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SECTION 1

Document Information			
Document #	**DOE/RL-2003-64**	**Revision**	**DRAFT A REISSUE**
Title	**FEASIBILITY STUDY FOR THE 200-TW-1 SCAVENGED WASTE GROUP & THE 200-TW-2 TANK WASTE GROUP & THE 200-PW-5 FISSION-PRODUCT RICH WASTE GROUP OU**		
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Keywords			
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DOE/RL-2003-64
Draft A
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Feasibility Study for the 200-TW-1 Scavenged Waste Group, the 200-TW-2 Tank Waste Group, and the 200-PW-5 Fission-Product Rich Waste Group Operable Units

March 2004

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

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

Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

Janis Aardal 3-25-2004
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(Print and Sign)

Responsible Manager

B H Ford (signature)
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FEASIBILITY STUDY FOR THE 200-TW-1, 200-TW-2, AND 200-PW-5 OPERABLE UNITS, DRAFT A

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

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

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CONTENTS

APPENDICES

FIGURES

TABLES

TERMS

ALARA	as low as reasonably achievable
amsl	above mean sea level
ARAR	applicable or relevant and appropriate requirement
BCG	biota concentration guide (see DOE-STD-1153-2002)
BDAC	Biota Dose Assessment Committee
bgs	below ground surface
BRMaP	*Hanford Site Biological Resource Management Plan*, DOE/RL-96-32
CCU	Cold Creek unit
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CLUP-EIS	*Final Hanford Comprehensive Land-Use Plan - Environmental Impact Statement* (DOE/EIS-0222-F)
COC	contaminant of concern
COPC	contaminant of potential concern
CPP	CERCLA past-practice
DOE	U.S. Department of Energy
Ecology	Washington State Department of Ecology
ELCR	excess lifetime cancer risk
EPA	U.S. Environmental Protection Agency
ERA	ecological risk assessment
ERDF	Environmental Restoration Disposal Facility
ET	evapotranspiration
FS	feasibility study
GRA	general response action
HAB	Hanford Advisory Board
HAMMER	Hazardous Materials Management and Emergency Response
HHRA	human health risk assessment
HI	hazard index
HQ	hazard quotient
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
Implementation Plan	*200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program*, DOE/RL-98-28
ISG	in situ grouting
K_d	distribution coefficient
MCL	maximum contaminant level
NA	not applicable
NBS	National Bureau of Standards
NCP	"National Oil and Hazardous Substances Pollution Contingency Plan" (40 CFR 300)
NEPA	*National Environmental Policy Act of 1969*

NPL	"National Priorities List" (40 CFR 300, Appendix B)
ORNL	Oak Ridge National Laboratory
OU	operable unit
PNNL	Pacific Northwest National Laboratory
PQL	practical quantitation limit
PRG	preliminary remediation goal
PRTR	Plutonium Recycle Test Reactor
PUREX	Plutonium-Uranium Extraction (Plant or process)
RAO	remedial action objective
RCRA	*Resource Conservation and Recovery Act of 1976*
RDR/RAWP	remedial design report/remedial action work plan
REDOX	Reduction-Oxidation (Plant or process)
RESRAD	RESidual RADioactivity (dose model)
RI	remedial investigation
RI Report	*Remedial Investigation Report for the 200-TW-1 and 200-TW-2 Operable Units (Includes the 200-PW-5 Operable Unit)*, DOE/RL-2002-42
RL	U.S. Department of Energy, Richland Operations Office
RLS	radionuclide logging system
ROD	record of decision
RPP	RCRA past practice
SLERA	screening-level ecological risk assessment
SST	single-shell tank
STOMP	Subsurface Transport Over Multiple Phases (code)
TAL	target analyte list
TBP	tributyl phosphate
TCL	target compound list.
TCLP	toxicity characteristic leaching procedure
Tri-Parties	U.S. Department of Energy, U.S. Environmental Protection Agency, and Washington State Department of Ecology
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1989)
TRU	transuranic (waste materials contaminated with 100 nCi/g of transuranic materials having half-lives longer than 20 years)
TSD	treatment, storage, and/or disposal (unit)
UCL	upper confidence limit
UPR	unplanned release
URP	uranium recovery process
VCP	vitrified clay pipeline
VOC	volatile organic compound
WAC	*Washington Administrative Code*
WIDS	*Waste Information Data System*

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1.0 INTRODUCTION

The Hanford Site, managed by the U.S. Department of Energy (DOE), encompasses approximately 1,517 km^2 (586 mi^2) in the Columbia Basin of south-central Washington State. In 1989, the U.S. Environmental Protection Agency (EPA) placed the 100, 200, 300, and 1100 Areas of the Hanford Site on the 40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan," (NCP) Appendix B, "National Priorities List" (NPL), pursuant to the *Comprehensive Response, Compensation, and Liability Act of 1980* (CERCLA). The 200 Areas NPL site consists of the 200 West Area and the 200 East Area (Figure 1-1), which contain waste management facilities and inactive irradiated fuel reprocessing facilities, and the 200 North Area, formerly used for interim storage and staging of irradiated fuel. Several waste sites in the 600 Area, which are located near the 200 Areas, also are included in the 200 Areas NPL site. The 200 Areas consist of approximately 700 waste sites, organized into 23 waste site groups called operable units (OU). The 200-TW-1 Scavenged Waste Group OU, the 200-TW-2 Tank Waste Group OU, and the 200-PW-5 Fission-Product-Rich Waste Group OU are the focus of this Feasibility Study (FS). Waste sites in these OUs are located in the 200 East and 200 West Areas and in an area south of the 200 East Area (Figures 1-2 through 1-6). In addition, four waste sites from the 200-LW-1 300 Area Chemical Laboratory Waste Group OU have been included in this FS. These four waste sites (216-B-53A, 216-B-53B, 216-B-54, and 216-B-58 Trenches) are located in the BC Cribs and Trenches Area and are included to support the accelerated remedial actions in this area. These waste sites will be transferred from the 200-LW-1 OU to the 200-TW-1 OU to facilitate the remedial action process.

The process for characterization and remediation of waste sites at the Hanford Site is addressed in the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1989). The Tri-Party Agreement establishes major milestones for completing the waste site investigation by December 31, 2008, and completing waste site remediation by September 30, 2024 (Milestones M-15-00C and M-16-00, respectively) for non-tank farm OUs in the 200 Areas. In 2002, the DOE Richland Operations Office (RL), the EPA, and the Washington State Department of Ecology (Ecology) (the Tri-Parties) renegotiated the 200 Areas waste site cleanup milestones under the Tri-Party Agreement; the results of these negotiations are documented in Tri-Party Agreement change forms M-13-02-01, M-15-02-01, M-16-02-01, and M-20-02-01 (*Hanford Tri-Party Agreement Modifications to 200 Area Waste Sites Cleanup Milestones, Tri-Party Agreement Change Requests and Comment and Response Document*, Ecology et al. 2002). As part of these negotiations, the Tri-Parties agreed to incorporate evaluation of the 200-PW-5 OU into the 200-TW-1 and 200-TW-2 OU remedial investigation (RI)/FS and remediation processes. The 200-TW-1, 200-TW-2, and 200-PW-5 OU waste sites lie inside the exclusive land-use boundary (core zone) identified in DOE/EIS-0222-F, *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement* (CLUP-EIS) and shown in Figure 1-1.

The Tri-Party Agreement also addresses the need for the cleanup programs to integrate the requirements of the CERCLA and the *Resource Conservation and Recovery Act of 1976* (RCRA), to provide a standard approach to direct cleanup activities in a consistent manner and to ensure that applicable regulatory requirements are met. Details of this integration for the 200 Areas are presented in DOE/RL-98-28, *200 Areas Remedial Investigation/Feasibility Study*

Implementation Plan - Environmental Restoration Program (Implementation Plan). This FS implements the RCRA/CERCLA integration process presented in DOE/RL-98-28 and the Tri-Party Agreement.

The 200-TW-1, 200-TW-2, and 200-PW-5 OUs are located near the center of the Hanford Site in south-central Washington State (Figure 1-1). The 200-TW-1 OU consists of 36 CERCLA past-practice (CPP) waste sites, 4 RCRA past-practice (RPP) waste sites (the four 200-LW-1 waste sites that are to be transferred to the 200-TW-1 OU through the Tri-Party Agreement change process), and one associated unplanned release (UPR) site as defined in the Implementation Plan (DOE/RL-98-28). The 200-TW-2 OU consists of 29 RPP waste sites and one UPR site. The 200-PW-5 OU consists of seven CPP waste sites and two UPR sites. The waste sites for these OUs are shown in Figures 1-2 through 1-6. The EPA is the lead regulatory agency for the 200-TW-1 OU. Ecology is the lead regulator for the 200-TW-2 and 200-PW-5 OUs.

The 200-TW-1 waste sites received scavenged waste from the Uranium Recovery Project (URP) and the ferrocyanide processes at the 221/224-U Plant, which recovered the uranium from the metal waste streams at the B and T Plants. The scavenged waste discharges contributed perhaps the largest liquid fraction of contaminants to the ground in the 200 Areas. Three of the four 200-LW-1 waste sites included in this FS (216-B-53B, 216-B-54, and 216-B-58 Trenches) received waste from the 300 Area laboratory facilities and the 340 Waste Neutralization Facility. The fourth 200-LW-1 waste site (216-B-53A Trench) received waste from the Plutonium Recycle Test Reactor, including an estimated 100 g of plutonium. The 200-TW-2 OU waste sites received tank waste from first- and second-cycle decontamination processes associated with the bismuth-phosphate process at the B and T Plants. The tank wastes contained inorganic anions and cations as well as low levels of radionuclides. The 200-PW-5 OU waste sites received fission-product-rich wastes that were generated during the fuel-rod enrichment cycle and then released when the fuel elements were decladded or dissolved in sodium hydroxide or nitric acid. The sites in this group generally received more than 20 Ci of fission products (e.g., Cs-137 or Sr-90) and contained smaller quantities of plutonium, uranium, and organic wastes than those in the plutonium, uranium, or organic-rich groups. Most of the waste streams in this group were low-salt neutral/basic, although the 216-B-50 and 216-B-57 Cribs contained some inorganic compounds. The individual waste sites are discussed in more detail in Chapter 2.0.

The RI activities were conducted from June to October 2001 on one representative site for the 200-TW-1 OU (216-T-26 Crib) and two representative sites for the 200-TW-2 OU (216-B-7A Crib and 216-B-38 Trench) in accordance with DOE/RL-98-28 and DOE/RL-2000-38, *200-TW-1 Scavenged Waste Group Operable Unit and 200-TW-2 Tank Waste Group Operable Unit RI/FS Work Plan*. These activities included installing and geophysically logging drive casings and boreholes. Data collection activities were conducted previously at the other two 200-TW-1 and 200-TW-2 representative sites (216-B-46 Crib and 216-B-5 Injection/Reverse Well); therefore, no additional data collection activities were conducted at these sites. Data collection activities also were conducted for the 216-B-57 Crib as part of the 200-BP-1 OU RI (DOE/RL-92-70, *Phase I Remedial Investigation Report for 200-BP-1 Operable Unit*). This crib is a representative waste site for the 200-PW-5 OU. These remedial action activities are described in DOE/RL-2002-42, *Remedial Investigation Report for the 200-TW-1 and 200-TW-2*

Operable Units (Includes the 200-PW-5 Operable Unit). The RI Report includes RI results and risk assessment and modeling for representative sites.

An RI/FS Work Plan (DOE/RL-2001-66, *Chemical Laboratory Waste Group Operable Unit RI/FS Work Plan*) has been prepared for the 200-LW-1 and 200-LW-2 OUs. The 216-B-58 Trench was identified in this document as a representative site for the four 200-LW-1 OU sites contained in this FS. DOE/RL-2001-66 provides estimates of contaminants in the 216-B-58 Trench and provides a conceptual contaminant distribution model for this site. Remedial investigation activities were conducted at the 216-B-58 Trench in December 2003. The data collection activities and data evaluation for this waste site are incorporated into this FS. The data from the representative sites support the evaluation of remedial alternatives for all the waste sites addressed by this FS.

Tri-Party Agreement (Ecology et al. 1989) milestones govern the schedule of work at the Hanford Site. The interim milestone controlling the schedule for the 200-TW-1, 200-TW-2, and 200-PW-5 OUs is M-15-41C, "Submit 200-TW-1 OU and 200-TW-2 OU FS and Proposed Plan to EPA and Ecology and includes the Past Practice Waste Sites in the 200-PW-5 Fission Product-Rich Process Waste Group. The waste site associated with the Hanford prototype barrier (216-B-57 Crib) will be addressed by the TW-1/TW-2 Proposed Plan." This milestone was established under Tri-Party Agreement change form M-15-02-01 (Ecology et al. 2002).

1.1 PURPOSE

The purpose of this FS is to develop and evaluate alternatives for remediation of the waste sites in the 200-TW-1, 200-TW-2, and 200-PW-5 OUs and to support acceleration of remedial actions at the BC Cribs and Trenches Area. This FS refines preliminary potential applicable or relevant and appropriate requirements (ARAR), remedial action objectives (RAO), and general response actions (GRA) initially identified in the Implementation Plan (DOE/RL-98-28). Technology screening and alternatives development initially performed in the Implementation Plan are reviewed and refined, as necessary, based on the site-specific data generated in the 200-TW-1 and 200-TW-2 OU RI (as reported in DOE/RL-2002-42) and 200-BP-1 OU RI (as reported in DOE/RL-92-70) and other sources of existing information. The alternatives considered provide a range of potential response actions (e.g., no action, remove and dispose, containment) that are appropriate to address site-specific risk conditions. The alternatives are evaluated against the CERCLA criteria. The Tri-Parties will use this FS as the basis for selecting a remedy to mitigate potential risks to human health and the environment. A preferred remedial alternative (or alternatives) will be presented to the public in a proposed plan for review and comment.

1.2 SCOPE

Cleanup of the 200-TW-1, 200-TW-2, and 200-PW-5 OUs is a source-control action that addresses contaminated soil and structures (e.g., concrete, pipelines) associated with cribs, trenches, reverse wells, pipelines, unplanned release sites, settling and siphon tanks, and other associated waste sites. Other than the requirement for the source-control action to be protective of groundwater and surface water, the scope does not include remediation of groundwater that may be beneath these waste sites. Contaminated groundwater in the 200 East Area is being addressed by the 200-BP-5 and 200-PO-1 OUs. Contaminated groundwater in the 200 West Area is being addressed by the 200-UP-1 and 200-ZP-1 OUs.

