuric acid and sodium hydroxide solutions. The corrosive discharges occurred

from 1970 until October 1985. After 1985, the cation column effluent was treated with sodium carbonate, and the anion column effluent was treated with monosodium phosphate to maintain a combined pH between 4 and 10.

As of 1985, the waste discharged to 216-B-63 Trench was no longer considered to be dangerous waste. Radiological discharges to the trench were relatively low. The chemical sewer pipelines to the trench were recognized as leaking near B Plant from 1970 until a sewer upgrade was completed in 1985. No other influent pipelines associated with the chemical sewer OU were reported to leak as extensively as the head end of the 216-B-63 pipeline. As part of the sewer upgrade, a major portion of the vitrified clay pipeline on the north side of the 221-B/271-B Building was re-lined with reinforced thermosetting resin pipe. In 1992, discharge to the trench ceased, and the trench was backfilled with clean fill by November 1994. A total of 7.2 billion L (nearly 2 billion gal) of effluent were discharged to the 216-B-63 Trench.

B1.3.3 216-S-10 Ditch/216-S-10 Pond

The 216-S-10 Ditch received discharge from the REDOX Facility. The site started receiving liquid waste in May 1952. This ditch conveyed wastewater to the 216-S-10 Pond and the 216-S-11 Pond. In addition to these three sites, during May 1955 there was a 0.405-hectare (approximately one-acre) overflow from the ditch that released an estimated 215 kg of uranium from the ditch in the southeast dike of the 216-S-11 Pond. This unplanned release is referenced as UPR-200-W-34. After the unplanned release, the ditch was dredged and the sludge was removed and placed in low spots on both sides of the ditch (the specific location is unknown). The ditch was then covered with 0.6 m (2 ft) of soil.

The 216-S-10 Ditch and Pond both routinely received large quantities of nondangerous, low-level radioactive liquid effluent from the REDOX Facility chemical sewer and the Chemical Engineering Laboratory within REDOX. The waste stream was comprised of cooling water, steam condensate, water tower overflow, and drain effluent. The effluent to the chemical sewer was comprised of approximately 60% REDOX Facility raw water, 20% sanitary water, and 20% steam condensate. The 216-S-10 Ditch and Pond remained in use until 1984, when the south two-thirds of the ditch and the entire pond were backfilled and stabilized. The head end of the 216-S-10 Ditch last received discharges during 1991 and was permanently isolated in July 1994.

B1.4 CONTAMINANTS OF CONCERN

Step 1 of the DQO process identifies the need to develop a list of contaminants of potential concern (COPCs) for 200-CS-1 OU waste sites. Development of the list of COPCs is an essential step in refining the site conceptual model. From an initial list of 395 contaminants that potentially could have been discharged to 200-CS-1 OU waste sites, 71 COCs were identified during the DQO development process. Development of this list is described in the 200-CS-1 DQO workbook (BHI 1999) and is summarized in Section 3.4 of the work plan. The potential COCs are identified in Table B1-1.

If contaminants not identified as potential COCs are detected during laboratory analysis, the data will be evaluated against existing regulatory standards or risk-based levels if exposure data are available and existing process knowledge to determine the need for remedial action.

In addition to the potential COCs identified in Table B1-1, hydrazine (which entered the 216-A-29 Ditch from the PUREX Plant aqueous makeup unit tanks) will be analyzed in samples taken at both test pits at the 216-A-29 Ditch. This data will be used to support a contained-in determination as described in Section 3.1.1.4.

B1.5 DATA QUALITY OBJECTIVES

The U.S. Environmental Protection Agency's (EPA's) document, *Guidance for the Data Quality Objectives Process* (EPA 1994a), was used to support the development of this SAP. The EPA's DQO guidance document is a strategic planning approach that provides a systematic procedure 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 presents only a summary of the key outputs resulting from the implementation of the seven-step DQO process. For additional details, the reader should refer to the DQO workbook (BHI 1999).

B1.5.1 Statement of the Problem

The 200-CS-1 OU consists of seven waste sites where a combination of ditches, ponds, and trenches (and associated piping systems at 216-B-63) received chemical wastewater from 200 Areas facilities. The majority of the effluents released to the waste sites were greatly diluted and dispersed by large volumes of water, but the vadose zone under some of these sites became saturated over time. After the water discharges ceased and most surfaces of the waste sites were stabilized with clean soil and gravel, portions of the vadose zone remained at or near saturation for some period of time. The historical discharge of wastewater to the 200-CS-1 OU may have resulted in the contamination of vadose zone soils and/or groundwater.

The primary objective of the DQO process for the 200-CS-1 OU was to collect the data that are necessary to support remedial decision making (i.e., remedial investigation) and to confirm the site conceptual contaminant distribution model. Possible remedial alternatives considered in the development of the DQO included the following:

- No action alternative (no institutional controls)
- Capping (for 216-B-63 Trench and 216-S-10 Pond only)
- In situ vitrification
- Insitu grouting and stabilization
- Excavate and dispose of waste
- Monitored natural attenuation (with institutional controls).

B1.5.2 Decision Rules

Decision rules 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. Decision rules are generally structured as "IF...THEN" statements that indicate what action will be taken when a prescribed condition is met. Decision rules 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 action(s) that would result. The 200-CS-1 OU decision statements are summarized in Table B1-2.

B1.5.3 Error Tolerance and Decision Consequences

The consequence of selecting an inadequate nonstatistical sampling design is not considered severe. Based on the guidance in Table 4-5a of the DQO workbook (BHI 1999), the sampling design rigor requirements are not significant because of the combination of low severity and accessibility after remedial investigation sampling. If the sampling design is determined to be inadequate, additional sampling can be performed because the sites will be still accessible. Section 5.5 of the work plan summarized the additional sampling activities that are planned after the RI that are described in this SAP.

B1.5.4 Sample Design Summary

A nonstatistical sampling design (i.e., professional judgment) was used to select sample locations at the waste sites. This biased sampling approached was selected based on process knowledge, expected behavior of COCs, the expected distribution of contamination, and the preliminary conceptual site model developed for this waste group. Using this approach, sample locations are selected that increase the chance of encountering the worst-case conditions/maximum concentrations of contaminants. This approach was recently applied at the 200-CW-1 OU sites. The biased sampling approach used at boreholes and test pits at the 200-CW-1 OU sites appears to support the preliminary site conceptual model for 200-CS-1 OU presented in the waste site groupings report (DOE-RL 1997).

The total number of samples for the 200-CS-1 OU waste sites was selected based on the preliminary site conceptual model and the expected distribution of contamination. The model suggests that the highest contaminant concentrations should be detected near the bottom of the pond/ditch (i.e., the top of the sediment layer) and that the concentrations should decrease with depth. Therefore, a greater frequency of sampling is planned in the zone immediately below the historical bottom of the pond/ditch/trench. Sample frequency will decrease with depth based on the expected distribution of contamination. Additional samples will be collected at the discretion of the site geologist based on the field screening data. All material excavated will be screened as described in Section B3.2.2. Field screening will be performed to reduce the potential of overlooking zones of significant contamination. The optimal sample design for this initial phase of characterization is presented in Section B3.0.

Figure B1-1. Location of the Hanford Site and Waste Sites to be Characterized in the 200-CS-1 Operable Unit.

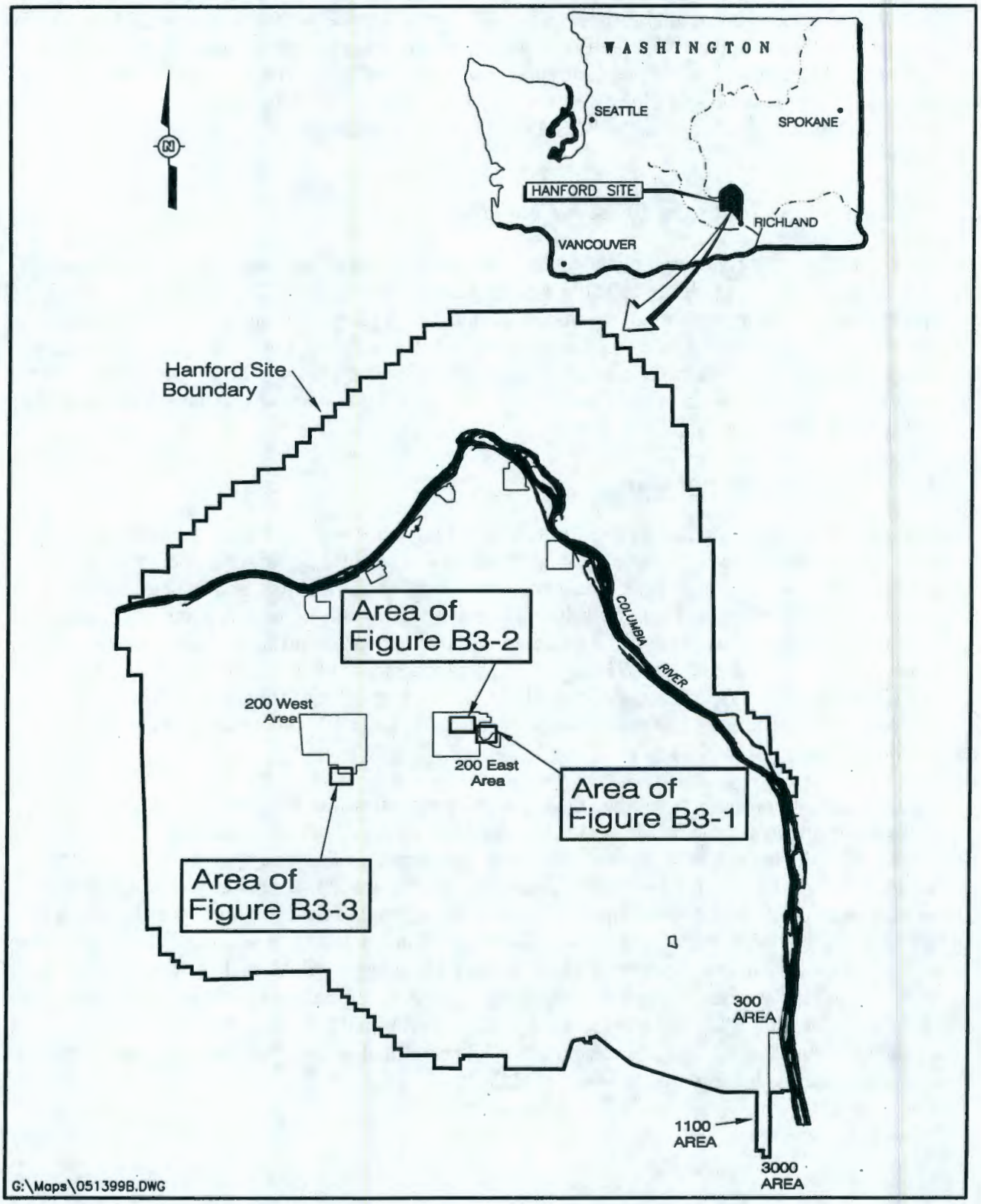

Table B1-1. Contaminants of Concern for 200-CS-1 Operable Unit (from BHI 1999).

Radioactive Constituents	
Americium-241	Plutonium-238
Cesium-137	Plutonium-239/240
Cobalt-60	Radium-228
Europium-152	Strontium-90
Europium-154	Technetium-99[a]
Europium-155	Tritium[a]
Gross alpha	Thorium-232
Gross beta	Uranium-233/234[b]
Neptunium-237	Uranium-235/236[b]
Nickel-63[a]	Uranium-238[b]
Chemical Constituents - Metals	
Arsenic	Lead
Barium	Mercury
Beryllium	Nickel
Cadmium	Selenium
Chromium	Silver
Hexavalent chromium	Vanadium
Copper	Zinc
Chemical Constituents - Other Inorganics	
Ammonia	Phosphate
Chloride	Sulfate
Cyanide	Sulfide
Fluoride	pH
Nitrate/nitrite	
Chemical Constituents - Volatile Organics	
Acetone	Halogenated hydrocarbons
1-butanol (butyl alcohol)	Methyl isobutyl ketone (MIBK)
2-butanone (MEK)	Propanol (isopropyl alcohol)
Carbon tetrachloride	Toluene
Chloroform (trichloromethane)	1,1,1 trichloroethane
Decane	1,1,2 trichloroethane
Dichloromethane (methylene chloride)	Xylene
Ethanol	
Semi-Volatile Organics	
Diesel fuel[c]	Polychlorinated biphenyls
Kerosene[c]	Shell E-2342 (napthalene and paraffin)[c]
Normal paraffin hydrocarbon[c]	Soltrol-170 ($C_{10}H_{22}$ to C_6H_{34}; purified kerosene)[c]
Paraffin hydrocarbons[c]	Tributyl phosphate

[a] These contaminants of concern (COCs) are deep-zone sensitive only. Analyses are not required for these COCs in the shallow zone soils, as they are soft beta emitters in low abundance that have insignificant dose impact in the shallow zone.

[b] Uranium will be analyzed for total abundance in all samples; any samples with values significantly above background levels will be analyzed for these individual species.

[c] Analyzed as kerosene total petroleum hydrocarbons.

Table B1-2. Data Quality Objectives Decision Rules (from BHI 1999).

DR #	Decision Rule
1	If the RESRAD results for the maximum detected concentrations of the radiological COCs in the sediment layer exceed annual exposure limits for human health protection (under the appropriate exposure scenario), then remedial alternatives[a] will be evaluated for the sediment layer in a feasibility study.
2	If the RESRAD results for the maximum detected concentrations of the radiological COCs from the top of the sediment layer (about 1.8 m [6 ft] bgs) to 4.6 to 7.6 m (15 or 25 ft) below grade (below the sediment layer) exceed annual exposure limits for human health protection (under the appropriate exposure scenario), then remedial alternatives[a] will be evaluated for these soils in a feasibility study.
3	If the maximum detected concentrations of chemical COCs in the sediment layer exceed the action levels (Table B2-1), then remedial alternatives[a] will be evaluated for the sediment layer in a feasibility study.
4	If the maximum detected concentrations of chemical COCs from the top of the sediment layer (about 1.8 m [6 ft] bgs) to 4.6 or 7.6 m (15 or 25 ft) (below the sediment layer) exceed action levels (Table B2-2), then remedial alternatives[a] will be evaluated for these soils in a feasibility study.
5	If the contaminant distributions in the 0 to 15 ft bgs or 25 ft zone and deep vadose zone (<4.6 m [>15 ft] or 7.6 m [25 ft] bgs) for all four RCRA TSD units sampled differ significantly from the conceptual contaminant distribution model, then the conceptual contaminant distribution model will be revised prior to use in remedial decision or remedial action planning efforts for the three non-RCRA TSD units.

[a] The use of the term "remedial alternative" is used collectively to refer to one or more of the alternatives described in Section B1.5.1. The selection of an appropriate alternative is beyond the scope of this document.
bgs = below ground surface
COCs = contaminants of concern
RESRAD = RESidual RADioactivity dose model
TSD = treatment, storage, and disposal

B2.0 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 *200 Areas Remedial Investigation/Feasibility Study Implementation Plan - Environmental Restoration Program* (hereinafter referred to as the Implementation Plan) (DOE-RL 1999). The QAPjP complies with the requirements of the U.S. Department of Energy (DOE) Order 5700.6c, *Quality Assurance*; the *Code of Federal Regulations* (CFR), 40 CFR 830.120, "Quality Assurance Requirements"; *EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations* (EPA 1994b); and *the Hanford Analytical Services Quality Assurance Requirements Documents* (HASQARD) (DOE-RL 1996a). The Implementation Plan provides the general framework of technical and administrative requirements that apply to 200-CS-1 and other OUs in the 200 Areas.

To meet the site-specific needs for the 200-CS-1 OU, the QAPjP identifies supplemental requirements developed during the DQO process and described in this group-specific SAP. These requirements are listed below:

- Analytical performance - Requirements for detection limits, precision, and accuracy are presented in Tables B2-1 and B2-2. The analytical methods are also shown in these tables.

- Field quality control (QC) - The frequency and type of QC samples to be collected are addressed in Section B2.1.

- Sample preservation, containers, and holding time - The requirements for the specific test/laboratory methods are addressed in Section B2.3 and in Table B2-3.

- Onsite measurements quality control - The specific types of QC samples for onsite measurements and the frequency of collection are addressed in Section B2.4.

- Data validation and usability - Specific validation requirements, including the frequency and level of validation, are addressed in Section B2.6.

The following sections describe the supplemental waste group quality requirements and the procedural controls applicable to this investigation. The 200 Area QAPjP (Appendix A of the Implementation Plan [DOE-RL 1999]) and this section of the SAP will serve as the QAPjP for the 200-CS-1 OU remedial investigation.

B2.1 FIELD QUALITY CONTROL

Field QC samples shall be collected to evaluate the potential of cross-contamination and laboratory performance. Field QC for sampling sites in the 200-CS-1 OU will require the

collection of co-located duplicates, field splits, equipment rinsate blanks, and trip blank samples. The QC samples are described in this section with the required frequency of collection.

B2.1.1 Co-Located Duplicates

Co-located duplicates are independent samples collected as close as possible to the same point in space and time, taken from the same source, stored in separate containers, and analyzed independently. These samples are useful in documenting homogeneity in the soil. It is important that these samples are not homogenized together.

A minimum of 5% of the total collected samples shall be duplicated, or one field duplicate shall be collected for every 20 samples, whichever is greater. At least two co-located duplicates shall be collected from each waste site and one will be collected from each borehole. The duplicates should generally be collected from an area that is expected to have some contamination so valid comparisons between the samples can be made (i.e., at least some of the COCs will be present above the detection limit). When sampling with a split-spoon sampler, the duplicate sample may be from a separate split-spoon sample, either above or below the main sample because of soil sample volume constraints. The split-spoon duplicate should be collected somewhere below the interval of continuous coring and above 7.6 m (25 ft) below ground surface (bgs), with the exception of the S Pond boring. The split-spoon co-located duplicate for the S Pond boring will be collected at the first sample interval.

B2.1.2 Field Splits

Split samples shall be collected at the same frequency as co-located duplicate samples, with at least two samples collected per waste site and one per borehole. Split samples shall be retrieved from the same sample interval using the same equipment and sampling technique; sampling limitations involving split-spoon samples, as discussed in Section B2.1.1, also apply to field splits. Samples shall be split in the field and sent to two independent laboratories. Splits will be used to verify the performance of the primary laboratory.

B2.1.3 Equipment Rinsate Blanks

Equipment blanks shall be collected at the same frequency as co-located duplicate samples (where applicable) and if sampling equipment is reused, and the equipment blanks are 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 field decontaminated sampling or pre-cleaned equipment and placed in containers identical to those used for actual field samples.

Equipment rinsate blanks shall be analyzed for the following:

- Gross alpha
- Gross beta
- Metals (excluding hexavalent chromium and mercury)
- Anions (except cyanide)
- pH

- Semi-volatile organic analyte
- Volatile organic analytes.

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

B2.1.4 Trip Blanks

The volatile organic trip blanks will constitute approximately 5% of all volatile organic compound samples, which equates to approximately every sixth batch (cooler) of sample containers shipped. A total of eight trip blanks are expected to be collected (see Table B3-6). The trip blank shall consist of pure deionized water added to one clean sample container in the field 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 for volatile organic compounds only.

B2.1.5 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 them on or near potential contamination sources such as uncovered ground
- Handling bottles or equipment with dirty hands
- Improperly decontaminating equipment before sampling or between sampling events.

B2.2 QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

Quality objectives and criteria for measurement data are presented in Tables B2-1 and B2-2 for radiological and chemical analytes of interest and for soil physical properties.

B2.3 SAMPLE PRESERVATION, CONTAINERS, AND HOLDING TIMES

Sample preservation, containers, and holding times for radiological and chemical analyses and for soil physical property tests are presented in Table B2-3. Final sample collection requirements will be identified on a Sampling Authorization Form.

B2.4 ONSITE MEASUREMENTS QUALITY CONTROL

The collection of QC samples for onsite measurements QC is not applicable the field screening techniques described in this plan. Field screening instrumentation will be calibrated and controlled according to the procedures identified in Section B2.7.

B2.5 DATA MANAGEMENT

Data resulting from the implementation of this QAPjP shall be managed and stored by the Environmental Restoration Contractor (ERC) organization responsible for data management, in accordance with BHI-EE-01, *Environmental Investigations Procedures*, Section 2.0, "Sample Management." The information management overview (IMO) for data management activities is provided in detail in Appendix C of the Implementation Plan (DOE-RL 1999). The IMO will be used to define the process for collection and control of all data, records, documents, and correspondence generated at 200 Area OUs. At the direction of the task lead, all analytical data packages shall be subject to final technical review by qualified personnel before submittal to regulatory agencies or 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* (Ecology et al. 1990).

B2.6 DATA VALIDATION REQUIREMENT

Validation shall be performed on completed data packages by qualified Bechtel Hanford, Inc. (BHI) sample management personnel or by a qualified independent contractor. Validation shall consist of verifying required deliverables, requested versus reported analyses and associated requirements, 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 10% of all data, and/or a minimum of one data package/sample delivery group, shall be validated. Assuming that approximately 132 samples will be collected during the 200-CS-1 OU investigations (including full QC sets, but exclusive of discretionary samples [see Table B3-6]), at least six data packages (sample delivery groups containing 20 sample sets) will be generated. At least one sample data package will be validated. Validation requirements identified in this section are consistent with Level C validation, as defined in data validation procedures (WHC 1993a, 1993b). Validation for physical data will not be performed.

B2.7 TECHNICAL PROCEDURES AND SPECIFICATIONS

Sampling and onsite environmental measurements shall be performed according to approved procedures. Sampling and field measurements will be conducted according to BHI-EE-01;

BHI-EE-05, *Field Screening Procedures*; and 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*

  Section 1.0, General Information
  - Procedure 1.5, "Field Logbooks"
  - Procedure 1.6, "Survey Requirements and Techniques"

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

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

  Section 4.0, Soil, Groundwater, and Biotic Sampling
  - Procedure 4.0, "Soil and Sediment Sampling"
  - Procedure 4.2, "Sample Storage and Shipping Facility"

  Section 5.0, Sampling Techniques
  - Procedure 5.2, "Test Pit Excavation in Contaminated Areas"

  Section 6.0, Drilling
  - Procedure 6.0, "Documentation of Well Drilling, Abandonment, Remediation, and Completion Operations"
  - Procedure 6.1, "Drilling and Sampling in Radiological Contaminated Areas"
  - Procedure 6.2, "Field Cleaning and/or Decontamination of 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 2.4. "Operation of the Man-Carried Radiological Detection System (MRDS)"
  - Procedure 2.5, "Operation of the Mobile Surface Contaminant Monitor II"
  - Procedure 2.12, "Eberline E-600 Usage for Environmental Surveys"

- BHI-FS-03, *Field Support Waste Management Instructions*
  - Instruction W-011, "Control of CERCLA and Other Past-Practice Investigation Derived Waste"

- *Environmental Investigations Instructions*, WHC-CM-7-7 (WHC 1988)
  - Instruction 5.5, "Laboratory Cleaning of RCRA/CERCLA Sampling Equipment."

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

- BHI-EE-02, *Environmental Requirements*, Section 11.0, "Solid Waste Management"
- BHI-QA-01, *ERC Quality Program*
- BHI-QA-03, *ERC Quality Assurance Program Plans*
  - Plan 5.1, "Field Sampling Quality Assurance Program Plan"
  - Plan 5.2, "Onsite Measurements Quality Assurance Program Plan"
  - Plan 5.3, "Radiological Measurements and Environmental Support Quality Assurance Program Plan"
- BHI-MA-02, *ERC Project Procedures*
- BHI-SH-01, *Hanford ERC Environmental, Safety, and Health Program*
- BHI-SH-05, *Industrial Hygiene Work Instructions*
- BHI-SH-02, *Safety and Health Procedures,* Volumes 1 through 4
- BHI-EE-10, *Waste Management Plan*
- BHI-SH-04, *Radiological Control Work Instructions*
- *Hanford Site Radiological Control Manual* (DOE-RL 1996b)
- Specification for environmental drilling services specific to 200-CW-1.