1.3 REPORT ORGANIZATION

The essential elements of the FS process are presented in Chapters 1.0 through 8.0, and are summarized as follows.

- Chapter 1.0 presents the purpose, scope, and regulatory framework for the FS, as well as this overview of report organization.
- Chapter 2.0 presents descriptions of the physical setting, waste sites, and site contamination; presents a description of the conceptual site model; compares analogous sites to the models developed for the representative sites; and summarizes risk assessments.
- Chapter 3.0 discusses land-use assumptions and develops the overall cleanup objectives and media-specific goals for the waste sites.
- Chapter 4.0 refines the technologies identified for these OUs and waste sites in the Implementation Plan (DOE/RL-98-28) by evaluating new information on existing technologies or promising and relevant emerging technologies.
- Chapter 5.0 describes the remedial alternative development process, initially conducted as part of the Implementation Plan development, and uses that information in concert with site-specific data from the RI to refine the remedial alternatives to be carried forward for detailed and comparative analyses.
- Chapter 6.0 presents a detailed analysis of each of the remedial alternatives against standard CERCLA criteria.
- Chapter 7.0 compares the alternatives on the basis of the same CERCLA criteria used in the detailed analyses.
- Chapter 8.0 summarizes the conclusions of the FS.
- Chapter 9.0 contains all references for the main body of the report; the appendices each contain their own reference lists.
- Appendix A, "Waste Site Photographs," includes current photographs of the waste sites, showing the amount and type of vegetation present on and/or around the waste sites.
- Appendix B, "Potential Applicable or Relevant and Appropriate Requirements," presents an analysis of regulatory requirements and available guidance with respect to the 200-TW-1, 200-TW-2, and 200-PW-5 OUs.

- Appendix C, "Human Health and Ecological Risk Assessment," presents the human health and ecological risk evaluations, including the methodology, results, and uncertainties for analogous sites with data.
- Appendix D, "Cost Estimate Backup," presents the basis for the cost estimates.
- Appendix E, "Intruder Scenario," presents the risk analysis for a potential intruder to the representative sites and analogous sites with characterization data.

Figure 1-1. Location of the Hanford Site and the 200-TW-1, 200-TW-2, and 200-PW-5 Operable Unit Waste Sites

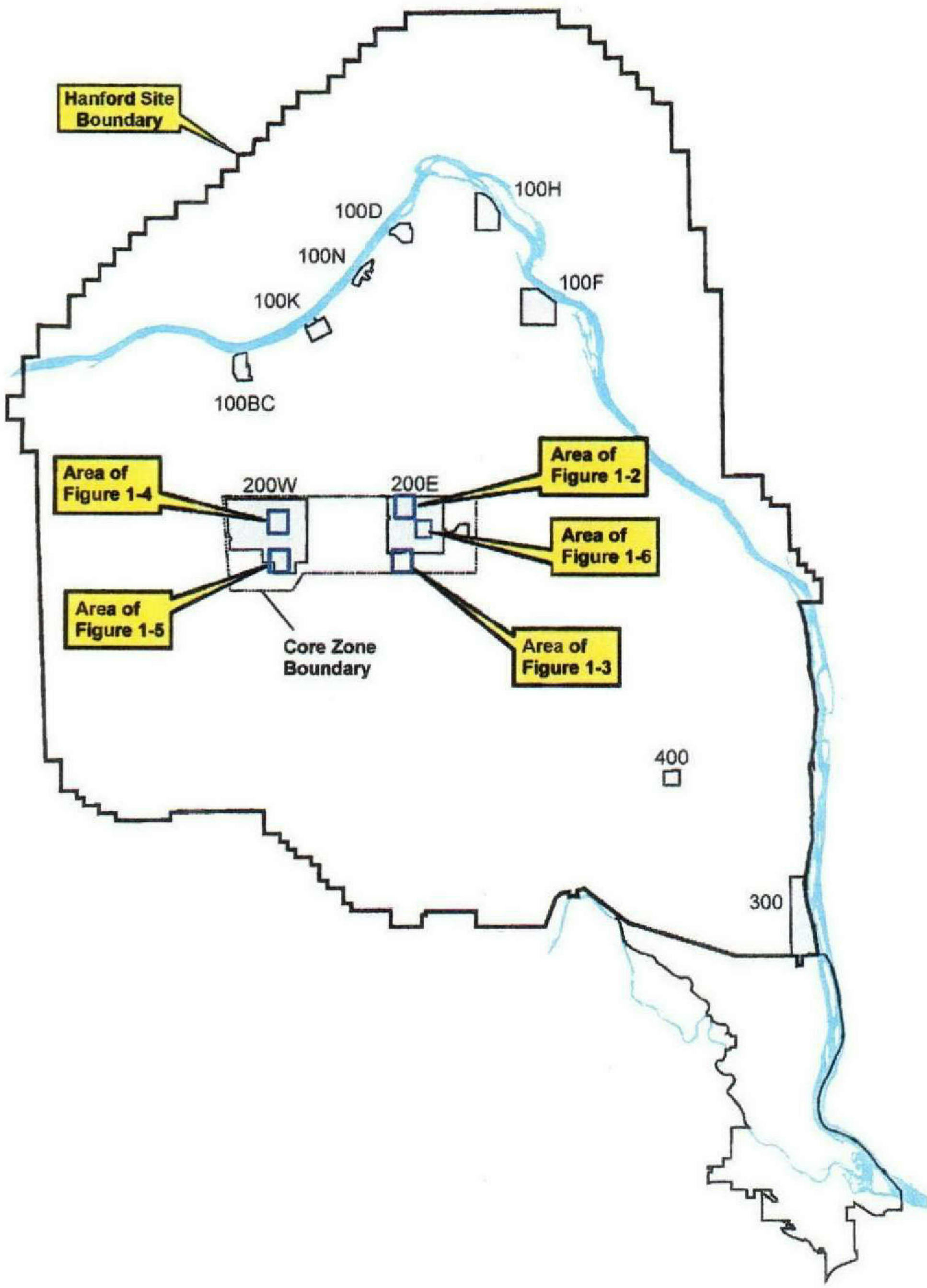


Figure 1-2. Location of the 200-TW-1 200-TW-2, and 200-PW-5 Operable Unit Waste Sites In the 200 East Area.

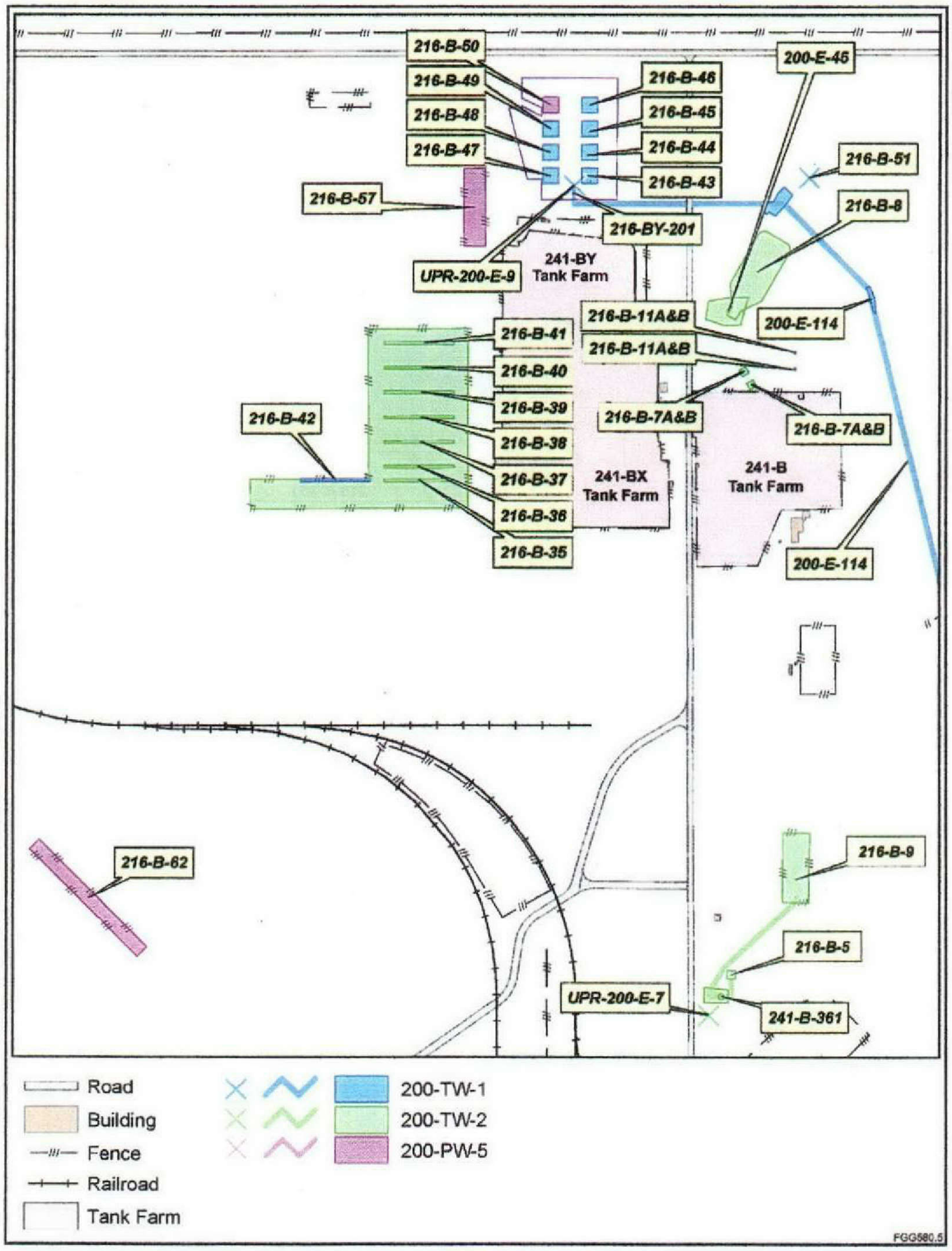


Figure 1-3. Location of the 200-TW-1 Operable Unit Waste Sites South of the 200 East Area.

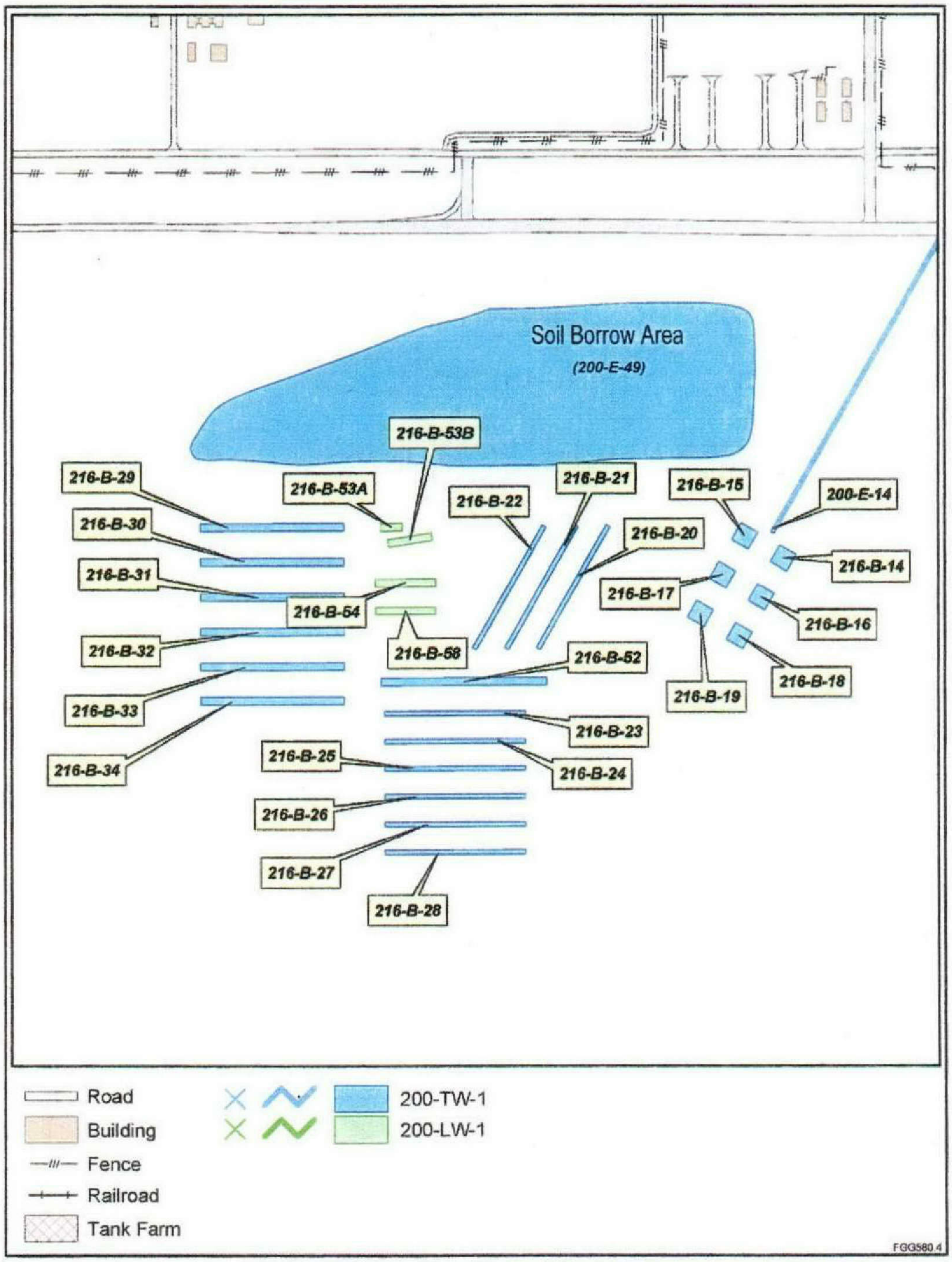


Figure 1-4. Location of the 200-TW-1 and TW-2 Operable Unit Waste Sites in the 200 West Area.

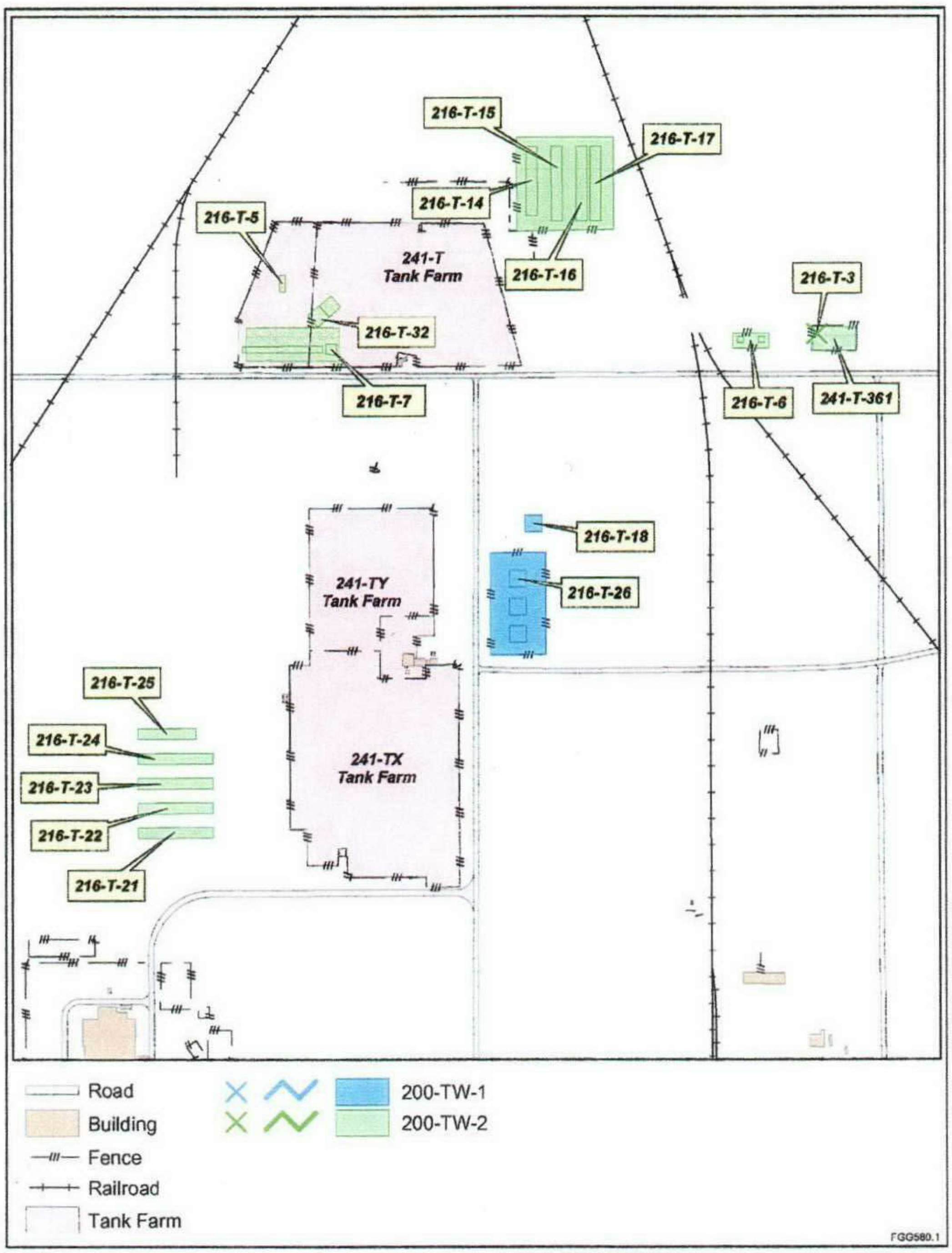


Figure 1-5. Location of the 200-PW-5 Operable Unit Waste Sites in the 200 West Area.

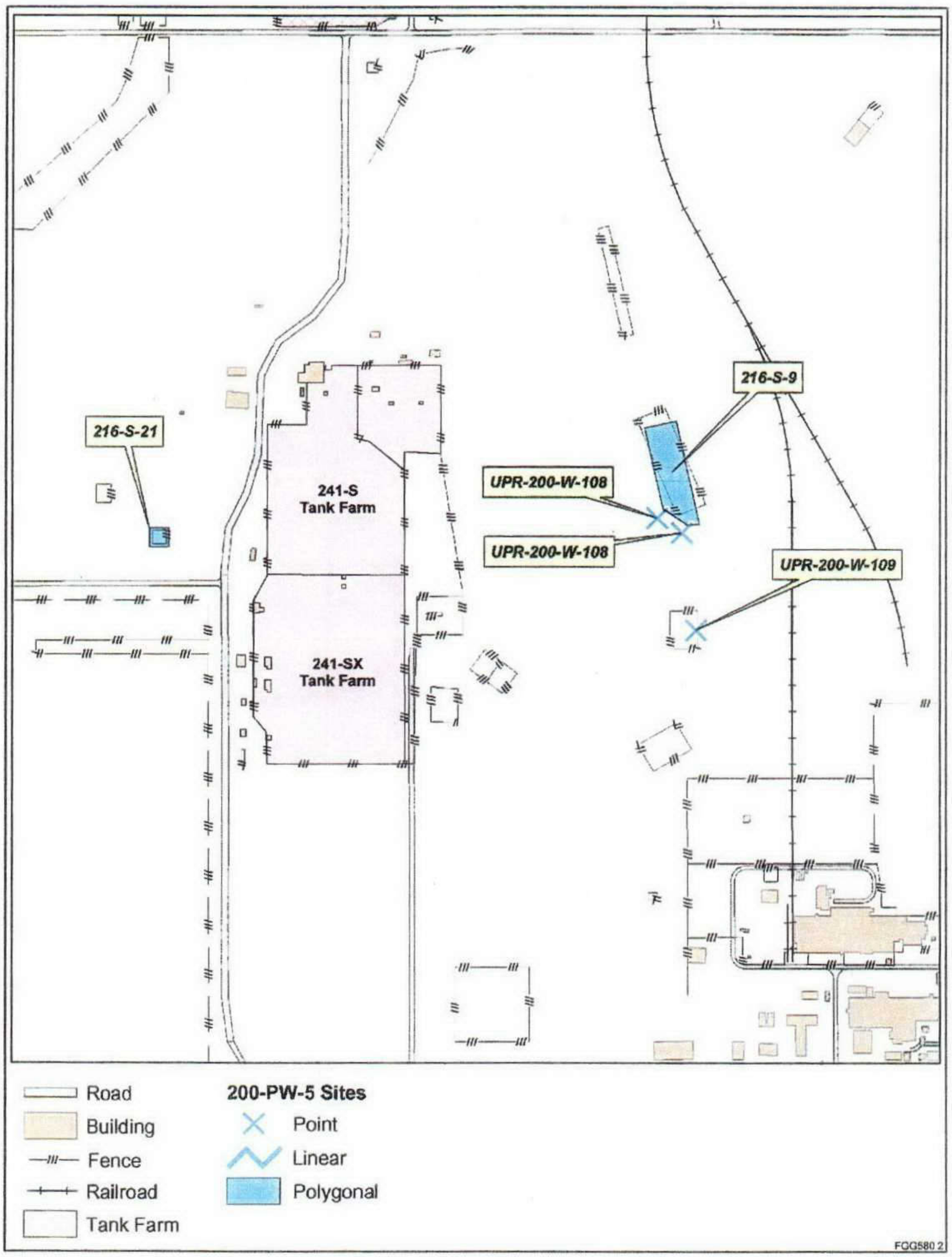
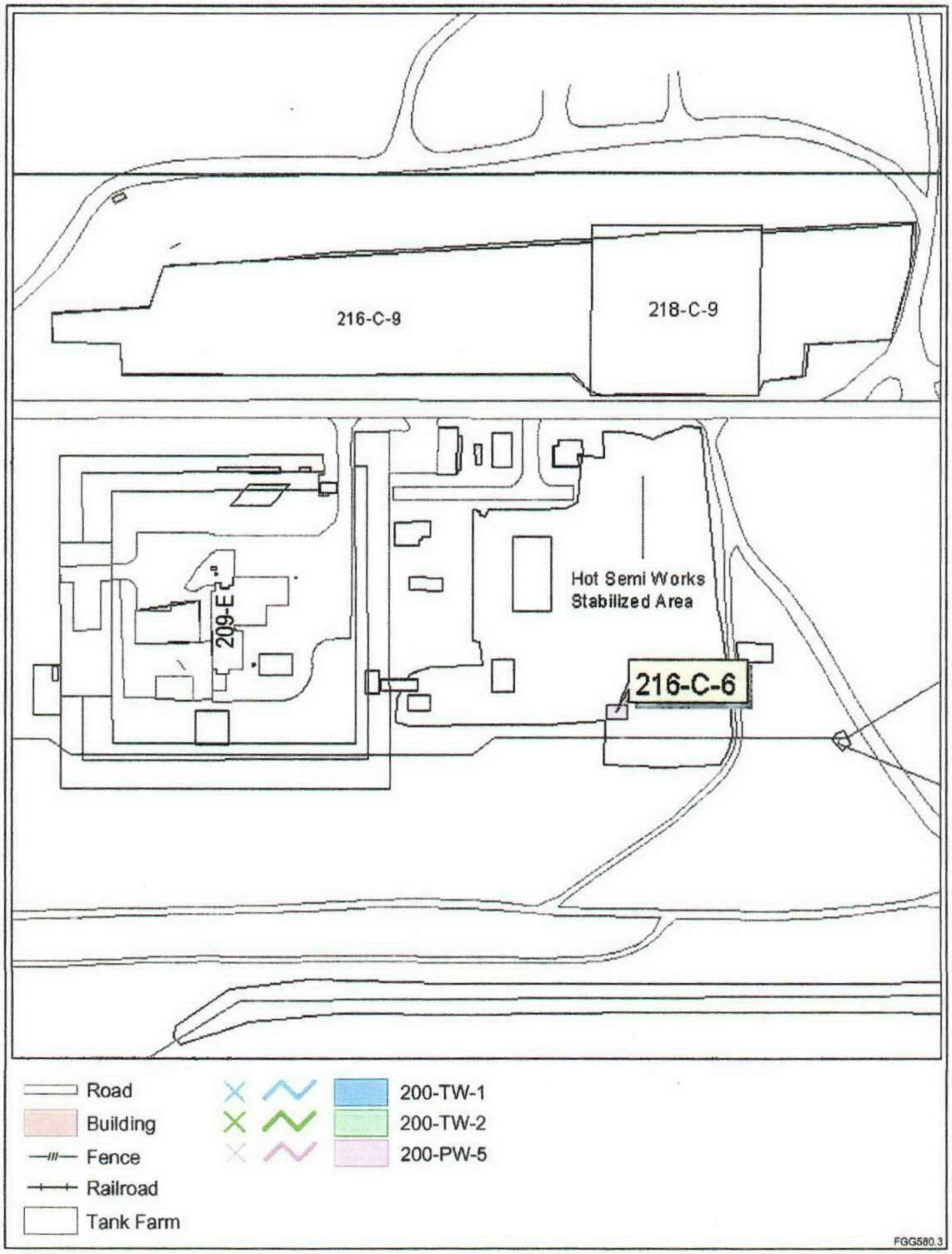


Figure 1-6. Location of the 200-PW-5 Operable Unit Waste Sites in the 200 East Area.



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2.0 BACKGROUND INFORMATION

This chapter of the 200-TW-1, 200-TW-2 and 200-PW-5 FS presents the background and history of the OUs, including descriptions of the liquid waste generating processes, the physical setting, natural resources, cultural resources, socioeconomics, representative sites, the nature and extent of contamination, and a risk evaluation. Information for the four 200-LW-1 waste sites that have been transferred to the 200-TW-1 OU is included also.

This chapter also includes the available information on waste sites not identified as representative sites. Waste sites not identified as representative sites generally fall into two categories: wastes sites that have been characterized sufficiently to support the RI/FS process and those that do not have sufficient analytical data to support separate risk assessments. These latter sites are evaluated in this FS using information from the representative sites. The available information on waste sites in the OUs is presented for the purpose of identifying waste sites that are analogous to representative sites. Similarities between the representative and analogous sites are described to support the evaluation of remedial alternatives.

DOE/RL-98-28; DOE/RL-96-81, *Waste Site Grouping for 200 Areas Soil Investigations Report*; BHI-01356, *Remedial Investigation Data Quality Objectives Summary Report for the 200-TW-1 Scavenged Waste Group and 200-TW-2 Tank Waste Group Operable Units*, and DOE/RL-2000-38 identify the representative sites for the OUs. The representative sites were selected for evaluation in an RI because of the amount of characterization already performed and because the sites are generally considered worst case (upper bound) or typical of the waste characteristics for the OUs.

The RI for characterization of the representative sites is identified in DOE/RL-2000-38. Results of the RI are presented in DOE/RL-2002-42. Knowledge gained from characterization of the representative sites is used to make decisions for the OUs using the analogous site approach described in this chapter and in DOE/RL-98-28.

An RI Report for the 200-LW-1 OU has not been completed. However, DOE/RL-2001-66 provides estimates of contaminants at the 216-B-58 Trench. Two boreholes were drilled in the 216-B-58 Trench to support this FS and the acceleration of remedial actions at the BC Cribs and Trenches. This information is included in this FS.

In addition to the seven representative sites, eight waste sites (216-B-43 Crib, 216-B-44 Crib, 216-B-45 Crib, 216-B-47 Crib, 216-B-48 Crib, 216-B-49 Crib, 216-B-50 Crib, and 216-B-26 Trench) are described in similar detail in this FS. These eight waste sites are characterized sufficiently to support development of contaminant distribution models and risk evaluations.

2.1 OPERABLE UNITS BACKGROUND AND HISTORY

2.1.1 Buildings and Ancillary Facilities

The Hanford Site, established in 1943, was originally designed, built, and operated to produce plutonium for nuclear weapons using production reactors and chemical reprocessing plants. In March 1943, construction began on three reactor facilities (B, D, and F Reactors) in the 100 Areas and three chemical processing facilities (B, T, and U Plants) in the 200 Areas. Operations in the 200 East and 200 West Areas mainly were related to separation of special nuclear materials from spent nuclear fuel (i.e., fuel that has been withdrawn from a nuclear reactor following irradiation). Operations in the 200 Areas consisted of eight main processing areas.