B2.7.1 Sample Location

Sample locations (e.g., boreholes and test pits) shall be staked and labeled prior to beginning the sampling. Locations shall be staked by the technical lead or the field team leader assigned by the project manager. After the locations have been staked, minor adjustments to location may be made to mitigate unsafe conditions, avoid structural interferences, or bypass utilities. Locations shall be identified during or after sampling following BHI-EE-01, Procedure 1.6, "Survey Requirements and Techniques." Changes in test pit and borehole locations that do not impact the DQOs will require approval of the project manager. However, if a change in the location results in an impact to the DQOs, Ecology will be notified to concur with the strategy.

B2.7.2 Sample Identification

The ERC Sample and Data Tracking database will be used to track the samples through the collection and 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/initials of person collecting the sample
- Analysis required
- Preservation method, if applicable.

B2.7.3 Field Sampling Logbook

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 making the entry.

B2.7.4 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 (cooler) shipped to any laboratory 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 prior to sample shipment and transmit the chain-of-custody to ERC Sample and Data 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 affixed to the lid of each sample jar. 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 a glovebox.

B2.7.5 Sample Containers and Preservatives

Level I EPA pre-cleaned sample containers will be used for soil samples collected for radiological and chemical analyses. Container sizes may vary depending upon laboratory-specific volumes needed to meet 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 and Data Management to determine acceptable volumes. Preliminary container types and volumes are identified in Table B2-3.

B2.7.6 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 by the Radiological Counting Facility (RCF), the 222-S Laboratory, or other suitable onsite laboratory prior to shipment. This information, as well as 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. The sampler will send copies of the shipping documentation to ERC Sample and Data Management within 24 hours of shipping, as detailed in BHI-EE-01, Procedure 2.1, "Sampling Documentation Processing."

As a general rule, samples with activities <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 and Data Management. Samples with activities >10 mR/hr will be sent to an onsite laboratory.

Table B2-1. Analytical Performance Requirements – Shallow Zone Soils (<15 ft bgs). (3 pages)

Data Type	Analytical Method	Analyte	Preliminary Action Level		Detection Limit Requirement		Accuracy Required	Precision Required
			Meth C[a]	Meth B	MDL	PQL		
Radiological Constituents, in pCi/g								
Rad, α	GeLi/HPGe AmAEA[b]	Americium-241	i		0.1 0.1	1 1	80-120 70-130	±30 ±30
Rad, γ	GeLi/HPGe	Cesium-137	i		0.05	0.1	80-120	±30
Rad, γ	GeLi/HPGe	Cobalt-60	i		0.05	0.1	80-120	±30
Rad, γ	GeLi//HPGe	Europium-152	i		0.1	0.2	80-120	±30
Rad, γ	GeLi/HPGe	Europium-154	i		0.1	0.2	80-120	±30
Rad, γ	GeLi/HPGe	Europium-155	i		0.05	0.1	80-120	±30
Rad, α	Gross alpha, GPC	Gross alpha	i		5	10	70-130	±30
Rad, β	Gross beta, GPC	Gross beta	i		3	15	70-130	±30
Rad, α	NpAEA[b]	Neptunium-237	i		0.1	1	70-130	±30
Rad, α	PuAEA[b]	Plutonium-238	i		0.1	1	70-130	±30
Rad, α	PuAEA[b]	Plutonium-239/240	i		0.1	1	70-130	±30
Rad	GeLi/HPGe	Radium-228	i		0.1	0.2	80-120	±30
Rad	RADSr	Total radioactive strontium	i		0.2	1	70-130	±30
Rad, α	ThAEA[b]	Thorium-232	i		0.1	1	70-130	±30
Rad	KPA	Total uranium	N/A		0.2 mg/kg	1.0 mg/kg	70-130	±30
Rad, α	UAEA[b]	Uranium-233/234	i		0.1	1	70-130	±30
Rad, α		Uranium-235/236	i		0.1	1	70-130	±30
Rad, α		Uranium-238	i		0.1	1	70-130	±30
Inorganic Chemical Constituents, in mg/kg[c]								
Chem	EPA 6010	Arsenic	6.5[d]	6.5[d]	2.5/.2[e]	10/1[e]	70-130	±30
Chem	EPA 6010	Barium	245[f]	132[d,f]	0.1	1	70-130	±30
Chem	EPA 6010	Beryllium	1.51[d]	1.51[d]	0.03	0.2	70-130	±30
Chem	EPA 6010	Cadmium	0.5[f]	0.5[f]	0.3	0.8	70-130	±30
Chem	EPA 6010	Chromium (III)	3,500[f]	1,600[f]	0.4	1	70-130	±30
Chem	EPA 7196	Hexavalent chromium	17.5	8.0	0.1	0.7	70-130	±30
Chem	EPA 6010	Copper	130[f]	59.2[f]	0.5	2	70-130	±30
Chem	EPA 6010	Lead	353[f,g]	353[f,g]	3	20	70-130	±30
Chem	EPA 7471	Mercury	0.33[d,f]	0.33[d,f]	0.005	0.05	70-130	±30
Chem	EPA 6010	Nickel	70[f]	32[f]	1	4	70-130	±30
Chem	EPA 6010	Selenium	5[f]	5[f]	5	20	70-130	±30
Chem	EPA 6010	Silver	10[f]	8[f]	0.7	2	70-130	±30
Chem	EPA 6010	Vanadium	24.5[f]	11.2[f]	0.5	3	70-130	±30
Chem	EPA 6010	Zinc	500[f]	480[f]	0.5	2	70-130	±30
Chem	EPA 350.1	Ammonia	59,500	27,200	0.2	0.5	70-130	±30
Chem	EPA 300.0	Chloride	25,000	25,000	0.2	2	70-130	±30
Chem	EPA 9010	Cyanide	20	20	0.25	1	70-130	±30
Chem	EPA 300.0	Fluoride	200	96	0.2	1	70-130	±30

Table B2-1. Analytical Performance Requirements – Shallow Zone Soils (<15 ft bgs). (3 pages)

Data Type	Analytical Method	Analyte	Preliminary Action Level		Detection Limit Requirement		Accuracy Required	Precision Required
			Meth C[a]	Meth B	MDL	PQL		
Chem	IC 353.1[h] and EPA 300.0	Nitrate and nitrate/nitrite as N	4,400/330	4,400/330	0.02/ 0.1	0.2/ 0.5	70-130	±30
Chem	IC 353.1[h] and EPA 300.0	Nitrite and nitrate/nitrite as N	330	330	0.2	1	70-130	±30
Chem	EPA 300.0	Phosphate	N/A[e]	N/A[e]	0.6	6	70-130	±30
Chem	EPA 300.0	Sulfate	25,000	25,000	2	10	70-130	±30
Chem	EPA 9030	Sulfide	N/A	N/A	4	20	70-130	±30
Chem	EPA 9045 or field measurement	pH	N/A	N/A	N/A	N/A	70-130	±30
Organic Chemical Constituents, in mg/kg								
Chem	EPA 8260	Acetone	175	80	0.05	0.01	70-130	±30
Chem	EPA 8260	1-Butanol (butyl alcohol)	350	160	0.4	1	70-130	±30
Chem	EPA 8260	2-butanone (MEK)	1,050	480	0.005	0.01	70-130	±30
Chem	EPA 8260	Carbon tetrachloride	0.337	0.0337	0.001	0.005	70-130	±30
Chem	EPA 8260	Chloroform (trichloromethane)	7.17	0.717	0.001	0.005	70-130	±30
Chem	EPA 8260 as TIC	Decane	N/A	N/A	N/A	N/A	N/A	N/A
Chem	EPA 8260	Dichloromethane (methylene chloride)	0.5	0.5	0.002	0.005	70-130	±30
Chem	EPA 8260 as TIC	Ethanol	N/A	N/A	N/A	N/A	N/A	N/A
Chem	EPA 8260	Halogenated hydrocarbons	N/A	N/A	0.002	0.005	70-130	±30
Chem	EPA 8260	Methyl isobutyl ketone (MIBK)	64	140	N/A	N/A	N/A	N/A
Chem	EPA 8260 as TIC	Propanol (isopropyl alcohol)	N/A	N/A	N/A	N/A	N/A	N/A
Chem	EPA 8260	Toluene	100	100	0.001	0.005	70-130	±30
Chem	EPA 8260	Xylene	1,000	1,000	0.001	0.005	70-130	±30
Chem	EPA 8260	1,1,1-trichloroethane	20	20	0.001	0.005	70-130	±30
Chem	EPA 8260	1,1,2-trichloroethane	0.3	0.0768	0.001	0.005	70-130	±30
Chem	EPA 8270	Tributyl phosphate	N/A	N/A	0.4	4	70-130	±30
Chem	EPA 8082	Polychlorinated biphenyls	65[f]	0.5[f]	0.01	0.1	70-130	±30
Chem	NWTPH-Dx modified for kerosene range	Kerosene, normal paraffin hydrocarbons, paraffin hydrocarbons, shell E-2342 (napthalene and paraffin), Soltrol-170 ($C_{10}H_{22}$ to $C_{16}H_{34}$) purified kerosene, and diesel fuel	N/A	N/A	0.5	5	70-130	±30

Table B2-1. Analytical Performance Requirements – Shallow Zone Soils (<15 ft bgs). (3 pages)

Data Type	Analytical Method	Analyte	Preliminary Action Level		Detection Limit Requirement		Accuracy Required	Precision Required
			Meth C[a]	Meth B	MDL	PQL		
Soil Physical Properties								
Phys	ASTM D2216	Moisture content (wt%)	N/A	N/A	N/A	N/A	N/A	N/A
Phys	ASTM D422	Particle size distribution (wt%)	N/A	N/A	N/A	N/A	N/A	N/A
Phys	BHI-EE-01	Lithology	N/A	N/A	N/A	N/A	N/A	N/A
Phys	ASTM D2937 or field measurement	Bulk density (g/cm^3)	N/A	N/A	N/A	N/A	N/A	N/A

Notes: Detection limits in this table are based on optimal conditions. Interferences and different matrices may significantly degrade the values shown.

Dangerous waste generation is not expected at this operable unit (i.e., contained-in determination is expected for listed waste hydrazine). If generated, the concentrations of any underlying hazardous constituents will be evaluated against applicable regulatory requirements.

[a] Method C values are based on *Model Toxics Control Act* (MTCA) industrial standards (WAC 173-340).

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

[c] This project is subject to Phase IV *Resource Conservation and Recovery Act of 1976* (RCRA) implementation. Therefore, if any of the toxicity characteristic (TC) metals exceed the land disposal restriction threshold values as expressed by 20 times the toxicity characteristic leachate procedure (TCLP) limits, the remaining sample media, or drummed drill cuttings will be analyzed using TCLP for the TC metals. The TCLP analysis will also include antimony and thallium as potential underlying hazardous constituents.

[d] Based on Hanford Site background values.

[e] First value shown is via routine inductively coupled plasma (ICP), second value via "trace" ICP.

[f] The RESRAD model for the 100 Areas remedial design/remedial action or 100-N Area corrective measures study predicts that this constituent will not reach groundwater in 1,000 years. It is anticipated that the same will be true in the 200 Areas.

[g] The lead value is based on the *Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children* from EPA (EPA 1994c).

[h] Method is from *Methods for Chemical Analysis of Water and Wastes* (EPA 1984).

[i] There are no preliminary action levels for radionuclides at this time; they will be developed in the remedial investigation/feasibility study process.