- 200 North Area. The 200 North Area was used for irradiated nuclear fuel and contaminated equipment storage.
- B Plant. In the B Plant, the bismuth-phosphate process was used to separate plutonium from irradiated fuel rods. Recovery of cesium, strontium, and other rare earth metals also was performed, using an acid-side oxalate-precipitation process.
- S Plant. In the S Plant, the reduction/oxidation (REDOX) process was used to separate plutonium from irradiated fuel rods.
- T Plant. In the T Plant, the bismuth phosphate process was used to separate plutonium from irradiated fuel rods.
- A Plant. In the Plutonium-Uranium Extraction (PUREX) Plant, the tributyl phosphate (TBP) process was used to separate plutonium from irradiated fuel rods.
- C Plant. In the Hot Semiworks Plant, the bismuth-phosphate process was used in plutonium separation.
- U Plant. In the U Plant, the TBP process was used to recover uranium from bismuth-phosphate process wastes.
- Z Plant. In the Z Plant, dibutyl butyl phosphonate, TBP, carbon tetrachloride, and acids were used in the americium and plutonium separation and recovery processes.

The following sections describe the B Plant, T Plant, and U Plant and the associated ancillary buildings and facilities, including a summary of the history of operations, important waste generating processes, and liquid waste disposal practices. The B Plant, T Plant, and U Plant were the primary contaminant sources for the 200-TW-1, 200-TW-2, and 200-PW-5 OUs. Although the buildings and ancillary facilities associated with the B Plant, T Plant, and U Plant are not within the scope of this FS, they represent the primary sources of waste disposed to the OUs and are, therefore, of interest for this FS. Figures 2-1a and 2-1b show the processes at that plants and identifies the waste sites that received effluents from these processes.

2.1.2 B Plant, T Plant, and U Plant History

B Plant and T Plant were constructed in 1944. B Plant and T Plant consist of several buildings each, including the 221-B Building and 221-T Building (also known as the canyon buildings because of their shape and appearance) and the 224-B Building and 224-T Building (also known as the concentration buildings because of the operational procedures performed there). The B and T Plants received and processed irradiated fuel rods from the 100 Area reactors. The fuel rods were subject to several chemical separation and purification steps to produce the desired plutonium product. The plutonium separation and purification operations ceased in 1952 at B Plant and in 1956 at T Plant (DOE/RL-92-05, *B Plant Source Aggregate Area Management Study Report*; DOE/RL-91-61, *T Plant Source Aggregate Area Management Study Report*).

U Plant, constructed in 1944, was based on the design of B Plant and T Plant and initially was used to train personnel for the uranium/plutonium separation operations conducted in B Plant and T Plant. Reportedly, only clean water was used for training purposes and no waste streams were generated in this early training operation. In 1951, U Plant was modified to facilitate the URP processes. This mission, conducted from 1952 to 1958, served two purposes: (1) to recover unprocessed uranium to be irradiated and processed into plutonium, and (2) to reduce the volume of waste generated at B Plant and T Plant. A secondary operation later was added to the URP processes in U Plant to "scavenge" or precipitate out of solution the long-lived fission products in the settling process before the waste was discharged (DOE-RL 91-52, *U Plant Source Aggregate Area Management Study Report*).

Liquid wastes generated at B Plant, T Plant, and U Plant were routed to several underground storage tanks within the B, BX, BY, T, TX, and TY Tank Farms through a series of collection and transfer tanks, diversion boxes, vaults, and piping. This allowed the heavier constituents to settle out from solution and form sludge and was known as "cascading." The remaining liquid supernatants were discharged to the soil column in cribs, drains, trenches, and injection/reverse wells (*Waste Information Data System* report [WIDS]).

Cribs and drains were designed to percolate wastewater into the ground without exposing it to the open air. French drains usually were constructed of steel or concrete pipe and were either open or filled with gravel. Cribs were shallow excavations that were either backfilled with permeable material or held open by wooden structures. Cribs usually had an additional layer of an impermeable substance, which allowed the water to flow directly into the backfilled material, or covered space, and percolate into the vadose zone soils. Cribs and drains typically received low-level radioactive waste for disposal. Most were designed to receive liquid until a specific retention volume or radionuclide capacity was met (DOE/RL-91-61, DOE/RL-92-05).

Trenches are shallow, long, narrow, unlined excavations. Trenches received limited quantities of sludge and/or liquid wastes. Trenches often were located in proximity to other trenches. Some trenches have been backfilled and marked as a single group, regardless of whether they all contained the same type of waste (DOE/RL-92-19, *200 East Groundwater Aggregate Area Management Study Report*; DOE/RL-91-61).

Injection/reverse wells usually were encased holes that were drilled with the lower end perforated or open to allow liquid to seep to the vadose zone. These units injected wastewater into the vadose soil at depths greater than the other disposal sites. Injection wells generally were constructed of steel or concrete pipe and were either open or filled with gravel. Injection wells were used for the disposal of early liquid wastes from B Plant and T Plant. However, liquid wastes were rerouted to cribs and trenches from the injection wells, as the wells reached their capacity (DOE/RL-91-61, DOE/RL-92-05).

2.1.3 Process Information

The chemical separations processes implemented at B Plant, T Plant, and U Plant generated liquid waste streams. The B Plant, T Plant, and U Plant processes that are the primary sources of waste disposed to the 200-TW-1, 200-TW-2 and 200-PW-5 OU waste sites include the following.

- The bismuth-phosphate separation process generated 221-B Building or 221-T Building waste including dissolved cladding, metal waste, and first- and second-cycle waste streams.
- The lanthanum-fluoride purification process generated 224-B Concentration Facility or 224-T Concentration Facility waste streams including purification waste or lanthanum/fluoride waste streams.
- The URP process generated U Plant waste including TBP waste or column waste, solvent recovery waste, acid recovery waste, off-gas condensates, and uranium trioxide or powdered waste streams.
- The scavenging (fission-product precipitation) process generated the scavenged and in-tank scavenged waste, including the fission-products waste streams.
- The plant shut-down and equipment decontamination process generated dilute washings of the waste streams mentioned above.

2.1.3.1 Bismuth-Phosphate Separation Process

Irradiated uranium slugs rich with plutonium were transferred from the 100 Areas to the 200 North Area via shielded rail cars for a 45- to 60-day period of intermediate storage in large tanks containing water. After the necessary period of storage, the slugs were sent via rail car to the 221-B and 221-T Buildings (OUT-1462, *History of Operations (1 January 1944 to 20 March 1945)*). The rods came with an aluminum/aluminum-silicate cladding as a protective jacket. The first step of the separation process was to dissolve this cladding using a sodium hydroxide solution; sodium nitrate and mercury were added to prevent the generation of hydrogen gas and to assist in dissolving the aluminum cladding. The liquid effluent was composed of the sodium hydroxide solution and the dissolved aluminate-sodium nitrate/nitrite. This solution became known as the dissolved-cladding waste stream (HW-10475, *Hanford Engineer Works Technical Manual (T/B Plants)*). This waste stream was sent to Tanks 241-B-110, 241-B-111, 241-B-112, 241-B-201, 241-B-202, 241-B-203, and 241-B-204 and to Tanks 241-T-104, 241-T-105, 241-T-106, 241-T-109, 241-T-110, and 241-T-111. This waste stream often was combined with first-cycle waste. Waste sites 216-T-14 to 216-T-17, 216-T-21 to 216-T-25, and 216-B-35 to 216-B-41 (all trenches) are specifically referenced to contain waste generated from this process

(DOE/RL-91-61, 92-05). However, it is likely that all of the 200-TW-2 OU waste sites may contain some of this waste through drainage or overflow from canyon buildings (HW-10475).

After the cladding was removed, the fuel rod was rinsed with water and dissolved into a concentrated solution of nitric acid, known as the dissolver solution. Plutonium, uranium, and fission products including Co-60, Sr-90, and Cs-137 isotopes were present in this solution (HW-10475).

The next step of the bismuth-phosphate process involved the separation of the fission products and uranium ions from the plutonium ions. Sodium nitrite solution was added to a batch of dissolver solution to ensure that the plutonium ion would have a valence of 3+ or 4+. Bismuth nitrate, phosphoric acid, and sulfuric acid were added to this solution, causing the plutonium and approximately 10 percent of the fission products to precipitate out of solution as a bismuth-phosphate complex, a white powder (HW-10475).

Once the precipitant was separated from the supernatant, the supernatant was sent to the B, BX, BY, T, TX, and TY Tank Farms. This waste stream was known as the metal wastes stream and contained approximately 100 percent of the uranium and 90 percent of the fission products from the original waste. This waste was so concentrated with radionuclides that storage in the tank farms was the only acceptable waste disposal solution (HW-10475).

The plutonium/bismuth-phosphate precipitant was washed with water; washings were disposed of as first-cycle waste. The precipitant was then redissolved in a concentrated solution of nitric and phosphoric acids, recreating the plutonium 4+ ion in solution. A sodium dichromate solution was added to convert and stabilize the plutonium 4+ ion to a 6+ ion by an oxidation reaction. The plutonium was in the form of a plutonium oxide complex, which was insoluble during the bismuth-phosphate precipitation (HW-10475).

Bismuth nitrate, phosphoric acid, and sodium metabismuthate were added to the solution. The plutonium 6+ ion remained in solution and a bismuth-phosphate precipitant again formed, containing more of the residual fission-product impurities. The precipitant containing the fission-product impurities was redissolved and disposed of as first-cycle waste (HW-10475). The plutonium 6+ ion-rich solution was then combined with ammonium fluosilicate, ferrous ammonium sulfate, bismuth oxynitrate, hydrogen peroxide, and phosphoric acid. Again, the white plutonium/bismuth-phosphate precipitant formed, separating more of the fission products (remaining in solution) from the desired plutonium. This liquid also was disposed of as first-cycle waste (HW-10475).

First-cycle waste was thought to have contained approximately 10 percent of the fission products. First-cycle waste was routed for disposal through tanks at the B, BX, BY, T, TX, and TY Tank Farms. The 200-TW-2 OU waste sites 216-B-35 to 216-B-41, 216-T-14 to 216-T-17, and 216-T-21 to 216-T-25 (all trenches), are reported to contain waste generated from this process. However, it is likely that all of the 200-TW-2 OU waste sites may contain some of this waste through drainage or overflow from canyon building cells 5 and 6 (HW-10475; WHC-MR-0227, *Tank Wastes Discharged Directly to the Soil at the Hanford Site*).

This entire precipitation cycle was repeated. The resulting waste stream was known as the second-cycle waste stream. The second-cycle waste contained approximately 0.1 percent of the fission products and was routed for disposal through Tanks 241-B-110, 241-B-111, 241-B-112, 241-B-201 to 241-B-204, 241-T-105, 241-T-110, 241-T-111, 241-T-112, and 241-T-201 to 241-T-204. Waste sites 216-B-5 Reverse Well, 216-B-7A&B Cribs, 216-B-8 Crib, 216-B-9 Crib, 216-T-3 Reverse Well, 216-T-5 Crib, 216-T-6 Crib, 216-T-7 Crib, and 216-T-32 Crib are reported to contain waste generated from this process. However, all of the 200-TW-2 OU waste sites likely contain some of this waste through drainage or overflow from canyon building cells 5 and 6. The solution resulting from the second precipitation cycle was a dilute plutonium nitrate supernatant that was sent to the 224-B Concentration Facility and 224-T Concentration Facility for further purification and volume reduction (HW-10475, WHC-MR-0227).

2.1.3.2 Lanthanum-Fluoride Purification Process

The lanthanum-fluoride purification process was a second part of the bismuth-phosphate separation process. The lanthanum-fluoride purification process further purified the dilute solution created in the last step of the bismuth-phosphate process. The dilute plutonium nitrate supernatant was first oxidized with sodium metabismuthate. Phosphoric acid was added to precipitate out impurities. The waste precipitant was redissolved in nitric acid and disposed of as waste from the 224-B Concentration Facility or 224-T Concentration Facility. The plutonium-containing supernatant was then treated with oxalic and hydrofluoric acids and lanthanum salt. As a result, lanthanum fluoride and plutonium fluorides were co-precipitated. The supernatant was discharged as waste from the 224-B Concentration Facility or 224-T Concentration Facility. These solids were washed with water. The washings were discharged as 224-B Concentration Facility or 224-T Concentration Facility waste (HW-10475, WHC-MR-0227, DOE/RL-91-61, DOE/RL-92-05).

The lanthanum and plutonium fluoride solids then were converted to hydroxides by the addition of a hot potassium hydroxide solution. The hydroxides were washed with water (washings were again discharged as 224-B Concentration Facility or 224-T Concentration Facility waste), dissolved in nitric acid, and heated to form a concentrated plutonium nitrate solution. This solution was sent to the isolation building (231-B Building or 231-T Building) for further purification treatments and evaporation. A concentrated plutonium nitrate paste was the final product. For every batch or 760 L (200 gal) of dilute plutonium unpurified solution entering the 224-T Concentration Facility, an estimated 30 L (8 gal) of purified concentrated weapons-grade plutonium solution was produced (HW-10475).

The waste generated by the lanthanum-fluoride purification and volume reduction process was routed initially to the 241-B-361 Settling Tank and the 241-T-361 Settling Tanks, with the overflow proceeding to the 216-B-5 Injection/Reverse Well and the 216-T-3 Injection/Reverse Well for discharge. When the 241-B-361Settling Tank, the 241-T-361 Settling Tank, the 216-B-5 Injection/Reverse Well, and the 216-T-3 Injection/Reverse Well reached their respective capacities, the 224-B Concentration Facility or 224-T Concentration Facility waste then was diverted to single-shell tanks (SST) 241-B-201 through 241-B-204 and 241-T-201 through 241-T-204. This allowed the solids in the waste to settle before discharging the liquid effluents to the 216-B-7A&B, 216-T-6, 216-T-7, and 216-T-32 Cribs (WIDS).

2.1.3.3 Uranium Recovery Process

From 1952 to 1958, the URP was implemented at the U Plant to recover the spent uranium from the metal waste and first-cycle waste streams generated in the B Plant and T Plant for reuse in weapons-grade plutonium production. The URP was performed in the following three phases (HW-19140, *Uranium Recovery Technical Manual*):

- Removal of bismuth-phosphate waste (metal waste, first-cycle supernatants, and cell 5 and 6 drainage) from underground storage and preparation of the sludge/slurry solution
- Separation of the uranium from plutonium, fission products, and chemicals
- Conversion of the uranium into uranium trioxide powder.

The metal waste and first-cycle waste stored in the B and T Tank Farms was sent via a network of underground pipes, tanks, and diversion boxes to U Plant, where it was deposited into cascading underground storage tanks. The uranium-rich bismuth-phosphate waste streams often turned into a sludge/supernatant combination because of the basic pH level of the waste solution (pH usually was adjusted and maintained at 10.5 because of the corrosiveness of the waste stored in the tanks). The sludge was dissolved into a liquid solution, to be pumped from the tanks into the 221-U Canyon Building. An aqueous solution was jetted at a high pressure into the sludge to dissolve it into a slurry solution. Water and/or sodium carbonate, ammonium bicarbonate, or sodium bicarbonate solutions were used as alternatives to enhance solubility. The supernatant was recycled and reused in the dissolution process of the sludge.

The sludge/supernatant slurry was pumped to an accumulation tank. The sludge settled and was transferred to an agitated dissolver tank, while the supernatant was recycled. To prepare the separation feed, a large quantity of nitric acid was added to the sludge. The nitric acid served two purposes. First, it dissolved the uranium-rich sludge into an aqueous phase. Second, it acted as a salting agent, reducing the solubility of the uranyl nitrate in the aqueous phase and increasing its solubility during the first separation via an extraction column. The pH was adjusted in the resulting solution, which was concentrated by evaporation. This concentrated feed solution then was sent to the first-cycle extraction column. The off-gasses were collected, condensed, and disposed of in cribs, ditches, and trenches near the U Plant; these sites are not included in the 200-TW-1, 200-TW-2, or 200-PW-5 OUs.

The uranium-rich feed entered the extraction column at mid-point. A countercurrent flow of TBP dissolved in a hydrocarbon solution (usually kerosene or paraffin) extracted the uranium from the feed solution into the TBP/organic solution. The fission products, plutonium, and other inorganic chemicals from the bismuth-phosphate process remained in the aqueous feed solution. A scrub solution, composed of nitric and sulfamic acids along with ferrous ammonium sulfate, also was introduced at the top of the column. The scrub solution was used to scrub the fission products from the extraction column and to ensure that the plutonium remained in solution as a 3^+ ion. The aqueous waste steam was sent to a waste treatment collection tank for further processing. This separation/extraction was a continuous flow process.

The TBP/organic solution rich with uranium left the first extraction column and continued to a second extraction column. At this column, the TBP/organic solution entered the bottom of the column and was met by a countercurrent flow of water. Because the organic solution did not contain a salting agent to bind the uranium in solution, the water extracted the uranium from the organic solution into an aqueous phase. The waste organic solution was sent to the solvent recovery operation in U Plant while the aqueous solution, containing the uranium, was sent to the uranium trioxide process in U Plant.

The solvent recovery operation at U Plant used a scrubber column and a sodium sulfate solution to remove any residual fission products, plutonium, and/or inorganic salts including nitrates from the organic solvent. The purified organic/TBP solvent was recycled, and the scrubber solution containing impurities was sent to the waste collection tank in the 241-WR Vault and later scavenged and sent to cribs and trenches, including the 200-TW-1 OU waste sites 216-B-20 to 216-B-34 Trenches, 216-B-42 Trench and 216-B-43 to 216-B-49 Cribs, 216-B-51 French Drain, 216-B-52 Trench, 216-T-18 Crib, and 216-T-26 Crib via underground pipelines and diversion boxes (ARH-947, *200 Areas Disposal Sites for Radioactive Liquid Wastes*; WHC-MR-0132, *A History of the 200 Area Tank Farms*).

The aqueous phase containing the uranium was combined with the concentrated uranyl nitrate hexahydrate solution from the REDOX operations and sent to the uranium trioxide plant for conversion of the uranyl nitrate solution into uranium trioxide powder. The solutions passed through two evaporators that evaporated the water/nitric aqueous component and concentrated the solution with uranyl nitrate. The off-gasses were collected and sent to a fractionation operation in U Plant, where the nitric acid was recovered and reused in the dissolver tank for feed preparation or routed to cribs, ditches, and trenches near the U Plant for disposal (ARH-947).

The concentrated uranyl nitrate solution was sent to calcination vessels. These vessels were electrically heated and contained agitators or stirring mechanisms. The vessels were heated for 5 hours. This allowed the uranyl nitrate solution to maintain a temperature of 400 °F. The off-gasses were again collected and sent to a fractionation operation, where nitric acid was recovered and reused in the dissolver tank for feed preparation and/or routed to cribs, ditches, and trenches near U Plant for disposal. Once thermo-decomposition was completed, uranium trioxide powder was formed. The powder was removed from the vessels, packaged, and shipped offsite to Oak Ridge, Tennessee, where it was converted to uranium metal. The metal was returned to the 300 Area to be reincorporated into the uranium fuel-rod production (HW-19140).

The aqueous waste streams generated in this TBP/URP process from each of the extraction columns were sent to an aqueous waste collection tank. The waste was pooled until an optimal volume was received and a sample was obtained. Once the waste collection tank reached optimal volume (usually 45,425 L [12,000 gal]), it was condensed and then sent back to the feed accumulation tank for reprocessing, or routed to the neutralization tank. In the neutralization tank, the waste was combined with an equal volume of 50 percent caustic soda (sodium hydroxide) to obtain a pH of 9.5. Because a measurable quantity of ammonia was generated by neutralization, quantities of 50 percent caustic soda (sodium hydroxide) were added to raise the pH to 11.5 (HW-19140).

Waste from the neutralization tank was sent to a concentrator in the 221-U Building, where the volume of the aqueous waste was reduced through evaporation. The concentrate (or remaining sludge/slurry solution) was pumped back to underground storage tanks in the B, BX, BY, T, TX, and TY Tank Farms. The recovered condensate and other recovered condensates (from off-gasses generated during the feed preparation, calcination, solvent recovery, and nitric acid recovery operations) were routed to cribs, trenches, and ditches for disposal via diversion vaults (including the waste sites within the 200-TW-1 OU). Cooling water, steam condensates, nonradioactive, and nonhazardous wastes were routed to U Plant trenches and ditches for disposal into the soil column (HW-19140).

2.1.3.4 Scavenging Process

In 1953, tests to further treat the metal waste and first-cycle waste streams generated at T Plant and B Plant during the bismuth-phosphate campaign proved successful. The scavenging process separated the long-lived fission products, including strontium and cesium, from the waste solutions by precipitation. This process served two purposes: (1) it reduced the volume of waste containing long-lived fission products previously stored within the tank farms, and (2) it allowed the remaining waste liquid effluents (no longer containing the long-lived fission products) to be discharged to the soil column. Waste liquid effluents from the test batches were sent to the 216-T-18 Crib for disposal into the soil column (LA-UR-96-3860, *Hanford Tank Chemical and Radionuclide Inventories: HDW Model*; ARH-947; GE 1958, *Record of Scavenged TBP Waste (Logbook)*).

From 1954 to 1958, the scavenging process was conducted at U Plant after the URP operations. The order of operations often was modified throughout the duration of the scavenging process. Parameters such as pH, addition of other metals to enhance precipitation, and soil retention properties also were continually changing. After URP processing, TBP column wastes were sent to a neutralization tank at U Plant, where the pH was adjusted to 9 ± 1. Chemicals used to scavenge fission products included potassium and sodium derivatives of the metal/ferrocyanide complex ion. The most notable and widely used metals (used to assist precipitation) were iron, nickel, and cobalt. Calcium nitrate and/or strontium nitrate often were added to enhance the precipitation of the radioactive Sr-90. Phosphate ions also were added to aid the soil retention of Sr-90. Once the TBP waste had been scavenged, the waste was returned to the B, BX, BY, T, TX, and TY Tank Farms to allow the solids (containing the fission products and scavenging chemicals) to settle for approximately one week. The waste liquid effluent was sampled and analyzed from the tanks at various depths. The waste liquid effluent was sent to cribs and/or trenches if the amounts of Cs-137 and Sr-90 were within limits; otherwise, the liquid waste was rerouted to other nearby tanks and settling continued. In extreme cases, scavenging occurred in-tank to further precipitate fission products out of solution. The cribs and trenches receiving the scavenged TBP waste include 200-TW-1 OU waste sites 216-B-14 to 216-B-19 Cribs and 216-B-20 to 216-B-34 Trenches, 216-B-42 Trench and 216-B-43 to 216-B-49 Cribs, 216-B-51 French Drain, 216-B-52 Trench, and 216-T-26 Crib (HW-19140; DOE/RL-91-52; WIDS; WHC-SD-WM-ER-133, *An Assessment of the Inventories of the Ferrocyanide Watchlist Tanks*; GE 1958).

In 1955, in-tank or in-tank-farm scavenging operations also began. In-tank scavenging was conducted to process the TBP waste, previously generated in U Plant before the implementation of the scavenging operation, that had been returned to the B, BX, BY, T, TX, and TY Tank Farms. The TBP wastes were transferred from the tanks to vaults, including the 244-CR Vault near the PUREX Plant, where the TBP waste was scavenged and sent back to the original tank farms. The same chemicals were used in the in-tank scavenging that were used in the U Plant.

Often, scavenging was performed in batches from tanks in the B, BX, BY, T, TX, and TY Tank Farms when the liquid effluents did not meet cribbing or trenching limits. The cribs and trenches that received in-tank or in-tank-farm scavenged and/or rescavenged TBP waste include 200-TW-1 OU waste sites 216-B-17 Crib, 216-B-19 Crib, 216-B-20 to 216-B-23 Trenches, 216-B-28 Trench, 216-B-30 to 216-B-34 Trenches, and 216-B-52 Trench (ARH-947). The "in tank" scavenging operations ended in 1957, and the last of the liquid effluents were discharged in 1958 (HW-31442, *Recovery of Cesium-137 from Uranium Recovery Process Wastes*; HW-33591, *Summary of Liquid Radioactive Wastes Discharged to the Ground – 200 Areas (July 1952 Through June 1954)*; HW-38562, *Radioactive Contaminants in Liquid Wastes Discharged to Ground at Separation Facilities Through June 1955*; HW-42612, *Cobalt-60 in Groundwater and Separation Waste Streams*).

Post-B Plant and T Plant sources of waste disposed in the 200-TW-1 and 200-TW-2 OU waste sites include the following (DOE/RL-91-61, DOE/RL-92-05):

- Decontamination and equipment refurbishment, including ammonium silica fluoride tests
- Pacific Northwest National Laboratory (PNNL) waste
- Bismuth-phosphate waste treatment experiments
- Dissolved coating wastes from PUREX Plant.

The facilities of B Plant and T Plant were used for several different purposes after the bismuth/phosphate campaign ended. Additional waste streams that may have contributed to either 200-TW-1 or 200-TW-2 OU waste sites include the following.

- 221-T Canyon Building, 1957 to 1991: The 221-T Building was converted to a decontamination and equipment refurbishment facility. The facility provided services in radioactive decontamination, reclamation, and decommissioning of process equipment. Radioactive wastes from these decontamination activities were discharged to double-shell tanks. Nonradioactive waste streams including condensate, cooling water, and heating coil water were discharged to the chemical sewer. Usually steam was used as the primary scrubbing solution for early decontamination and equipment refurbishment. Tests also were performed using ammonium silica fluoride, chromic acid, glycerin, and citrate and oxalate compounds, along with many industrial caustics including borax and Calgon[1], as different dissolver solutions. The waste from early decontamination operations was discharged to the soil at disposal sites 216-T-9 to 216-T-11 Trenches, 216-T-13 Trench, and 216-T-28 Crib (sites not in either OU); however, there is a possibility that the 200-TW-2 OU waste sites received small amounts. During the bismuth-phosphate campaign, decontamination efforts were performed on a routine basis as housekeeping measures to wash/rinse the equipment and cell walls within the building.

- 221-T Canyon Building and 2706-T Equipment Contamination Building, 1959 to 1969: 300 Area laboratory wastes were shipped via truck from the 340 Building to the 200 West Area and combined with the 221-T Building and 2706-T Building waste streams. These were disposed of via tanks into the 216-T-27 Crib, 216-T-28 Crib (these two cribs are not in either OU), and possibly the 216-T-26 Crib (WIDS).

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[1] Calgon is a trademark of Calgon Corporation, Pittsburgh, Pennsylvania.

Laboratory waste streams generated in the 300 Area could contain aluminum canning process wastes including bronze, tin, silica, and aluminum. Bismuth-phosphate, URP, REDOX (ion exchange), and PUREX separation processes also were tested in the 300 Area; however, it was noted that these "bench-scale" experiments contained mainly inorganic chemicals and very small amounts of radionuclides during the 216-T-26, 216-T-27, and 216-T-28 Cribs active disposal period.

- 221-B Canyon Building, 1950 to 1966: 221-B was used to begin waste treatment methods including scavenging operational experiments. Chemicals used for this experimental work included metals; acids; bases; and complexing agents, including ferro- and ferrouscyanide. The amounts of this specific type of waste were extremely small, and few records were kept regarding the disposal of this waste. Most of the waste treatment experiments are believed to have been performed on "tank waste" and very few were successful (other than the scavenging process); most of the waste was disposed into nearby tanks. From 1963 to 1966, the first phase of the Waste Fractionalization Project was completed in the 221-B Building. This first phase included the recovery of strontium, cerium, and rare-earth metals using an acid oxalate-precipitation process. Once the waste had been fractionalized by centrifuge, it was pumped via underground pipelines to the Hot Semiworks (C Plant) for further processing.

- B and BY Tank Farms, 1956 to 1988: Dissolved coating or cladding waste from PUREX often was sent to the B and/or BY Tank Farms. This waste was produced by dissolving the aluminum/zirconium "can" around the plutonium-enriched uranium sludge with sodium hydroxide. This PUREX chemical process was the same chemical process that was used during the bismuth-phosphate campaign. Thus, the intermixing of these two waste streams proved to be inconsequential. It is unclear if any PUREX cladding waste was released with bismuth-phosphate cladding waste when it was mixed with first-cycle waste and released to the 216-B-5 Reverse Well, 216-B-8 Crib, and 216-B-35 to 216-B-41 Trenches waste sites; however, all chemical constituents are the same.