α = alpha analysis
β = beta analysis
γ = gamma analysis
ASTM = American Society for Testing and Materials
EPA = U.S. Environmental Protection Agency
N/A = not applicable
GeLi = lithium-drifted germanium detector
GPC = gas proportional counting
HPGe = high-purity germanium
KPA = kinetic phosphorescence analysis
MDL = maximum detection limit
PQL = practical quantiation limit
RADSr = total radioactive strontium
TIC = tentatively identified compound

Table B2-2. Analytical Performance Requirements - Deep Zone Soils (>15 ft bgs). (3 pages)

Data Type	Analytical Method	Analyte	Preliminary Action Level		Detection Limit Requirements		Accuracy Req'd	Precision Req'd
			Meth C[a]	Meth B	MDL	PQL		
Radionuclides, in pCi/g								
Rad, α	GeLi/HPGe AmAEA[b]	Americium-241	i		0.1 0.1	1 1	80-120 70-130	±30 ±30
Rad, γ	GeLi/HPGe	Cesium-137	i		0.05	0.1	80-120	±30
Rad, γ	GeLi/HPGe	Cobalt-60	i		0.05	0.1	80-120	±30
Rad, γ	GeLi//HPGe	Europium-152	i		0.1	0.2	80-120	±30
Rad, γ	GeLi/HPGe	Europium-154	i		0.1	0.2	80-120	±30
Rad, γ	GeLi/HPGe	Europium-155	i		0.05	0.1	80-120	±30
Rad, α	Gross alpha, GPC	Gross alpha	i		5	10	70-130	±30
Rad, B	Gross beta, GPC	Gross beta	i		3	15	70-130	±30
Rad, α	NpAEA[b]	Neptunium-237	i		0.1	1	70-130	±30
Rad	Chem Separation Liq Scintillation	Nickel-63	i		5	30	70-130	±30
Rad, α	PuAEA[b]	Plutonium-238	i		0.1	1	70-130	±30
Rad, α	PuAEA[b]	Plutonium-239/240	i		0.1	1	70-130	±30
Rad, γ	GeLi/HPGe	Radium-228	i		0.1	0.2	80-120	±30
Rad	RADSr	Total radioactive strontium	i		0.2	1	70-130	±30
Rad	Chem Separation Liq Scintillation	Technetium-99	i		5	15	70-130	±30
Rad	Distillation Liq Separation	Tritium	i		5	400	70-130	±30
Rad, α	ThAEA[b]	Thorium-232	i		0.1	1	70-130	±30
Rad	KPA	Total uranium	N/A		0.2 mg/kg	1 mg/kg	70-130	±30
Rad, α	UAEA[b]	Uranium-233/234	i		0.1	1	70-130	±30
Rad		Uranium-235/236	i		0.1	1	70-130	±30
Rad		Uranium-238	i		0.1	1	70-130	±30
Inorganic Chemicals, in mg/kg[c]								
Chem	EPA 6010	Arsenic	6.5[d]	6.5[d]	2.5/0.2[e]	10/1[e]	70-130	±30
Chem	EPA 6010	Barium	245[f]	132[d,f]	0.1	1	70-130	±30
Chem	EPA 6010	Beryllium	1.51[d]	1.51[d]	0.03	0.2	70-130	±30
Chem	EPA 6010	Cadmium	0.5[f]	0.5[f]	0.3/0.02[d]	0.8/0.04[d]	70-130	±30
Chem	EPA 6010	Chromium (III)	3,500[f]	1,600[f]	0.4	1	70-130	±30
Chem	EPA 7196	Hexavalent chromium	17.5	8.0	0.1	0.7	70-130	±30
Chem	EPA 6010	Copper	130[f]	59.2[f]	0.5	2	70-130	±30
Chem	EPA 6010	Lead	353[f,g]	353[f,g]	3	20	70-130	± 30
Chem	EPA 7471	Mercury	0.33[d,f]	0.33[d,f]	0.005	0.05	70-130	±30
Chem	EPA 6010	Nickel	70[f]	32[f]	1	4	70-130	±30
Chem	EPA 6010	Selenium	5[f]	5[f]	5	20	70-130	±30
Chem	EPA 6010	Silver	10[f]	8[f]	0.7	2	70-130	±30
Chem	EPA 6010	Vanadium	24.5[f]	11.2[f]	0.5	3	70-130	±30
Chem	EPA 6010	Zinc	500[f]	480[f]	0.5	2	70-130	±30
Chem	EPA 350.1	Ammonia	59,500	27,200	0.2	0.5	70-130	±30

Table B2-2. Analytical Performance Requirements - Deep Zone Soils (>15 ft bgs). (3 pages)

Data Type	Analytical Method	Analyte	Preliminary Action Level		Detection Limit Requirements		Accuracy Req'd	Precision Req'd
			Meth C[a]	Meth B	MDL	PQL		
Chem	EPA 300.0	Chloride	25,000	25,000	0.2	2	70-130	±30
Chem	EPA 9010	Cyanide	20[f]	20[f]	0.25	1	70-130	±30
Chem	EPA 300.0	Fluoride	200	96	0.2	1	70-130	±30
Chem	IC 353.1[h] and EPA 300.0	Nitrate and nitrate/nitrite as N	4,400	4,400	0.02	0.2	70-130	±30
Chem	IC 353.1[h] and EPA 300.0	Nitrite and nitrate/nitrite as N	330	330	0.2	1	70-130	±30
Chem	EPA 300.0	Phosphate	N/A[e]	N/A[e]	0.6	6	70-130	±30
Chem	EPA 300.0	Sulfate	25,000	25,000	2	10	70-130	±30
Chem	EPA 9030	Sulfide	N/A	N/A	4	20	70-130	±30
Chem	EPA 9045	pH	N/A	N/A	N/A	N/A	70-130	±30
Chem	Field measurement	pH	N/A	N/A	N/A	N/A	N/A	N/A
Organic Chemicals, in mg/kg								
Chem	EPA 8260	Acetone	175	80	0.05	0.01	70-130	±30
Chem	EPA 8260	1-butanol (butyl alcohol)	350	160	0.4	1	70-130	±30
Chem	EPA 8260	2-butanone (MEK)	1,050	480	0.005	0.01	70-130	±30
Chem	EPA 8260	Carbon tetrachloride	0.337	0.0337	0.001	0.005	70-130	±30
Chem	EPA 8260	Chloroform (trichloromethane)	7.17	0.717	0.001	0.005	70-130	±30
Chem	EPA 8260 as TIC	Decane	N/A	N/A	N/A	N/A	N/A	N/A
Chem	EPA 8260	Dichloromethane (methylene chloride)	0.5	0.5	0.002	0.005	70-130	±30
Chem	EPA 8260 as TIC	Ethanol	N/A	N/A	N/A	N/A	70-130	±30
Chem	EPA 8260	Halogenated hydrocarbons	N/A	N/A	0.002	0.005	70-130	±30
Chem	EPA 8260	Methyl isobutyl ketone (MIBK)	64	140	N/A	N/A	N/A	N/A
Chem	EPA 8260 as TIC	Propanol (isopropyl alcohol)	N/A	N/A	N/A	N/A	N/A	N/A
Chem	EPA 8260	Toluene	100	100	0.001	0.005	70-130	±30
Chem	EPA 8260	Xylene	1,000	1,000	0.001	0.005	70-130	±30
Chem	EPA 8260	1,1,1-trichloroethane	20	20	0.001	0.005	70-130	±30
Chem	EPA 8260	1,1,2-trichloroethane	0.3	0.0768	0.001	0.005	70-130	±30
Chem	EPA 8270	Tributyl phosphate	N/A	N/A	0.4	4	70-130	±30
Chem	EPA 8080/8082	Polychlorinated biphenyls	65[e]	0.5[e]	0.01	0.1	70-130	±30
Chem	NWTPH-Dx modified for kerosene range	Kerosene, normal paraffin hydrocarbons, paraffin hydrocarbons, Shell E-2342 (napthalene and paraffin), Soltrol-170 ($C_{10}H_{22}$ to $C_{16}H_{34}$), purified kerosene, and diesel fuel	N/A	N/A	0.5	5	70-130	±30

Table B2-2. Analytical Performance Requirements - Deep Zone Soils (>15 ft bgs). (3 pages)

Data Type	Analytical Method	Analyte	Preliminary Action Level		Detection Limit Requirements		Accuracy Req'd	Precision Req'd
			Meth C[a]	Meth B	MDL	PQL		
Soil Physical Properties								
Phys	ASTM D2216	Moisture content (wt%)	N/A	N/A	N/A	N/A	N/A	N/A
Phys	ASTM D422	Particle size distribution (wt%)	N/A	N/A	N/A	N/A	N/A	N/A
Phys	BHI-EE-01	Lithology	N/A	N/A	N/A	N/A	N/A	N/A
Phys	Field Measurement	Bulk density (g/cm^3)	N/A	N/A	N/A	N/A	N/A	N/A

Notes: Detection limits in this table are based on optimal conditions. Interferences and different matrices may significantly degrade the values shown.
Dangerous waste generation is not expected at this operable unit (i.e., contained-in determination is expected for listed waste hydrazine). If generated, the concentrations of any underlying hazardous constituents will be evaluated against applicable regulatory requirements.

[a] Method C values are based on *Model Toxics Control Act* (MTCA) industrial standards (WAC 173-340).
[b] AmAEA, PuAEA, UAEA, NpAEA, ThAEA -- chemical separation, electro/microprecipitation deposition, alpha energy analysis via Si barrier detector.
[c] This project is subject to Phase IV *Resource Conservation and Recovery Act of 1976* (RCRA) implementation. Therefore, if any of the toxicity characteristic (TC) metals exceed the land disposal restriction threshold values as expressed by 20 times the toxicity characteristic leachate procedure (TCLP) limits, the remaining sample media, or drummed drill cuttings will be analyzed using TCLP for the TC metals. The TCLP analysis will also include antimony and thallium as potential underlying hazardous constituents.
[d] Based on Hanford Site background values.
[e] First value shown is via routine inductively coupled plasma (ICP), second value via "trace" ICP.
[f] The RESRAD model for the 100 Areas remedial design/remedial action or 100-N Area corrective measures study predicts that this constituent will not reach groundwater in 1,000 years. It is anticipated that the same will be true in the 200 Areas.
[g] The lead value is based on the *Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children* from EPA (EPA 1994c).
[h] Method is from *Methods for Chemical Analysis of Water and Wastes* (EPA (1984).
[i] There are no preliminary action levels for radionuclides at this time; they will be developed in the remedial investigation/feasibility study process.

α = alpha analysis
β= beta analysis
γ = gamma analysis
ASTM = American Society for Testing and Materials
EPA = U.S. Environmental Protection Agency
N/A = not applicable
GeLi = lithium-drifted germanium detector
HPGe = high-purity germanium
KPA = kinetic phosphorescence analysis
MDL = maximum detection limit
PQL = practical quantitation limit
TIC = tentatively identified compound

Table B2-3. Sample Preservation, Container, and Holding Time Guidelines. (2 pages)

Analytical Method	Analytes	Analytical Priority	Bottle		Volume[a]	Preservation	Packing Requirements	Holding Time
			Number	Type				
Radionuclides								
GeLi/HPGe AmAEA[b]	Americium-241	10	1	G/P	10 g	None	None	6 months
Gross alpha, GPC	Gross alpha	TBD	1	G/P	10 g	None	None	6 months
Gross beta, GPC	Gross beta	TBD	1	G/P	10 g	None	None	6 months
Gamma spectroscopy	Cesium-137,; cobalt-60,; europium-152, -154, -155; radium-228	1	1	G/P	1,500 g	None	None	6 months
PuAEA[b]	Isotopic plutonium	5	1	G/P	10 g	None	None	6 months
ThAEA[b]	Isotopic thorium	6	1	G/P	6 g	None	None	6 months
UAEA[b]	Isotopic uranium	[c]	1	G/P	10 g	None	None	6 months
NpAEA[b]	Neptunium-237	7[d]	1	G/P	10 g	None	None	6 months
Chem Separation Liq Scintillation	Nickel-63[d]	4[d]	1	G/P	6 g	None	None	6 months
RADSr	Total radioactive strontium	2	1	G/P	10 g	None	None	6 months
Chem Separation Liq Scintillation	Technetium-99[c]	4[d]	1	G/P	6 g	None	None	6 months
KPA	Total uranium[c]	3	1	G/P	6 g	None	None	6 months
Chem Separation Liq Scintillation	Tritium – H3[d]	4[d]	1	G	100 g	None	None	6 months
Inorganic Chemicals								
ICP metals – 6010A	ICP metals	4	1	G/P	250 g	None	None	6 months
ICP metals – 6010A (TAL)	ICP metals (TAL)	4	1	G/P	15 g	None	None	6 months
EPA 7196	Hexavalent chromium	4	1	G/P	500 mL	None	Cool 4°C	30 days
EPA 7471	Mercury–(CV)	12	1	G	125 g	None	None	28 days
EPA 9010	Total cyanide	16	1	G	40 g	None	Cool 4°C	14 days
EPA 350.1	Ammonia	15	1	G/P	300 mL	None	Cool 4°C	28 days
EPA 300.0 and IC 353.1	Nitrate and nitrate/nitrite as N[e]	7	1	G/P	250 g	None	None	28 days/48 hours
EPA 9030	Sulfide	11	1	G	40 g	None	Cool 4°C	7 days
pH (soil) – 9045 or field method	pH (soil) – 9045	17	1	G/P	250 g	None	None	ASAP
Chem	Field pH measurement	17	N/A	N/A	N/A	N/A	N/A	N/A
Organic Chemicals								
EPA 8260 (TCL)	VOA (TCL)	18	1	G	50 g	None	Cool 4°C	14 days
EPA 8270A	SVOA (TCL)	8	1	aG	250 g	None	Cool 4°C	14/40 days
EPA 8082	PCBs	14	1	aG	250 g	None	Cool 4°C	14/40 days
NWTPH-Dx modified for kerosene range	TPH – diesel range	9	1	G	200 g	None	Cool 4°C	14 days

Table B2-3. Sample Preservation, Container, and Holding Time Guidelines. (2 pages)

Analytical Method	Analytes	Analytical Priority	Bottle		Volume[a]	Preservation	Packing Requirements	Holding Time
			Number	Type				
Physical Properties								
ASTM D2216	Moisture content	19	1	G/P	1,000 g	None	None	None
ASTM D422	Particle size distribution	20	1	G/P	TBD	None	None	None
BHI-EE-01	Lithology	TBD	TBD	TBD	TBD	None	None	None
ASTM D2937 or field method	Bulk density (g/cm^3)	21	1	G/P	1,000 g	None	None	None

[a] Optimal volumes, which may be adjusted downward to accommodate the possibility of retrieval of small amount of sample. Minimum sample size will be defined in the Sampling Authorization Form.