2.1.3.5 Fission Product-Rich Process Condensate

Fission-products process condensates were generated during the fuel rod enrichment cycle and were released during decladding or dissolved in sodium hydroxide or nitric acid in the separation processes. Because of their radioactivity, the high-fission product-rich wastes were separated and placed in tanks for storage and decay. Less concentrated fission product-rich wastes were discharged to the 200-PW-5 OU waste sites.

Concentrators, waste evaporators, dissolvers, and in-tank solidification used condensers and deentrainers to condense boiled-off vapors and entrained liquids. Process vessel off-gasses also were vented via a vessel vent system to condensers, where vapors were condensed to become process condensate.

Acid recovery at most plants consisted of a single or double distillation. Acid vapors also were condensed and passed through an absorber, then sent to a vacuum fractionator to produce 60 percent nitric acid. The acid was recycled back to the dissolvers. The condensate escaping from these steps and the tailings from the vacuum fractionator were discharged to cribs (216-B-57 and 216-S-9 Cribs). The effluent discharge to the soil column generally contained more than 20 Ci of fission products (either Cs-137 or Sr-90) and lower quantities of plutonium, uranium, and organic wastes.

2.1.3.6 300 Area Chemical Laboratory Waste

The 216-B-58 Trench, 216-B-53A Trench, 216-B-53B Trench, and 216-B-54 Trench from the 200-LW-1 OU have been included in this FS because they are located in the BC Cribs and Trenches Area, which is undergoing accelerated remedial action to address high risk to human and ecological receptors and the groundwater.

From 1962 to 1967, liquid laboratory waste from the 300 Area was sent to the 340 Facility via the process sewer. Waste that was above the release limits for the 300 Area Process Ponds was sent by tanker truck to the 216-B-58, 216-B-53B, and 216-B-54 Trenches for disposal. Laboratory process waste was characterized as slightly acidic to alkaline radioactive waste (mainly cesium and strontium) with a low salt and organic content.

The 216-B-53A Trench was active during October and November 1965. The site received waste from a liquid release at the Plutonium Recycle Test Reactor in the 300 Area. The waste was transported to the trench in tanker trucks. The waste contained an estimated 100 grams of plutonium; the 216-B-53A Trench may contain soil contaminated with transuranic constituents at levels of concern (100 nanocuries per gram [100 nCi/g]).

2.2 PHYSICAL SETTING

The meteorology, topography, and hydrogeologic frameworks for the 200-TW-1, 200-TW-2, and 200-PW-5 OU waste sites are briefly described in the following sections. Additional discussions are provided in DOE/RL-92-19; PNNL-13788, *Hanford Site Groundwater Monitoring for Fiscal Year 2001*; PNNL-13910, *Hanford Site Environmental Report for Calendar Year 2001*; PNNL-6415, *Hanford Site National Environmental Policy Act (NEPA) Characterization*; DOE/RL-2002-42; and DOE/RL-2000-38.

2.2.1 Meteorology

The Hanford Site lies east of the Cascade Mountains and has a semiarid climate caused by the rain shadow effect of the mountains. Climatological data are monitored at the Hanford Meteorological Station and other locations throughout the Hanford Site. From 1945 through 2001, the recorded maximum temperature was 45 °C (113 °F), and the recorded minimum temperature was –30.6 °C (-23 °F) (PNNL-6415). The two extremes occurred during August and February, respectively. The monthly average temperature ranged from a low of –0.24 °C (31.7 °F) in January to a high of 24.6 °C (76.3 °F) in July. The annual average relative humidity is 54 percent (PNNL-6415).

Most precipitation occurs during late autumn and winter, with more than half of the annual amount occurring from November through February (PNNL-6415). Normal annual precipitation is 17.7 cm (6.98 in.). Because this area typically receives less than 25.5 cm (10 in.) of precipitation a year, the climate is considered to be semiarid (PNNL-6415).

The prevailing wind direction at the Hanford Monitoring Station is from the northwest during all months of the year (PNNL-6415). Monthly average wind speeds are lowest during the winter months and average about 3 m/s (6 to 7 mi/h). The highest average wind occurs during the summer and is about 4 m/s (8 to 9 mi/h). The record wind gust was 35.7 m/s (80 mi/h) in 1972.

2.2.2 Topography

The Hanford Site is located in the Pasco Basin on the Columbia Plateau. The 200 West and 200 East Areas are located on the 200 Areas Central Plateau near the center of the Hanford Site. The 200 Areas Central Plateau is the common reference used to describe the Cold Creek Bar – a relatively flat, prominent terrace that trends generally east to west with elevations between 198 m and 230 m (650 to 755 ft) above mean sea level (amsl). The Cold Creek Bar formed during the cataclysmic flooding events of the Missoula floods, which ended approximately 13,000 years ago. The floodwaters deposited a thick sand and gravel bar that constitutes the higher southern portion of the 200 Areas Central Plateau. In the waning stages of the ice age, these floodwaters also eroded a channel north of the 200 Areas in the area currently occupied by Gable Mountain Pond. 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 southerly from the main channel bisects the 200 West Area. The surface in the 200 West Area slopes gently to the west.

2.2.3 Geology

The Hanford Site 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 Cold Creek unit (CCU) (formerly Plio-Pleistocene Unit, early Palouse soil, a caliche layer, and pre-Missoula gravels) and the Hanford formation. A generalized stratigraphic column for the 200 East and 200 West Areas is shown in Figure 2-2. Figures 2-3 and 2-4 show the location of the boreholes of interest in the 200 Areas. Figures 2-5, 2-6, and 2-7 were generated using data collected from these boreholes near the representative sites, to show the spatial relationships of the geologic units across that area.

The Elephant Mountain Basalt Member is bedrock beneath the OUs and consists of a medium- to fine-grained tholeiitic basalt with abundant microphenocrysts of plagioclase (DOE/RW-0164-F, *Consultation Draft, Site Characterization Plan, Reference Repository Location, Hanford Site, Washington*). The basalt is overlain by the Ringold Formation over most of the 200 East Area and all of the 200 West Area. The Ringold Formation consists of an interstratified sequence of unconsolidated clay, silt, sand, and granule to cobble gravel deposited by the ancestral Columbia River. The fluvial-lacustrine Ringold Formation is informally divided into several units; these are (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 Ringold.

The Ringold Formation is overlain by the CCU in the 200 West Area (DOE/RL-2002-39, *Standardized Stratigraphic Nomenclature for Post-Ringold Formation Sediments Within the*

Central Pasco Basin). In the 200 East Area, near the B, BX, and BY Tank Farms, the CCU overlies basalt where the Ringold Formation is not present.

In the 200 East Area, the CCU was previously interpreted to be the Hanford formation/Plio-Pleistocene (HNF-5507, *Subsurface Conditions Description for the B-BX-BY Waste Management Area*). The Hanford formation/Plio-Pleistocene was interpreted to be equivalent or partially equivalent to the Plio-Pleistocene Unit in the 200 West Area or to represent the earliest ice age flood deposits overlain by a locally thick sequence of fine-grained non-flood deposits (HNF-5507).

In DOE/RL-2002-39, the CCU is divided into five lithofacies. The five lithofacies are differentiated based on grain size, sedimentary structure, sorting, fabric, and mineralogy:

- Fine-grained, laminated to massive
- Fine- to coarse-grained, calcium carbonate cemented
- Coarse-grained, multilithic
- Coarse-grained, angular, basaltic
- Coarse-grained, round basaltic lithofacies.

Description of the five lithofacies, depositional environments, and their association with previous site nomenclature are shown in Table 2-1. Detailed description of each facies of the CCU is presented in DOE/RL-2002-39.

The Hanford formation overlies the CCU in the 200 Areas. Where the Ringold Formation and the CCU are not present in the 200 East Area, 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 consist of cross-stratified, coarse-grained sands and granule to boulder gravel. The gravel is uncemented and matrix poor. The sand facies consists of well-stratified fine- to coarse-grained sand and granule gravel. Silt in these facies is variable and may be interbedded with the sand. Where the silt content is low, an open-framework texture is common. An upper and lower gravel unit and a middle sand facies are present in the study area.

The cataclysmic floodwaters that deposited the sediments of the Hanford formation also locally reshaped the topography of the Pasco Basin. The floodwaters deposited a thick sand and gravel bar that constitutes the higher southern portion of the 200 Areas, informally known as the 200 Areas 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 the basalt.

Holocene-aged deposits overlie the Hanford formation and are dominated by eloign sheets of sand that form a thin veneer across the site, except in localized areas where the deposits are absent. Surficial deposits consist of very fine- to medium-grained sand to occasionally silty sand. Silty deposits less than 1 m (approximately 3 ft) thick also have been documented at waste sites where fine-grained windblown material has settled out through standing water over many years.

2.2.4 Vadose Zone

The vadose zone is the region between the ground surface and the water table. In the vicinity of the 200 Areas, the vadose zone thickness ranges from 62 m (206 ft) in the 200 West Area to 105 m (345 ft) in the BC Control Area south of the 200 East Area fence. Sediments in the vadose zone are the Ringold Formation (the Ringold Unit E and the Upper Ringold), the CCU, and the Hanford formation. Erosion during cataclysmic flooding removed some of the Ringold Formation and CCU. Perched water historically has been documented above the CCU at locations in the 200 West Areas. Because discharge to the surface ceased in the late 1980s, and the water table continues to decline at 0.36 m/yr, the perched water is infrequently encountered during drilling.

Recharge to the unconfined aquifer in the 200 Areas is from artificial and possibly natural sources. Any natural recharge originates from precipitation. Estimates of recharge from precipitation at the Hanford Site range from 0 to 10 cm/yr (0 to 4 in/yr) and largely depend on soil texture and the type and density of vegetation. For areas where the ground cover is assumed to remain undisturbed, a recharge rate of 3.5 mm/yr was assumed, which is within the range of values reported for shrub-steppe ground cover (PNL-10285, Estimated *Recharge Rates at the Hanford Site*). For the disturbed areas above the waste sites (i.e., stabilization cover), a recharge rate of 1.44 cm/yr has been assumed. Artificial recharge occurred when effluents such as cooling water and process waste water were disposed to the ground. PNL-5506, *Hanford Site Water Table Changes 1950 Through 1980, Data Observation and Evaluation*, reports 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 largely is limited to liquid discharges from sanitary sewer system drainfields; two (2) state-approved land disposal structures; and 140 small-volume uncontaminated miscellaneous streams. A state-approved land disposal site is located 1,200 ft north of the 200 West Area exclusion fence and receives liquid waste that has been treated at the 200 Areas Effluent Treatment Facility in the 200 East Area (*Waste Information Data Summary Report 600-211 General Summary Report*). 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, these locally saturated soil columns are dewatering. As the soil column dewaters, the moisture flux decreases. Residual moisture in the vadose zone; however, may remain for some time. In the absence of artificial recharge, the potential for recharge from precipitation becomes a primary driving force for contaminant movement in the vadose zone.

2.2.5 Groundwater

The unconfined aquifer in the 200 Areas occurs in the Hanford formation, the CCU, and the Ringold Formation. Groundwater in the unconfined aquifer flows from areas where the water table is higher (west of the Hanford Site) to areas where it is lower (the Columbia River) (PNNL-13788). In general, groundwater flow through the 200 Areas Central Plateau occurs in a predominantly easterly direction, from the 200 West Area to the 200 East Area.

Historical discharges to the ground greatly altered the groundwater flow regime, especially around 216-U-10 (U Pond) in the 200 West Area and 216-B-3 (B Pond) in the 200 East Area.

Discharges to the 216-U-10 Pond resulted in a groundwater mound developing in excess of 26 m (85 ft). Discharges to the 216-B-3 Pond created a hydraulic barrier to groundwater flow coming from the 200 West Area, deflecting it to the north through the gap between Gable Mountain and Gable Butte, or to the south of the 216-B-3 Pond. As the hydraulic effects of these two discharge sites diminish, groundwater flow is expected to acquire a more easterly course through the 200 Areas, with some flow possibly continuing through Gable Gap (BHI-00469, *Hanford Sitewide Groundwater Remediation Strategy – Groundwater Contaminant Predictions*).

Groundwater in the 200 West Area occurs primarily in the Ringold Formation. The depth to the water table varies from about 63 m (206 ft) to greater than 88 m (290 ft) in the north. Groundwater flows from west to east. The water table beneath the 200 West Area is declining at a rate of 0.36 m/yr (1.2 ft/yr). A pump-and-treat system associated with Tc-99 and uranium contamination from the 216-U-1 and 216-U-2 Cribs has operated since 1994 as part of remediation activities at the 200-UP-1 Groundwater OU, and it has treated more than 6.09×10^6 L of groundwater (DOE/RL-2002-67, *Fiscal Year 2002 Annual Summary Report for 200-UP-1 and 200-ZP-1 Pump-and-Treat Operations*).

Groundwater in the 200 East Area occurs primarily in the Ringold Formation, CCU, and Hanford formation. The depth to the water table varies from about 58 m (191 ft) to greater than 105 m (345 ft). Groundwater flows to the northwest towards Gable Mountain and to the southeast and east toward the Columbia River. The water table beneath the 200 East Area is declining at a rate of 0.36 m/yr (1.2 ft/yr).

2.3 NATURAL RESOURCES

Natural resources in and surrounding the study area include vegetation and wildlife. Biological and ecological information aids in evaluating impacts to the environment from contaminants in the soils, including potential effects of implementing remedial actions and identification of sensitive environments and species. This section also considers cultural and aesthetic resources and socioeconomics associated with the 200 Areas.

Survey data collected in 2000 and 2001 for the 200 Areas Central Plateau as part of the Ecological Compliance Assessment Project were compiled to support Central Plateau ecological evaluations (DOE/RL-2001-54, *Central Plateau Ecological Evaluation Report*, Draft B). The information includes plant community descriptions, identification of plant and wildlife species, and avian census data. Designated levels of habitat under DOE/RL-96-32, *Hanford Site Biological Resources Management Plan*, (BRMaP), including rare plant populations, are identified and mapped. The data were collected before the Command 24 fire occurred in 2000. However, the fire did not impact any of the waste sites being considered in this FS.

2.3.1 Vegetation

The vegetation in the 200 Areas Central Plateau is characterized by native shrub-steppe, interspersed with large areas of disturbed ground dominated by annual grasses and forbs. In the native shrub-steppe, the dominant shrub is big sagebrush (*Artemisia tridentata*); the understory is dominated by the native perennial, Sandberg's bluegrass (*Poa sandbergii*), and the introduced annual, cheatgrass (*Bromus tectorum*). Other shrubs typically present include rabbitbrush (*Chrysothamnus spp.*), spiny hopsage (*Grayia spinosa*), and antelope bitterbrush (*Purshia tridentata*). Other native bunchgrasses that also are present include Indian ricegrass (*Oryzopsis hymnodies*) and needle-and-thread grass (*Stipa comata*). Common herbaceous species include turpentine cymopteris (*Cymopteris terebinthinus*), globemallow (*Sphaeralcea munroana*), balsamroot (*Balsamorhiza careyana*), milkvetch (*Astragalus spp.*), yarrow (*Achillea millefolium*), dwarf evening primrose (*Camissonia pygmaea*), and daisy (*Erigeron spp.*). Dwarf evening primrose is a rare plant that has been identified on the 200 Areas Central Plateau but has not been encountered in disturbed areas of the waste sites.

Many of the waste disposal and storage sites in the 200 Areas have been backfilled with clean soil and planted with crested or Siberian wheatgrass (*Agropyron cristatum* and *Agropyron sibericum*, respectively) to stabilize surface soil, control soil moisture, or displace more invasive deep-rooted species like Russian thistle (PNNL-6415). The area associated with the waste sites addressed in this FS is highly disturbed (see Appendix A for waste site photographs). This disturbed habitat primarily is the result of mechanical and operational disturbance. Outlying habitats also have been disturbed as a result of range fires, clearing, and construction activities.

2.3.2 Wildlife

The largest mammal frequenting the area is the mule deer (*Odocoileus hemionus*). While mule deer are much more common along the Columbia River, the few that forage throughout the 200 Areas make up a distinct group called the Central Population (PNNL-11472, *Hanford Site Environmental Report for Calendar Year 1996*). A large elk herd (*Cervus canadensis*) currently resides on the Fitzner-Eberhardt Arid Lands Ecology Reserve, and a few animals occasionally have been observed south of the 200 Areas.

Other mammals common to the 200 Areas are badgers (*Taxidea taxus*), coyotes (*Canis latrans*), Great Basin pocket mice (*Perognathus parvus*), northern pocket gophers (*Thomomys talpoides*), and deer mice (*Peromyscus maniculatus*). Badgers are known for their digging ability and have been suspected of excavating contaminated soil at 200 Areas radioactive waste sites (BNWL-1794, *Distribution of Radioactive Jackrabbit Pellets in the Vicinity of the B-C Cribs, 200 East Area, USAEC Hanford Reservation*). The majority of badger diggings are a result of searches for food, especially for other burrowing mammals such as pocket gophers and mice. Pocket gophers, Great Basin pocket mice, and deer mice are abundant herbivores in the 200 Areas. These small mammals can excavate significant amounts of soil as they construct their burrows (e.g., Hakonson et al. 1982, "Disturbance of a Low-Level Waste Burial Site Cover by Pocket Gophers"). Mammals associated with buildings and facilities include Nuttall's cottontails (*Sylvilagus nuttallii*), house mice (*Mus musculus*), Norway rats (*Rattus norvegicus*), and various bat species.

Common bird species in the area include the starling (*Sturnus vulgaris*), horned lark (*Eremophila alpestris*), meadowlark (*Sturnella neglecta*), western kingbird (*Tyrannus verticalis*), rock dove (*Columba livia*), black-billed magpie (*Pica pica*), and raven (*Corvus corax*). Burrowing owls (*Athene cunicularia*) commonly nest in the 200 Areas in abandoned badger or coyote holes or in open-ended stormwater pipes along roadsides in more industrialized areas. Loggerhead shrike (*Lanius ludovicianus*) and sage sparrow (*Amphispiza belli*) are common nesting species in habitats dominated by sagebrush. Long-billed curlews (*Numenius americanus*) have been observed nesting on inactive waste sites.

Reptiles common to the study area include gopher snakes (*Pituophis melanoleucus*) and sideblotched lizards (*Uta stansburiana*). Rattlesnakes (*Crotalus viridis*) also have been observed. Reptile sightings were not widespread, with only 23 observations of side-blotched lizards at 316 sites surveyed during a 2001 Ecological Compliance Assessment Project survey (DOE/RL-2001-54, Appendix B).

The three most common groups of insects include darkling beetles, grasshoppers, and ants. Some ant species have been known to burrow up to 2.7 m (9 ft) into the vadose zone and to bring contaminants to the surface.

2.3.3 Species of Concern

The Hanford Site is home to a number of species of concern, but many of these are associated with the Columbia River and its shoreline. Two Federally protected species have been observed at the Hanford Site, the Aleutian Canada Goose (*Branta canadensis leucopareia*) and the Bald Eagle (*Haliaeetus leucocephalus*). Both depend on the river corridor and rarely are seen in the Central Plateau. As migratory birds, these species also are protected under the *Migratory Bird Treaty Act* (1918).

Several threatened, endangered, and candidate species are found in and near the 200 Areas. These include the ferruginous hawk (*Buteo regalis*), burrowing owl, loggerhead shrike, long-billed curlew, and sage sparrow. Plant species of concern (which include those listed as state endangered, threatened, sensitive, and monitored) that may occur in the vicinity of the waste sites include dwarf evening primrose and Piper's daisy (*Erigeron piperianus*) (WNHP 1998, *Washington Rare Plant Species by County*).

Both plant and animal species of concern, their designations, and the places of their occurrence can change over time. At this time, it is not anticipated that remediation of the 200-TW-1, 200-TW-2, and 200-PW-5 OUs will affect any species of concern, but incorporating the needs of these species into project planning will help to mitigate any potential effects. Especially important is avoiding undisturbed shrub-steppe habitat where possible, because this is important to many species of concern. The undisturbed shrub steppe in the 200 Areas Central Plateau has been designated as Level 3 habitat in the BRMaP (DOE/RL-96-32), which requires mitigation of any disturbance (for example through avoidance and minimization) and possibly rectification and compensation. More detailed direction on protecting Level 3 habitats and species of concern is provided in the BRMaP guidance. In addition, site-specific environmental surveys, required before ground disturbance can occur, serve as a final check to ensure that ecological resources are adequately protected.

2.3.4 Cultural Resources

A comprehensive archaeological survey of the 200 Areas found artifacts in conjunction with areas of high topographic relief and nearby sources of permanent water, but few artifacts associated with open, inland flats (PNL-7264, *Archaeological Survey of the 200 East and 200 West Areas, Hanford Site, Washington*). In the 200 West area, the only culturally sensitive area identified is the historic White Bluffs Road that crosses the northwest corner of the site. The report concluded that additional cultural resource reviews are required only for proposed projects within 100 m (328 ft) of this road. None of the waste sites associated with the 200-TW-1, 200-TW-2, and 200-PW-5 OUs are within 100 m (328 ft) of this road (PNL-7264).

PNL-7264 addressed only undisturbed portions of the 200 Areas and did not address facilities and structures. The *National Historic Preservation Act of 1966* requires agencies to consult with the State Historic Preservation Officer and the Advisory Council on Historic Preservation to ensure that all potentially significant cultural resources, including structures and associated sites, have been adequately identified, evaluated, and considered in planning for a proposed undertaking (e.g., remediation, renovation, or demolition) (DOE/RL-97-56, *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan*).

DOE/RL-97-56 was developed to address these requirements and to determine the eligibility of historic properties in accordance with 30 CFR 60, "National Register of Historic Places." The treatment plan evaluated and classified waste sites and structures on the Hanford Site, including those in the 200 Areas, and proposed recommendations for mitigation. Treatment options for mitigation were determined using 36 CFR 60.4, "Criteria for Evaluation." None of the OU waste sites were recommended for individual documentation as contributing properties. Sites beginning with "216" (e.g., 216-T-26 Crib, 216-B-26 Trench) were identified as noncontributing exempt properties (DOE/RL-97-56). Some sites not addressed in DOE/RL-97-56, such as UPRs and septic tanks that were not considered to be significant enough to be evaluated, will be evaluated under site-specific preremediation cultural resource reviews.

No cultural resources have been directly associated with OU waste sites (PNL-7264, DOE/RL-97-56, PNNL-6415); however, site-specific cultural resource reviews will be required for each waste site before remediation or other ground-disturbing activities are begun. In addition to the site-specific review, a cursory field review of plant and animal life may be conducted in concert with this effort.

2.3.5 Aesthetics, Visual Resources, and Noise

With the exception of Rattlesnake Mountain, land on the Hanford Site generally is flat with little relief. Rattlesnake Mountain, rising to 1,060 m (3,478 ft) amsl, forms the southwestern boundary of the Hanford Site, and Gable Mountain (238 m [782ft] amsl) and Gable Butte (331 m [1,085 ft] amsl) are the highest landforms on the Hanford Site itself. The view toward Rattlesnake Mountain is visually pleasing, especially in the springtime when wildflowers are in bloom. Large rolling hills are located to the west and far north. The Columbia River, flowing across the northern part of the Site and forming the eastern boundary, generally is considered scenic.

Studies at the Hanford Site on the propagation of noise have been concerned primarily with occupational noise at work sites. Environmental noise levels have not been extensively evaluated because of the remoteness of most Hanford Site activities and their isolation from receptors covered by Federal or state statutes. Most industrial facilities on the Hanford Site are located far enough away from the Site boundary that noise levels at the boundary are not measurable or are indistinguishable from background noise levels (PNNL-6415).

2.3.6 Socioeconomics

The Hanford Site plays a dominant role in the socioeconomics of the Tri-Cities (Richland, Pasco, and Kennewick) and other parts of Benton and Franklin Counties. Major changes in Hanford Site activity and employment likely would affect these areas.

In 1999, the average number of jobs in the Tri-Cities was 72,200 (PNNL-6415). Of these, the DOE and its prime contractors employed an average of 10,290 people, making the Hanford Site the largest single source of employment in the area. The total wage payroll for the Hanford Site accounted for nearly 21 percent of the total wage income in the area. In addition to the direct employment and payrolls, Hanford Site activities also support a large number of jobs in the local economy through their procurement of equipment, supplies, and business services. Direct procurements and subcontracts represented about 12 percent of the total sales in the Tri-Cities economy during fiscal year 1999. Overall, about 28,250 Tri-Cities jobs, or 32 percent of the non-farm jobs in the economy, are supported directly or indirectly by the Hanford Site payroll, procurements, and contracts.

In addition to the Hanford Site, other key employers in the area are as follows:

- Energy Northwest
- The agricultural community (including the Lamb Weston food processing plants)
- Iowa Beef Processors, Inc.
- Framatome ANP (Advanced Nuclear Power) (formerly Siemens, Inc.)
- Boise Paper Solutions
- Burlington Northern and Santa Fe Railway.

Tourism and government transfer payments to retirees in the form of pension benefits also are important contributors to the local economy.

Estimates for 2000 placed the population totals for Benton and Franklin Counties at 140,700 and 45,900, respectively (PNNL-6415). When compared to the 1990 census data, the current population totals reflect the continued growth occurring in these two counties. Increased growth is expected in the future.

The 1999 estimates of ethnic categories indicate that in Benton and Franklin Counties, Asians represent a lower proportion, and individuals of Hispanic origin represent a higher proportion of the ethnic distribution than elsewhere in the state of Washington. PNNL-6415 provides maps showing distributions of minority and low-income populations.

2.4 WASTE SITE DESCRIPTIONS

This section describes the 200-TW-1, 200-TW-2, and 200-PW-5 representative sites and other OU wastes sites that have been characterized sufficiently to support the RI/FS process. These waste sites are described in detail to support development of contaminant distribution models and the evaluation of risk and to provide a baseline for implementing the analogous site approach.

Data from these sites are presented in the 200-TW-1, 200-TW-2, and 200-PW-5 RI Report (DOE/RL-2002-42), the 200-BP-1 RI Report (DOE-RL-92-70), and RHO-ST-37, *216-B-5 Reverse Well Characterization Study*. The following representative sites from the 200-TW-1, 200-TW-2, and 200-PW-5 OUs and the four 200-LW-1 OU waste sites were identified in the Implementation Plan (DOE/RL-98-28), the Waste Site Grouping Report (DOE/RL-96-81), and the Work Plans (DOE/RL-2000-38, DOE/RL-2001-66):

- 200-TW-1 Operable Unit
  - 216-B-46 Crib
  - 216-T-26 Crib
  - 216-B-58 Trench (for the four 200-LW-1 waste sites)
- 200-TW-2 Operable Unit
  - 216-B-5 Reverse Well
  - 216-B-7A&B Crib
  - 216-B-38 Trench
- 200-PW-5 Operable Unit
  - 216-B-57 Crib.

Although not selected as representative waste sites, the following OU waste sites have been characterized sufficiently to allow evaluation of risk and development of contaminant distribution models:

- 200-TW-1 Operable Unit
  - 216-B-43 Crib
  - 216-B-44 Crib
  - 216-B-45 Crib
  - 216-B-47 Crib
  - 216-B-48 Crib
  - 216-B-49 Crib
  - 216-B-26 Trench
- 200-PW-5 Operable Unit
  - 216-B-50 Crib.

2.4.1 Representative Sites Information

2.4.1.1 216-B-46 Crib

The 216-B-46 Crib is an inactive liquid waste disposal site located north of the BY Tank Farm and west of Baltimore Avenue; the crib is included in the 216-B-43 through 216-B-50 Crib series commonly referred to as the BY Cribs.

From September to December 1955, the crib received approximately 6,700,000 L (1,800,000 gal) of URP bismuth-phosphate waste that also had been scavenged (fission products precipitated out). Once the waste was processed at U Plant, it was sent to the BY Tank Farm to allow settling of the sludge. The remaining waste liquid effluent was discharged to the crib.