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

[c] Uranium will be analyzed for total abundance in all samples; any samples with values significantly above background levels will be analyzed for individual species (UAEA).

[d] These radionuclides are constituents of concern in the deep zone only and will only be analyzed for in the deeper borehole samples (>25 ft). Their analytical priority will be the same as ICP metals (four).

[e] Chloride, fluoride, nitrate, nitrite, phosphate, and sulfate.

G = glass
P = plastic
aG = amber glass
ASAP = as soon as possible
ASTM = American Society for Testing and Materials
CV = cold vapor
EPA = U.S. Environmental Protection Agency
GFAA = graphite furnace atomic absorption
GeLi = lithium-drifted germanium detector
HPGe = high-purity germanium
KPA = kinetic phosphorescence analysis
TBD = to be determined
TCL = target compound list
TAL = target analyte list

B3.0 FIELD SAMPLING PLAN

B3.1 SAMPLING OBJECTIVES

The primary objective of the field sampling plan (FSP) is to clearly identify and describe sampling and analysis activities that will be conducted to resolve decision rules identified in Step 5 of the DQO process (see Section B1.5.2). Decision rule statements indicate that remedial action will be necessary if risks to human health and the environment are unacceptable pursuant to the *Model Toxics Control Act* (MTCA) (Washington Administrative Code [WAC] 173-340), CERCLA, and dangerous waste regulations (WAC 173-303). The field activities described in this section are intended to address and resolve these decision rules. The FSP uses the sampling design proposed in DQO Step 7 (BHI 1999) and describes pertinent elements of the sampling program. Sampling methods, procedures, locations, frequencies, and depths are identified in this section.

Four boreholes and 10 test pits (or shallow auger borings) will be excavated to characterize the four waste sites in the 200-CS-1 OU. Samples will be collected to determine if residual contamination remains in the soil column that is attributable to past operation of liquid disposal units in the 200 Areas.

Soil samples will be collected from the vadose zone and analyzed for a suite of chemical and radiological components; samples collected from boreholes will be analyzed for selected physical properties. A split-spoon sampler will be the primary sampling device used for the boreholes (or auger borings); test pits shall be excavated and sampled with an excavator. The locations of planned and historical boreholes and the planned test pits are shown in Figures B3-1 through B3-3.

B3.2 FIELD MEASUREMENTS

B3.2.1 Surface Radiation Survey

A surface radiation survey shall be performed at each waste site. The survey shall be performed to document existing surface contamination and to support preparation of supporting health and safety documentation. Surface radiation surveys shall be conducted by qualified RCTs in accordance with applicable health and safety procedures. A survey report will be prepared for each site. Surveys shall be performed according to BHI-EE-05, Procedure 2.4, "Operation of the Man-Carried Radiological Detection System," and Procedure 2.5, "Operation of the Mobile Surface Contamination Monitoring System," or other applicable approved procedures. A post-sampling survey will also be performed at each sampling site to ensure that sampling activities have not contributed to surface contamination.

B3.2.2 Soil Screening

All samples and cuttings from boreholes and test pits will be field screened for evidence of radioactive contamination by the RCT or other qualified personnel. Surveys of these materials

shall be conducted with field instruments. Potential screening instruments are listed in Table B3-1 with their respective detection limits. The RCT shall record all field measurements, noting the depth of the sample and the instrument reading.

Prior to excavation or drilling, 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 excavated soil or drill cuttings and visual observations of the soil (i.e., sediment/clay layer, organic debris) will be used to identify the bottom of the ditch, pond, or trench where contamination is expected to be greatest (i.e., ditch/pond bottom sediment layer); to adjust sampling points; to assist in determining sample shipping requirements; and to support worker health and safety monitoring. The site geologists will use professional judgment, screening data, and the information provided in Tables B3-2 through B3-5 to finalize sampling interval decisions.

The action level for radionuclide screening is twice background, and the action level for volatile organic screening is 5 parts per million (ppm). Field screening for volatile organic analytes will not be performed except for health and safety concerns. Intervals above these action levels will be referred to as "hot spots" and will be assessed for sampling by the field geologist. Samples exceeding 0.5 mrem/hr will be stored at a temporary radioactive material storage area until shipment to the laboratory.

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.

B3.3 SOIL SAMPLING AND ANALYSIS

The following sections discuss the details of sampling soil from boreholes and test pits.

B3.3.1 Borehole Sampling and Analysis

Chemical, radiological, and physical samples shall be collected from four deep boreholes, one at each of the four sampling sites. Boreholes will be drilled in the following locations (shown in Figures B3-1 through B3-3):

- 216-A-29 Ditch - At the influent (south) end of the ditch, just downstream of the approximate intersection of the cooling water and chemical sewer streams. The borehole will be advanced to a depth just above the water table, which is expected to be encountered around 72 m (235 ft) bgs.

- 216-B-63 Trench - At the influent (west) end of the trench, where effluent discharges from the pipeline. The borehole will be advanced to a depth of 31 m (100 ft). Drilling will not be conducted beyond this depth because an existing borehole is located in the vicinity of the trench.

- 216-S-10 Ditch - At a location about half way between the influent (northeast) and effluent ends of the ditch, where the sides of the ditch have been stabilized. The borehole will not be located at the influent end of the ditch because the slope is too steep to allow equipment access.[1] The borehole will be advanced to just above the water table, which is expected to be encountered around 69 m (225 ft) bgs.

- 216-S-10 Pond - Borehole sampling at the 216-S-10 Pond will be integrated with the installation of a downgradient RCRA interim status groundwater monitoring well and will be located as close to the edge and influence of the waste site as possible. Field screening will only be conducted during the first 15.3 m (50 ft) of drilling at this boring.

At the ditch and trench sites, the borehole will be located at the approximate center of the ditch where the center of the channel is expected. Methods that may be used to locate the ditch center include excavating a shallow trench perpendicular to the sides of the ditch/trench and using field screening measurements (i.e., beta/gamma activity) and/or visual observations, Hanford Geologic Information System coordinates, or instrumentation such as ground-penetrating radar.

Borehole sample collection shall be guided by the sampling scheme illustrated in Figure B3-4 and are representative of what may be encountered in the field. Site-specific sampling schedules are presented in Tables B3-2 through B3-5.The intent of the sampling design is to begin sample collection at the top of the historical sediment layer, at the original bottom of the unit. The exception to this is the 216-S-10 Pond borehole that will be located outside of the pond proper. This borehole will be sampled beginning at the 10.7 to 11.3 m (35- to 37 ft) bgs interval at the request of the Washington State Department of Ecology (Ecology). A reduced analyte list will be associated with this sample. A test pit will be located at the influent to the pond to obtain shallow zone soil samples in the area where the largest amount of contamination possibly exists. The top of the sediment layer will be identified by retrieving soil samples and examining the samples using radiological field screening measurements for beta/gamma activity and by visual inspection of the soil. It is anticipated that the top of the sediment layer will be intercepted about 0.6 to 2.4 m (2 to 8 ft) bgs. A 0.6-m (2-ft) interval of soil using split-spoon samples will be collected at each depth for boreholes.

Borehole soil samples will be collected at the following depths:

- Five shallow zone samples will be collected from the top of the sediment layer to 3.1 m (10 ft) below the top of the sediment layer, at 0.76-m (2.5-ft) intervals.[2] Based on the expected depth of the top of the sediment layer, the bottom of the last interval sample (3.1 to 3.7 m [10 to 12 ft] below the top of the sediment layer) would correspond to a depth of 4.3 to 6.1 m (14 to 20 ft) bgs.

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[1] A shallow test pit is planned at the influent end of the 216-D-10 Ditch, which will be excavated using hand-held equipment.

[2] Sample depths refer to the top of the 0.6 m (2-ft) interval of soil at that location (e.g., a sample collected at 3.1 m [10 ft] below the top of the sediment layer will correspond to the interval from 3.1 to 3.7 m [10 to 12 ft] below the top of the sediment layer).

- Deep zone (greater than 4.6 m [15 ft] bgs) samples will be collected at 6.1 to 7.6 m (20 and 25 ft) bgs. If either of these samples that have the ground surface as the reference coincide with sampling intervals collected with reference to the top of the sediment layer, one sample will be sufficient.

- Deep zone samples will be collected at 15.3 m (50 ft) bgs, and at 15.3-m (50-ft) intervals to groundwater, with the exception of 216-B-63, which will not be collected below 30.5 m (100 ft) bgs. In addition, one sample will be collected at the historic high groundwater table at the three boreholes that will be constructed to groundwater: 216-A-29 Ditch, 216-S-10 Pond, and 216-S-10 Ditch. The 216-S-10 Pond sample will be collected at 54.9 m (180 ft), the 216-S-10 Ditch sample will be collected at 60 m (197 ft) and the 216-A-29 Ditch sample will be collected at 81.4 m (267 ft). These samples will be used to determine if residual contamination remains in the soil column that is attributable to past operation of liquid disposal units in the 200 Areas.

The top of the sediment layer is a critical sample point because the highest levels of contamination are expected to be encountered at this location and because sampling will be initiated from this soil horizon. Samples 4.6 m (15 ft) and 7.6 m (25 ft) bgs are critical because they delineate the highest to moderate levels of contamination and because they are subject to both direct exposure and groundwater/river protection MTCA cleanup standards.[1] Soil samples collected at 7.6 m (25 ft) bgs are also considered critical sampling points to evaluate remedial alternatives at sites where containment is a viable remedy (i.e., the 216-B-63 Trench and 216-S-10 Pond). Sample from depths greater than 7.6 m (25 ft) bgs will be used to verify the site conceptual model and to evaluate remedial action alternatives and groundwater impacts. Drilling and sampling will stop when the water table is encountered. Geologic logging will be performed at all boreholes to generate lithology data for borehole logs.

Sampling will be performed in accordance with BHI-EE-01, Procedure 4.0, "Soil and Sediment Sampling," using a split-spoon sampler. The split-spoon samplers will be equipped with four separate stainless-steel or lexan 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, then containerized in accordance with the sampling procedure. Samples collected for volatile organic analysis and shall be transferred directly from the liners to an appropriate container without mixing the sample.

Chemical and radiological analytes of interest are presented in Table B2-1, for soils at depths of up to 4.6 m (15 ft) bgs, and Table B2-2 for deeper soils. Dangerous waste generation is not expected at this OU (a contained-in determination is expected for listed waste hydrazine). One possible exception may be at the 216-A-29 Ditch, where relatively high lead concentrations have been reported in past sampling efforts (see Section 3.1.1.3 of the work plan). Should high total lead values (over 100 mg/kg) be encountered in samples, a toxic characteristic leaching procedure test will be given high priority for performance on remaining sample material to

[1] The sample obtained at 4.6 m (15 ft) bgs is considered a critical sample due to its significance to remedial actions under MTCA (WAC 173-303-340-740[6][c]). This sample, however, will be encompassed by a shallow zone interval and it is not specifically called out here.

ascertain whether the material must be disposed of as dangerous waste. If generated, the concentrations of any underlying hazardous constituents will be evaluated against applicable regulatory requirements. If sample volume requirements cannot be met, samples will be collected according to the priority presented in Table B2-3. Analytical priorities are based on expected contaminant inventories and associated potential level of risk, and groundwater impacts. Those contaminants with the largest inventory, are expected to be the greatest risk drivers, and/or are known to have impacted groundwater have the highest priority.

Physical property samples shall be collected from boreholes to provide site-specific values to support RESidual RADioactivity dose model (RESRAD) efforts. Soil properties of interest are lithology, particle-size distribution, bulk density, and moisture content. Samples for physical properties that require an undisturbed sample shall generally be collected with a split-spoon sampler equipped with four separate stainless-steel or lexan liners. Samples for physical properties will be analyzed in accordance with American Society for Testing and Materials (ASTM) methods, which are listed in Table B2-3 (ASTM 1993). Physical property samples shall be collected at all major geologic units at the four borehole locations. Requirements for the collection of physical property samples are also listed in Tables B3-2 through B3-5.

Investigation-derived waste (IDW) generated during this activity will be handled in accordance with the procedures identified in Section B5.0 and in a waste control plan.

B3.3.2 Test Pit (Auger) Sampling and Analysis

Chemical and radiological samples shall be collected from test pits (or shallow auger borings) at the four sampling sites. At 216-A-29 Ditch, 216-B-63 Trench, and 216-S-10 Ditch, two test pits will be excavated; four test pits will be excavated at 216-S-10 Pond. Sampling locations are shown in Figures B3-1 through B3-3.

Sample collection at the test pits shall be guided by the sampling scheme illustrated in Figure B3-5 and are representative of what may be encountered in the field. (Actual sampling frequencies may vary depending on the thickness of backfill placed over the ditch, trench, or pond.) Site-specific sampling schedules are presented in Tables B3-2 through B3-5. Sampling depths are similar to those for the boreholes, except that the maximum sampling depth varies by site (up to 7.6 m [25 ft] bgs). If contamination is observed during the excavation process via field screening equipment at the maximum sampling depth, an additional deeper sample will be attempted (depending on the limitations of the excavating equipment) for further resolution of the vertical contamination concentration profile. Similar to sampling at the boreholes, samples shall be collected for chemical and radiological analysis beginning at the top of the sediment layer at the bottom of the ditch, trench, or pond, which will be identified using radiological field screening measurements, visual observation of soil, and the professional judgment of the site geologist.

Samples at all test pit locations (with the exception of the test pit at the influent end of the 216-D-10 Ditch) shall be collected as follows:

- Five shallow zone samples will be collected from the top of the sediment layer to 3.1 m (10 ft) below the top of the sediment layer, at 0.76-m (2.5-ft) intervals.[1]

- At 216-B-63 Trench and 216-S-10 Pond, soil samples will be collected at 6.1 and 7.6 m (20 and 25 ft) bgs. If either of these samples coincide with sampling intervals collected with reference to the top of the sediment layer, one sample will be sufficient.

- Critical sampling depths are at the top of the sediment layer, within the shallow interval samples to approximately 4.6 m (15 ft) bgs, and at 7.6 m (25 ft) for 216-B-63 Trench and 216-S-10 Pond.

At the influent (northeast) end of 216-S-10 Ditch, the sides of the ditch have not been stabilized and the slope is too steep for heavy equipment. Therefore, a shallow test pit will be accessed at this location using hand augers and shovels. Two soil samples will be collected: one sample at the bottom of the ditch, and one sample approximately 0.6 to 0.9 m (2 to 3 ft) below the bottom of the ditch.

Sampling will be performed in accordance with BHI-EE-01, Procedure 4.0, "Soil and Sediment Sampling," using the excavator bucket or a split-spoon sampler, as applicable. If an excavator bucket is used as the sampling device, samples will be collected directly from the excavator bucket, which will target the interval 0.3 m (1 ft) below the specified sampling depth. If an auger borehole is used to collect samples, samples will be collected in 0.6-m (2-ft) segments, as described for the boreholes. Chemical and radiological analytes of interest are presented in Table B2-1 (depths up to 4.6 m [15 ft] bgs) and Table B2-2 (depths greater than 4.6 m [15 ft] bgs). If sample volume requirements cannot be met, samples will be collected and analyzed in the sequence shown in Table B2-3. Samples will not be collected to evaluate soil physical properties.

Test pits shall be excavated in a manner that minimizes the generation of visible emissions (e.g., dust) from the site boundary. To minimize the generation of dust during backhoe operations, water, or a fixant, shall be sprayed on the site before and during the activity. Samples will be collected from non-wetted soils in trenches, whenever possible, when fixant/water is used for dust control. This contamination control measure is necessary to prevent the release of contamination to the air and stabilized areas within the site boundary. If visible emissions cannot be controlled, the activity will be postponed.

Waste generated during this activity will be handled according to procedures listed in Section B5.0 and in the waste control plan (see Appendix C of the work plan). Wastes will be disposed at the Environmental Restoration Disposal Facility.

B3.3.3 Pre-Shipment Sample Screening

A representative portion of each sample that will be shipped offsite shall be submitted to the RCF, the 222-S Laboratory, or other suitable onsite laboratory for total activity analysis. Total

[1] The depth corresponds to the top of the soil interval (a 0.3-m [1-ft] interval for test pits; a 0.6-m [2-ft] interval if an auger is used).

activities will be utilized for sample pre-shipment characterization. Samples that slightly exceed the offsite laboratory criterion discussed in Section B2.7.6 may be reduced in volume to allow offsite shipment. Onsite and offsite laboratories will be identified prior to initiating field activities and will be mutually acceptable to the ERC's Sample and Data Management group and the task lead.

B3.3.4 Summary of Sampling Activities

A summary of the number and types of samples to be collected at all four waste sites is presented in Table B3-6.

B3.4 GEOPHYSICAL LOGGING

New boreholes will be logged with a high-resolution spectral gamma-ray-logging (SGL) system to provide continuous vertical logs of gamma-emitting radionuclides, and with a neutron moisture-logging system to provide continuous logs of moisture content. In addition to the logging performed on the new borings, SGL is proposed in two existing wells near the 216-S-10 Pond and Ditch (wells 299-W26-6 and 699-32-77). Other wells at the 216-S-10 Pond and Ditch, 216-B-63 Trench, and 216-A-29 Ditch are not suitable for logging because they have annular seals.

The boreholes shall be logged prior to telescoping of casing or before abandonment. The starting point for logging will be recorded, which is usually the ground surface or the top of the casing. The site geologist will witness logging runs and verify before and after field calibrations and repeat log intervals. Geophysical logging shall be performed in accordance with Environmental Investigations Instruction 11.1, "Geophysical Logging" (WHC 1988), or other approved procedures.

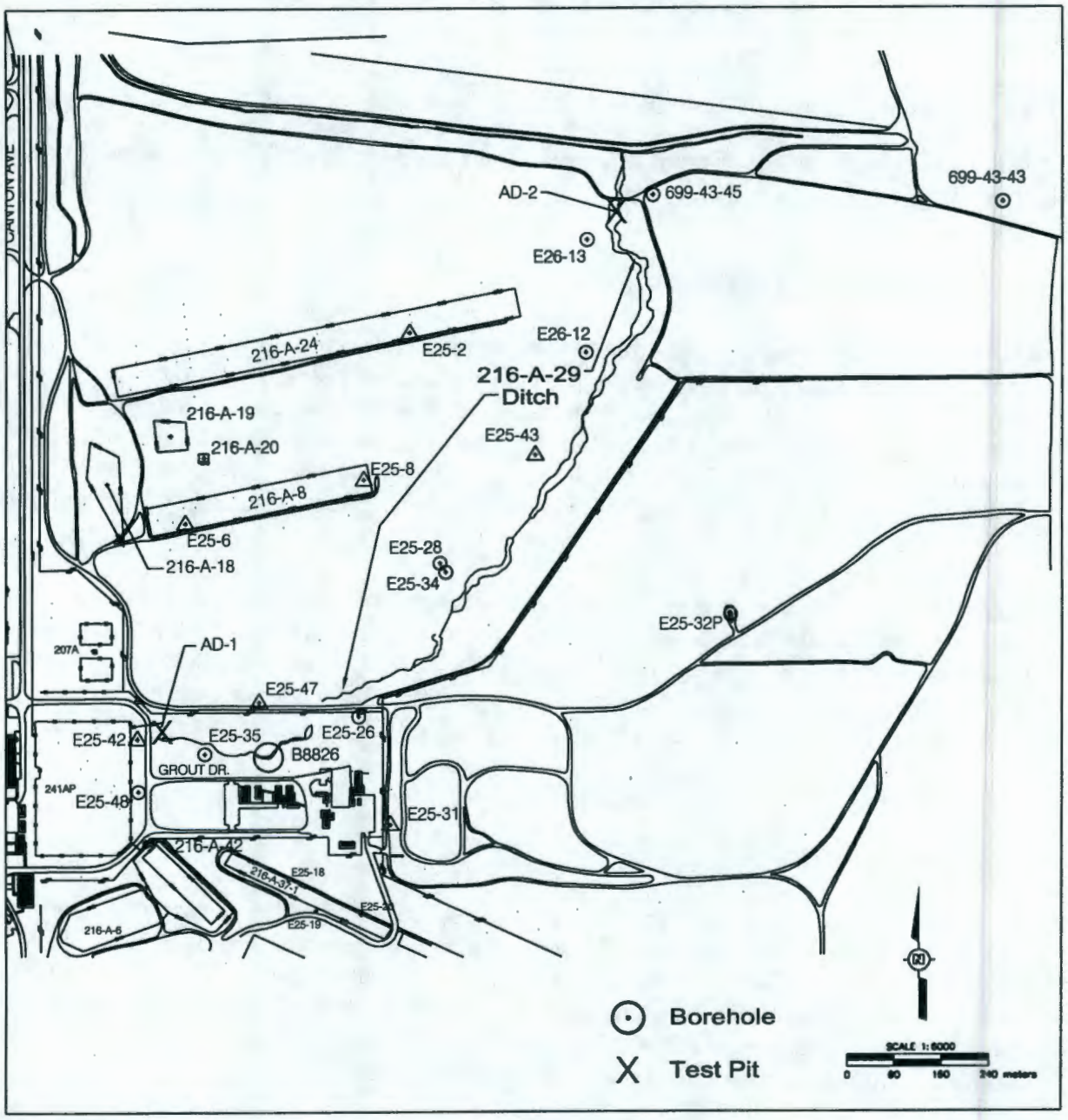
B3.5 SURVEYING

The location of all planned boreholes and test pits will be surveyed after the sampling and abandonment activities are completed. Surveys shall be performed according to BHI-EE-01, Procedure 1.6, "Survey Requirements and Techniques." 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 feet.

B3.6 REVEGETATION

If applicable, test pit and borehole locations shall be revegetated after the pits have been backfilled. Test pit locations shall be seeded with a mixture of grasses.

Figure B3-1. Approximate Location of Test Pits and Borehole at 216-A-29 Ditch.



G:\Maps\042999K.DWG

Figure B3-2. Approximate Locations of Test Pits and Borehole at 216-B-63 Trench.

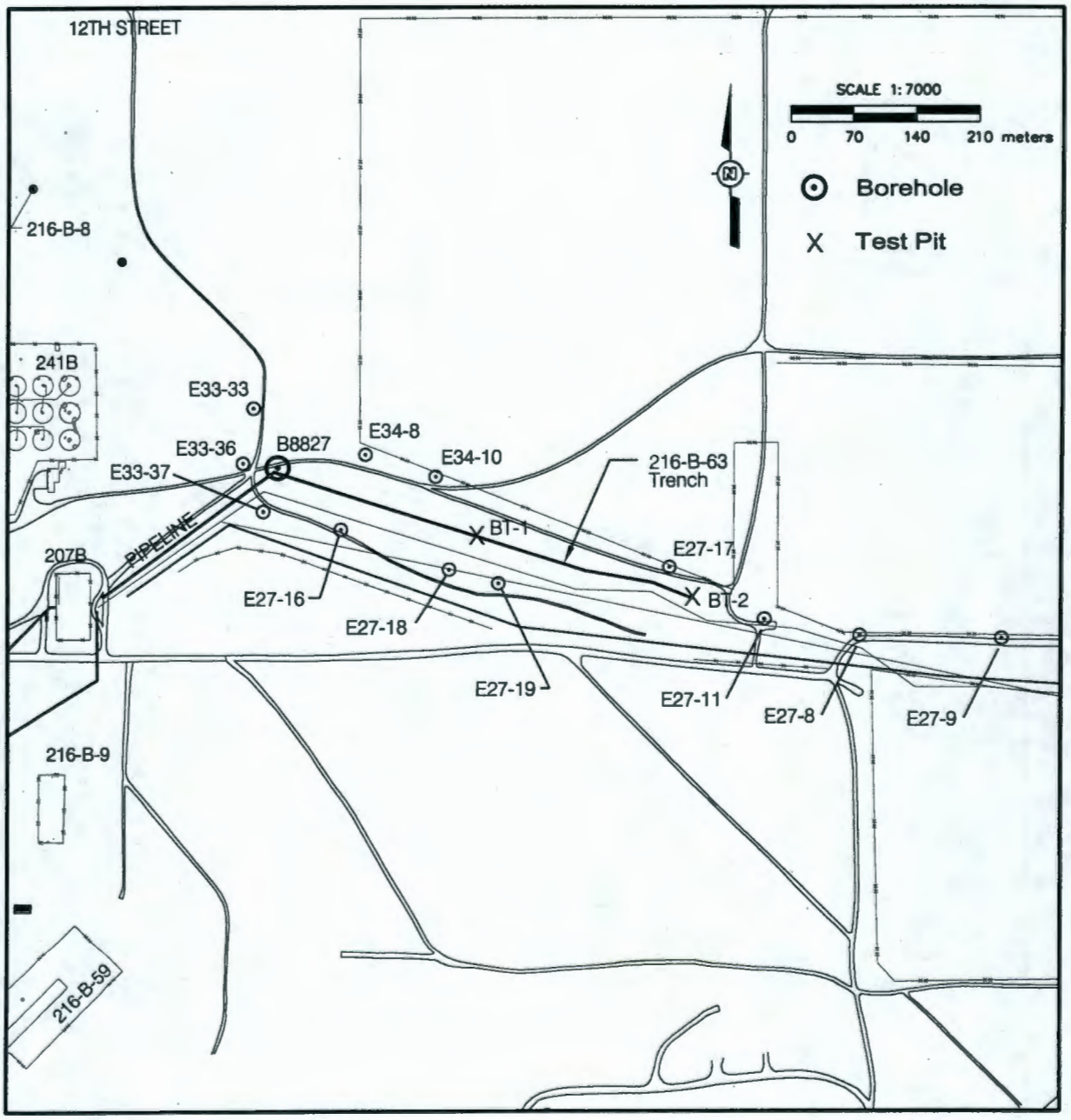


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Figure B3-3. Approximate Location of Test Pits and Boreholes at 216-S-10 Ditch and Pond.

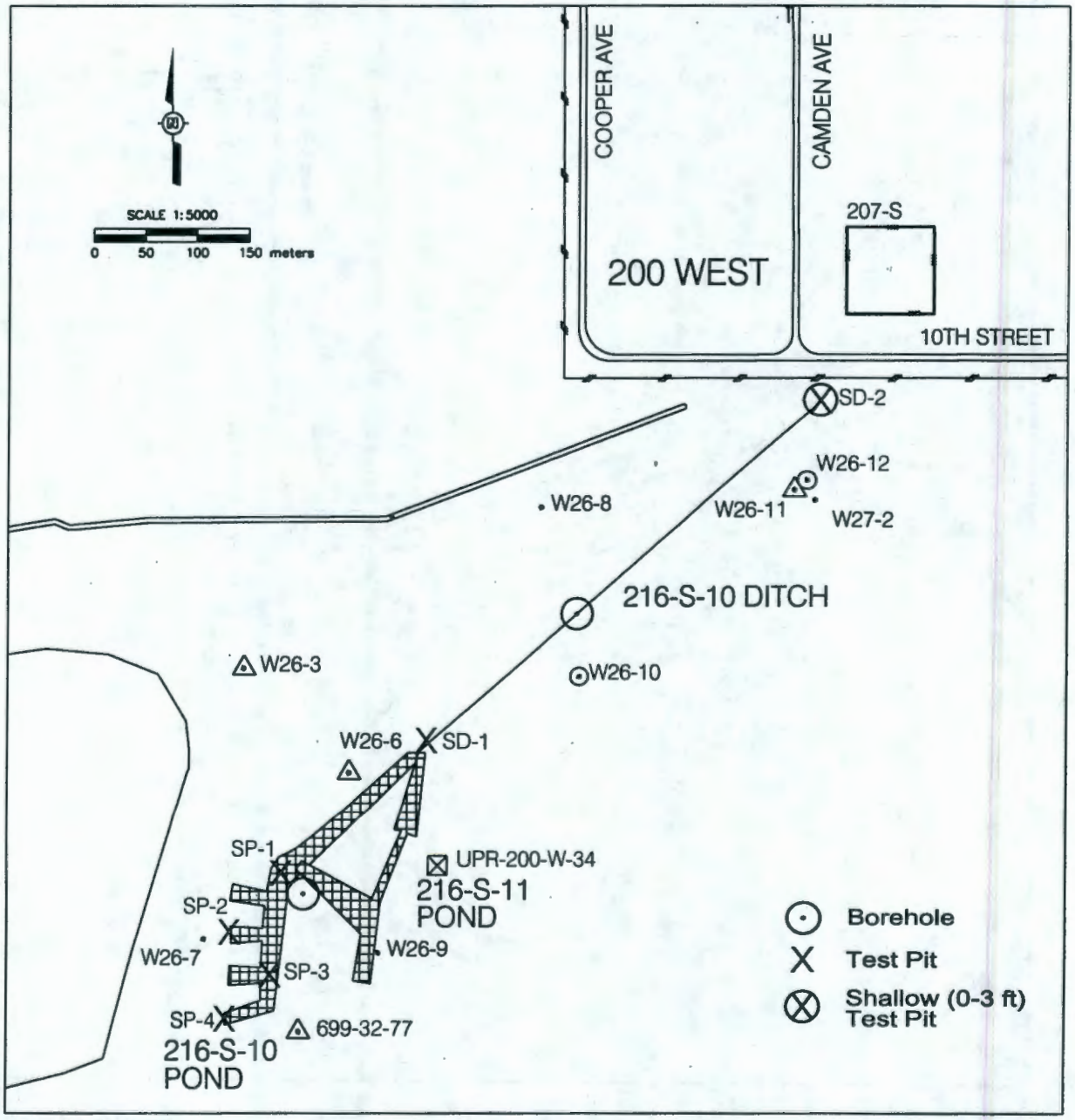

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Figure B3-4. Example Illustration of Borehole Sampling Intervals to Groundwater for a Typical Ditch, Pond, or Trench.

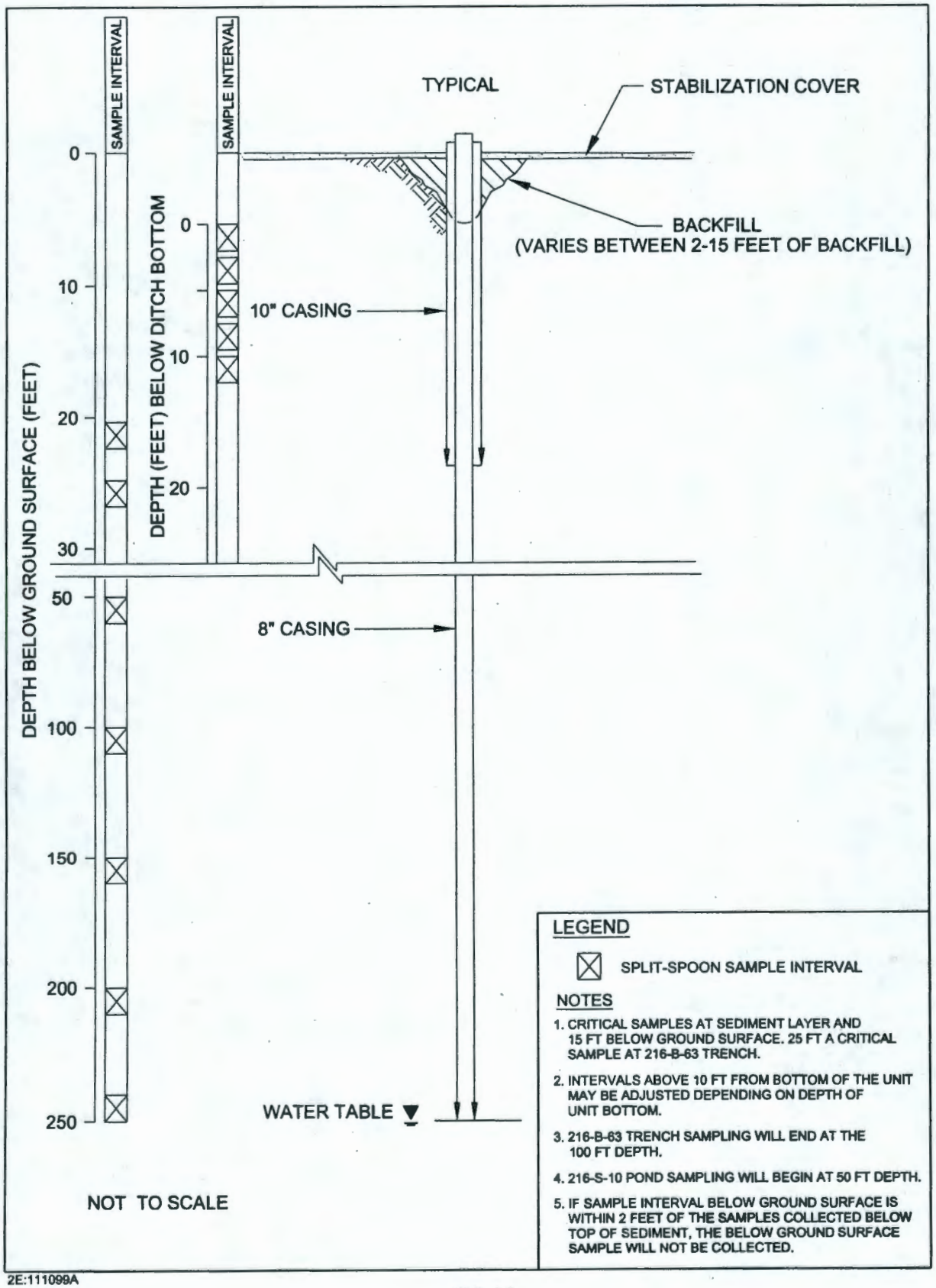

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Figure B3-5. Example Illustration of Test Pit Sampling Intervals for a Typical Ditch, Pond, or Trench.

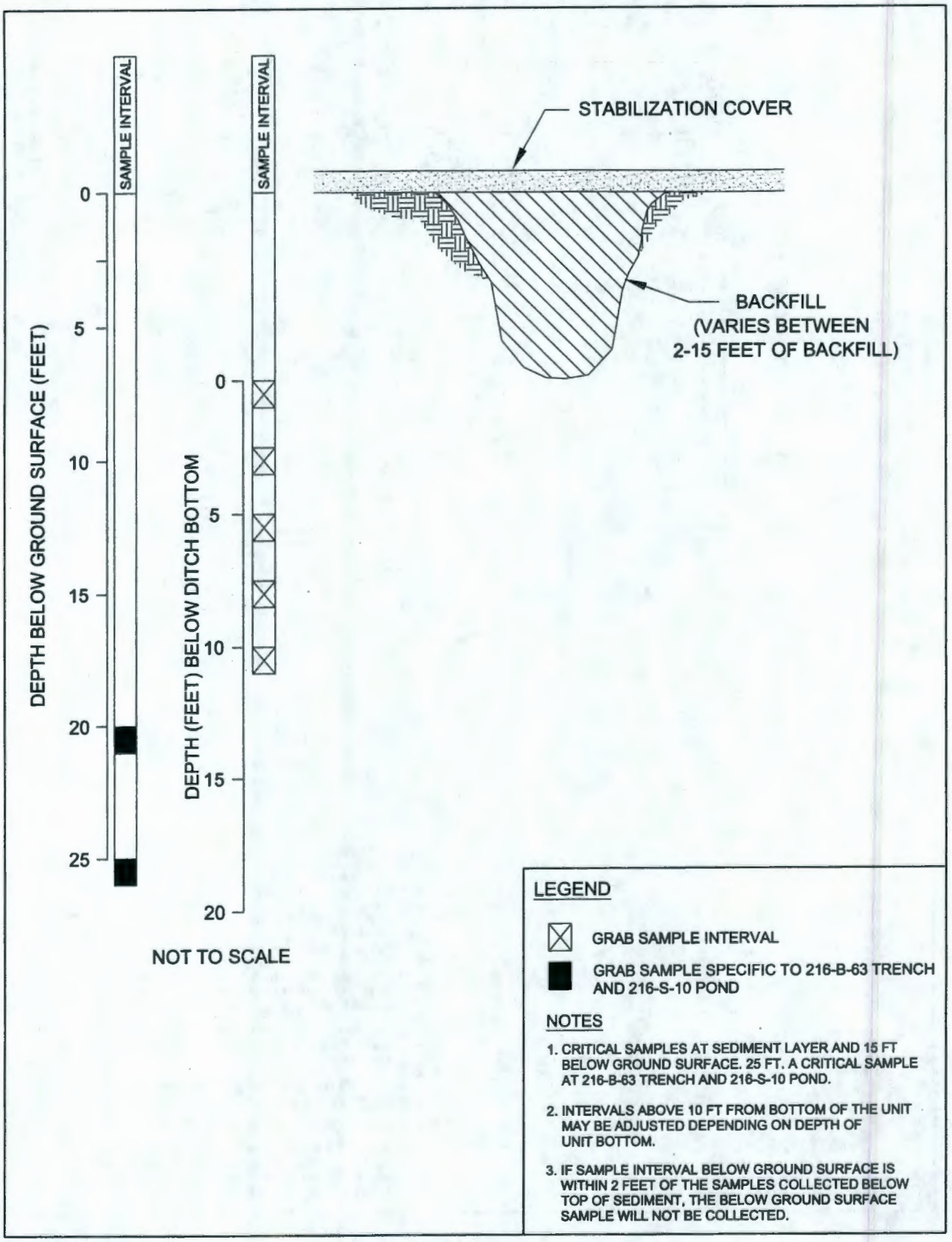

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Table B3-1. Potential Field Screening Methods.

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 alpha α 1,921 dpm beta/gamma β–γ
	Volatile organic compounds	Photoionization detector	2 ppm; may be higher for some compounds

dpm = disintegrations per minute
ppm = parts per million

Table B3-2. 216-A-29 Ditch Sampling Schedule.

Sample Collection Methodology	Sample Location	Maximum Depth of Investigation	Sample Interval Depth (ft)		Analyte List[b]		Physical Properties	
			BTS	bgs[a]	<15 ft bgs	>15 ft bgs	Sample Intervals	Parameters
Borehole B8826	B8826	235 ft	0-2, 2.5-4.5, 5-7, 7.5-9.5, 10-12	20-22, 25-27, 50-52, 100-102, 150-152, 200-202, just above water table (approximately ~235 ft) One sample will be collected at historic high groundwater level	Table B2-1	Table B2-2	One sample from: Hanford formation Unit 1 Hanford formation Unit 2	Lithology, particle-size distribution, bulk density, and moisture content
Test pits	AD-1, AD-2	15 ft bgs[c]	0-1, 2.5-3.5, 5-6, 7.5-8.5, 10-11	N/A	Table B2-1	N/A	N/A	N/A
Maximum number of samples	23							
Approximate number of field QC samples	8[d]							
Approximate total number of samples	31							
Approximate total number of physical samples	2							

[a] If sample interval below ground surface is within 0.6 m (2 ft) of the samples collected below top of sediment, the below ground surface sample will not be collected.
[b] See Table B2-1 for detection limits and other analytical parameters.
[c] Or 3.7 m (12 ft) below the top of the sediment layer, whichever is greater.
[d] See Table B3-6 for details of QC samples.
BTS = below top of sediment
bgs = below ground surface
N/A = not applicable
QC = quality control

Table B3-3. 216-B-63 Trench Sampling Schedule.

Sample Collection Methodology	Sample Location	Maximum Depth of Investigation	Sample Interval Depth (ft)		Analyte List[b]		Physical Properties	
			BTS	bgs[a]	<15 ft bgs	>15 ft bgs	Sample Intervals	Parameters
Borehole B8827	B8827	100 ft bgs	0-2, 2.5-4.5, 5-7, 7.5-9.5, 10-12	20-22, 25-27, 50-52, 98-100	Table B2-1	Table B2-2	One sample from: Hanford formation Unit 1 Hanford formation Unit 2	Lithology, particle-size distribution, bulk density, and moisture content
Test pits	BT-1, BT-2	26 ft bgs	0-1, 2.5-3.5, 5-6, 7.5-8.5, 10-11	20-21, 25-26	Table B2-1	Table B2-2	N/A	N/A
Maximum number of samples	23							
Approximate number of field QC samples	8[c]							
Approximate total number of samples	31							
Approximate total number of physical samples	2							

[a] If sample interval below ground surface is within 0.6 m (2 ft) of the samples collected below top of sediment, the below ground surface sample will not be collected.
[b] See Table B2-1 for detection limits and other analytical parameters.
[c] See Table B3-6 for details of QC samples.
BTS = below top of sediment
bgs = below ground surface
N/A = not applicable
QC = quality control

Table B3-4. 216-S-10 Ditch Sampling Schedule.

Sample Collection Methodology	Sample Location	Maximum Depth of Investigation	Sample Interval Depth (ft)		Analyte List[b]		Physical Properties	
			BTS	bgs[a]	<15 ft bgs	>15 ft bgs	Sample Intervals	Parameters
Borehole B8828	B8828	225 ft	0-2, 2.5-4.5, 5-7, 7.5-9.5, 10-12	20-22, 25-27, 50-52, 100-102, 150-152, 200-202, just above water table (approximately ~225 ft) One sample will be collected at historic high groundwater level	Table B2-1	Table B2-2	One sample from: Hanford formation Unit 2 Plio-Pleistocene unit – Early Palouse Ringold Formation	Lithology, particle-size distribution, bulk density, and moisture content
Test pits	SD-1	15 ft bgs[c]	0-1, 2.5-3.5, 5-6, 7.5-8.5, 10-11	N/A	Table B2-1	Table B2-2	N/A	N/A
Test pits	SD-2	BTS+3 ft bgs	0-1, 2-3	N/A	Table B2-1	Table B2-2	N/A	N/A
Maximum number of samples	20							
Approximate number of field QC samples	8[d]							
Approximate total number of samples	28							
Approximate total number of physical samples	3							

[a] If sample interval below ground surface is within 0.6 m (2 ft) of the samples collected below top of sediment, the below ground surface sample will not be collected.
[b] See Table B2-1 for detection limits and other analytical parameters.
[c] Or 3.7 m (12 ft) below the top of the sediment layer, whichever is greater.
[d] See Table B3-6 for details of QC samples.
BTS = below top of sediment
bgs = below ground surface
N/A = not applicable
QC = quality control

Table B3-5. 216-S-10 Pond Sampling Schedule.

Sample Collection Methodology	Sample Location	Maximum Depth of Investigation	Sample Interval Depth (ft)		Analyte List[b]		Physical Properties	
			BTS	bgs[a]	<15 ft bgs	>15 ft bgs	Sample Intervals	Parameters
Borehole B8817	B8817	200 ft	None	35-37[d], 50-52, 100-102, 150-152, 198-200, just above water table (approximately ~225 ft) One sample will be collected at historic high groundwater level	Not applicable	Table B2-2	One sample from: Hanford formation Unit 2 Plio-Pleistocene unit – Early Palouse Ringold Formation	Lithology, particle-size distribution, bulk density, and moisture content
Test pits	SP-1, SP-2, SP-3, SP-4	26 ft bgs	0-1, 2.5-3.5, 5-6, 7.5-8.5, 10-11	20-21, 25-26	Table B2-1	Table B2-2	N/A	N/A
Maximum number of samples	34							
Approximate number of field QC samples	8[c]							
Approximate total number of samples	42							
Approximate total number of physical samples	3							

[a] If sample interval below ground surface is within 0.6 m (2 ft) of the samples collected below top of sediment, the below ground surface sample will not be collected.
[b] See Table B2-1 for detection limits and other analytical parameters.
[c] See Table B3-6 for details of QC samples.
[d] The analyte list associated with this list will include gamma spectroscopy plus americium-241, radiological strontium, total uranium (isotopic uranium if total greater than background), isotopic plutonium, ICP metals plus hexavalent chromium, and anions excluding ammonia.
BTS = below top of sediment
bgs = below ground surface
N/A = not applicable
QC = quality control

Table B3-6. Summary of Projected Sample Collection Requirements.

	216-A-29 Ditch	216-B-63 Trench	216-S-10 Ditch	216-S-10 Pond	Project Total
Chemical Parameters					
Maximum number of characterization samples	23	23	20	34	100
Detail of QC samples					
Co-located duplicates	2	2	2	2	8
Splits	2	2	2	2	8
Equipment blanks	2	2	2	2	8
Trip blanks	2	2	2	2	8
Approximate number of field QC samples	8	8	8	8	24
Approximate total number of samples	31	31	28	42	132
Physical Properties					
Lithology, particle-size distribution, bulk density, and moisture content	2	2	3	3	12

QC = quality control

B4.0 HEALTH AND SAFETY

All field operations will be performed in accordance with BHI health and safety requirements outlined in BHI-SH-01, *Hanford ERC Environmental, Safety, and Health Program*, and in accordance with the requirements of the *Hanford Site Radiological Control Manual* (DOE-RL 1996b). 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-SH-01, *Hanford ERC Environmental, Safety, and Health Program.*

An air monitoring plan will be developed for drilling activities at the 200-CS-1 OU waste sites, with the exception of the 216-S-10 Pond boring. This plan will be provided in a separate document to Ecology, who will then seek concurrence from the Washington State Department of Health. The plan will address the substantive applicable or relevant and appropriate requirements for these activities. The plan will also include quantification of radioactive emissions, and will include implementation of best available radionuclide control technology, and will define air monitoring.

Samples from the 216-S-10 Pond boring will be collected during the drilling of a groundwater monitoring well being installed under the RCRA groundwater monitoring program. The project specific documentation associated with the RCRA groundwater monitoring program (i.e., health and safety plan) will be used for this boring.

B5.0 MANAGEMENT OF INVESTIGATION-DERIVED WASTE

The IDW generated by characterization activities will be managed in accordance with BHI-EE-10, *Waste Management Plan*, Appendix E of the Implementation Plan (DOE-RL 1999), and the waste control plan contained in Appendix C of this work plan. Containment, labeling, and tracking requirements are specified in BHI-FS-03, Instruction W-011, "Control of CERCLA and Other Past Practice Investigation Derived Waste," and BHI-EE-01, Procedure 5.2, "Test Pit Excavation in Contaminated Areas." These procedures have been prepared to implement Ecology's requirements found in *Strategy for Management of Investigation Derived Waste* (Ecology et al. 1999). Management of IDW, minimization practices, and waste types applicable to 200-CS-1 OU waste control are described in the waste control plan (Appendix C of this work plan).

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 of the material. The approval of the remedial project manager is required before returning unused samples or waste from offsite laboratories.

Samples from the 216-S-10 Pond boring will be collected during the drilling of a groundwater monitoring well being installed under the RCRA groundwater monitoring program. Management of IDW waste generated from this boring will follow the RCRA groundwater monitoring program's waste control plan.

B6.0 REFERENCES

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BHI-MA-02, *ERC Project Procedures*, Bechtel Hanford, Inc., Richland, Washington.

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