The 216-B-46 Crib is constructed of four large-diameter vertical concrete pipes, set below grade in a square pattern with the centers spaced 4.6 m (15 ft) apart in a 9 x 9 x 4.6 m (30 x 30 x 15-ft) deep excavation (DOE-RL-88-30, *Hanford Site Waste Management Units Report*) (Figure 2-8). The crib was fed by a central pipe that branches into a chevron pattern to feed each vertical pipe. The vertical pipes are 1.2 m (4 ft) in diameter and 1.2 m (4 ft) long, placed 2 m (7 ft) below grade and set on a 1.5 m (5-ft) thick bed of gravel (PNL-6456, *Hazard Ranking System Evaluation of CERCLA Inactive Waste Sites at Hanford*). RHO-CD-673, *Handbook 200 Areas Waste Sites*, reports that the feed pipe to the crib was valved out when the specific retention capacity of the soil under the crib was reached. DOE-RL 88-32, *Remedial Investigation/Feasibility Study Work Plan for the 200-BP-1 Operable Unit, Hanford Site, Richland, Washington*, states that the crib-received volumes beyond its specific retention capacity. Groundwater below the crib has been impacted (WIDS).

Inorganic compounds in the liquids disposed to the crib included ferrocyanide, nitrate, phosphate, sodium, and sulfate-based compounds. Radionuclides contained within the waste stream sent to these cribs include Cs-137, Sr-90, Ru-106, and plutonium and uranium isotopes (RHO-CD-673; WHC-MR-0227; WHC-EP-0141-2, *Westinghouse Hanford Company Effluent Discharges and Solid Waste Management Report for Calendar Year 1989, 200/600 Area*). The crib also contains organic constituents such as monobutyl phosphates, dibutyl phosphates, and TBPs.

In 1991, the site was interim stabilized with 0.6 m (2 ft) of clean soil. Three characterization boreholes were drilled and geophysically logged, and soil samples were collected and analyzed. Results of this investigation are documented in the Phase 1 RI for the 200-BP-1 OU (DOE-RL-92-70).

2.4.1.2 216-T-26 Crib

The 216-T-26 Crib is an inactive liquid waste disposal site located 61 m (200 ft) north of 22nd Street and east of the TY Tank Farm (WHC-MR-0227). It is the northernmost crib of the 216-T-26, 216-T-27, and 216-T-28 Crib series. The 216-T-26 through 216-T-28 Cribs currently are fenced within a light chain barricade and are posted with underground contamination warning placards.

Between August 1955 and November 1956, the 216-T-26 Crib received approximately 1.2×10^7 L (3.2×10^6 gal) of liquid waste. This waste originated at T Plant as metal waste and first-cycle waste that had been recovered through the URP and scavenged at U Plant. The waste then was transferred back to the TY Tank Farm to allow the sludge to settle, and the liquid effluent was discharged to the crib (WHC-SD-EN-TI-014, *Hydrogeologic Model of the 200 West Groundwater Aggregate Area*; PNL-6456).

This crib has the same basic construction as the 216-B-46 Crib (Figure 2-8). A 36 cm (14-in.) steel inlet pipe reduces to a 25-cm (10-in.) pipe located approximately 3 m (9 ft) below grade.

The smaller section of pipe branches into four 20-cm (8-in.) steel pipes that feed the large-diameter vertical concrete pipes, which are approximately 1.2 m (4 ft) long and 1.2 m (4 ft) in diameter. The piping lies within in a 9 m x 9 m x 4.6-m (30 ft x 30 ft x 15-ft)-deep excavation. The base of the crib was placed at 4.6 m (15 ft) bgs, and the excavation was filled with approximately 2.4 m (8 ft) of gravel followed by approximately 2.4 m (8 ft) of earth backfill.

This unit was deactivated in 1956 by blanking the line leading to the 216-T-26 and 216-T-28 Cribs between the TY Tank Farm and the roadway. In 1975, stabilization activities were performed for the 216-T-26, 216-T-27, and 216-T-28 Cribs. This remedial action consisted of scraping off the top 15 cm (6 in.) of soil and replacing the excavated material with clean fill to the original grade (WHC-MR-0227). The contaminated soil was placed in the 200 West Area dry waste burial grounds. This unit was surface stabilized again in May 1990 (WIDS).

Waste disposed of at this unit includes ferrocyanide complexes, fluoride, nitrate, nitrite, phosphate, sodium, sodium aluminate, sodium hydroxide, sodium silicate, sulfate, Cs-137, Ru-106, Sr-90, plutonium, and uranium.

2.4.1.3 216-B-58 Trench

The 216-B-58 Trench is an inactive liquid waste disposal site located in the BC Cribs and Trenches Area south of the 200 East Area. The trench is 61 m (200 ft) long, 3 m (10 ft) wide and 3 m (10 ft) deep. Earthen dams divided the trench into eight 7.6 m (25 ft) sections. Each section was covered with wooden cover frames covered by sisalkraft paper. A corrugated 1.2 m (4 ft) diameter steel pipe runs along the bottom of the trench except for the last section at the west end. The trench also includes a wooden cover. From 1965 to 1967, the trench received 413,000 L (109,000 gal) of liquid laboratory waste, brought via tanker truck from the 300 Area. The waste contained a total of 9.1 kg of uranium, 6.7 g of plutonium, 4.4 Ci of Cs-137, 5.6 Ci of Sr-90, and 10 kg of nitrate. In 1967, the overground piping was removed and the trench backfilled. In 1982, 0.6 m (2 ft) of clean soil were place over the site.

2.4.1.4 216-B-5 Injection/Reverse Well

The 216-B-5 Injection/Reverse Well is an inactive waste management unit that was constructed in 1944. It is located about 300 m (1,000 ft) northeast of the 221-B Canyon Building and east of Baltimore Road. From April 1945 until September 1946, it received overflow waste from the 241-B-361 Settling Tank, which received lanthanum-fluoride process waste from the 224-B Concentration Facility and bismuth-phosphate process drainage from cells 5 and 6 in the 221-B Building. Between September 1946 and October 1947, drainage and other liquid waste from cells 5 and 6 were directly injected into the well (WHC-MR-0227, WHC-EP-0141-2). Approximately 31,000,000 L (8,100,000 gal) of liquid were discharged to the 216-B-5 Injection/Reverse Well, containing an estimated 4,275 g of plutonium and 3,800 Ci of beta-gamma activity (HW-17088, *The Underground Disposal of Liquid Wastes at the Hanford Works, Washington*).

The 216-B-5 Injection/Reverse Well consists of four casing strings: a 40-cm (16-in.) casing to 4 m (13 ft), a 30-cm (12-in.) casing to 31 m (102 ft), a 25-cm (10-in.) casing to 74 m (243 ft), and a 20-cm (8-in.) casing to 92 m (302 ft). The final casing string is perforated from a depth of 74 to 92 m (243 to 302 ft) (HW-17088). Total depth of the reverse well is 92 m (302 ft). The well penetrated about 3 m (10 ft) into the aquifer in 1947. The well received effluent from the 241-B-361 Settling Tank through a 5-cm (2-in.) stainless steel inlet pipe located 4 m (13 ft) below grade.

In 1947, the water table elevation in Well 299-E33-18 demonstrated that the reverse well penetrated about 3 m (10 ft) into the groundwater and that radioactive waste had been discharged into the groundwater. The 216-B-5 Reverse Well was deactivated by blanking the pipeline inlet to the well and cell 5 and 6 wastes were rerouted to the 216-B-7A and 216-B-7B Cribs (RHO-CD-673).

A surface contamination area around the well was interim stabilized in 1994 with 46 to 61 cm (18 to 24 in.) of crushed concrete from the demolished 190-B Facility. The area was surveyed and down-posted to an Underground Radioactive Material area.

2.4.1.5 216-B-7A & B Cribs

The 216-B-7A&B Cribs consist of two inactive wooden cribs, approximately 6 m (20 ft) apart, located 30 m (100 ft) north of the B Tank Farm. The cribs operated from September 1946 to May 1967 and received a total volume of 43,600,000 L (11,500,000 gal) of waste (RHO-CD-673). From October 1946 to August 1948, these cribs received overflow from the 241-B-201 SST catch tank. The waste included second-cycle waste from the 221-B Canyon Building, lanthanum-fluoride process waste from the 224-B Concentration Facility, and cell drainage and other liquid waste (low salt, alkaline, radioactive liquid) via cells 5 and 6 in the 221-B Canyon Building. Tank 241-B-201 was taken out of service in October 1948 because it was nearly filled with sludge from 221-B Canyon Building and 224-B Concentration Facility wastes. The SSTs 241-B-202 through 241-B-204 were connected in series and began flowing into the cribs in December 1948. After August 1948, lanthanum-fluoride process waste from the 224-B Concentration Facility was disposed directly to the cribs until October 1961. From December 1954 to October 1961, the unit received cell 5 and 6 drainage and equipment cleanout waste from the 224-B Concentration Facility. From October 1961 to May 1967, material disposed of in these cribs consisted of decontamination construction waste from the 221-B Canyon Building. The cribs became inactive in 1967 (HW-17088; WHC-MR-0227).

The 216-B-7A&B Cribs are in line with an 8-cm (3-in.) steel inlet pipe that supplied waste to both cribs simultaneously. Each crib is a 4 x 4 x 1.2 m (12 x 12 x 4 ft) hollow (i.e., not gravel-filled) wooden structure made of 15 cm x 15 cm (6 in x 6 in.) timbers, placed in a 4.2 x 4.2 x 4.2 m (14 x 14 x 14 ft) deep excavation. Figure 2-9 illustrates the construction of the cribs. Both cribs are classified as having cave-in potential. Construction and operation of the 216-B-7A and 216-B-7B Cribs resulted in approximately 75 percent of the discharged waste being directed to the 216-B-7A Crib. The 216-B-7A Crib was the only crib characterized.

The radionuclides contained within the waste streams discharged to the cribs included Cs-137, Ru-106, Sr-90, Am-241, uranium, and plutonium (potentially at levels above 100 nCi/g) (WHC-EP-0141-2). Approximately 22,300,000 L (5,890,000 gal) of waste were jetted to the 241-B-201 through 241-B-204 SSTs between 1947 and 1950 from B Plant. An estimated 10 g of plutonium and 20 Ci of fission products were sent from the 241-B-201 and 241-B-202 SSTs to the cribs (HW-17088). Approximately 21,470,000 L (5,670,000 gal) ultimately reached the 216-B-7A&B Cribs. An additional 22,100,000 L (5,800,000 gal) of wastewater were discharged to the cribs after 1950 until they were taken out of service in 1967.

In 1992, the contaminated soil from the UPR-200-E-144 surface contamination area was scraped and consolidated over the 216-B-7A&B Cribs. The area was covered with approximately 0.45 m to 0.61 m (18 in. to 24 in.) of clean backfill.

2.4.1.6 216-B-38 Trench

The 216-B-38 Trench is an inactive waste site located north of the 216-B-37 Trench, north of the B Plant, and west of the BX Tank Farm. The trench, active only in July 1954, received 1,430,000 L (380,000 gal) of high-salt, neutral/basic first-cycle supernatant waste from the 221-B Canyon Building via Tanks 241-B-110, 241-B-111, and 241-B-112 (RHO-CD-673).

The 216-B-38 Trench is 77 m (250 ft) long, 3 m (10 ft) wide and 3 m (10 ft) deep (RHO-CD-673). The unit was deactivated by removing the above-ground piping when specific retention was reached (RHO-CD-673).

Compounds in the liquid disposed to this site include fluoride, nitrate, nitrite, phosphate, sodium aluminate, sodium hydroxide, sodium silicate, and sulfate-based compounds from the bismuth-phosphate campaign. Radionuclides contained in the waste stream at the time of discharge included 510 Ci of Cs-137, 1,900 Ci of Sr-90, 560 Ci of Ru-106, 1.2 g of plutonium, and 42 kg of uranium (RHO-CD-673). In October 1982, the trench was surface stabilized with 0.6 m (2 ft) of clean topsoil and treated with an herbicide.

2.4.1.7 216-B-57 Crib

The 216-B-57 Crib is an inactive waste site located adjacent to the northwest corner of he BY Tank Farm. It is 60 m (200 ft) long, 2.6 m (15 ft) wide and 3 m (10 ft) deep, and is composed of a perforated, 30 cm (12 in.) diameter pipe that runs the length of the crib 1 m (3 ft) above the bottom. From February 1968 to June 1973, the crib received 84,000,000 L (22,300,000 gal) of waste storage tank condensate from the in-tank solidification ITS-2 unit in the BY Tank Farm. Radionuclides contained in the waste stream at the time of discharge included Cs-137, Sr-90, Ru-106, plutonium, and uranium (RHO-CD-673). Inorganic wastes consisted primarily of aluminum carbonate. In October 1991, the crib was surface stabilized with 0.6 m (2 ft) of clean topsoil and treated with an herbicide along with the 216-B-43 through 216-B-49 Cribs.

2.4.2 Other Characterized Waste Sites

2.4.2.1 216-B 43 through 216-B-49 Cribs

The 216-B-43 through 216-B-49 Cribs are located north of the BY Tank Farm. Adjacent to, and analogous to the 216-B-46 Crib (representative site), the cribs received URP bismuth-phosphate waste that also had been scavenged (fission products precipitated out) in 1955. Once the waste was processed at U Plant, it was sent to the BY Tank Farm to allow settling of the sludge. The remaining waste liquid effluent was discharged to the cribs. The cribs received approximately 2,100,000 L (554,000 gal) to 6,700,000L (1,800,000 gal) of TBP waste between 1954 and 1955. Chemical inventories vary slightly between the sites. Construction of these cribs is the same as that of the 216-B-46 Crib, and they received similar wastes. Like the 216-B-46 Crib, the sites were interim stabilized in 1991 with 0.6 m (2 ft) of clean soil.

2.4.2.2 216-B-26 Trench

The 216-B-26 Trench is located in the BC Cribs and Trenches Area south of the 200 East Area. This unlined trench is 154 m (500 ft) long, 3 m (10 ft) wide and 2.4 m (8 ft) deep. From 1956 to 1957, the trench received 5,900,000 L of scavenged TBP supernate waste from 221-U Building. Cesium and strontium content was reduced by precipitation. Radioactive contaminants included 438 Ci of Cs-137, 475 Ci of Sr-90, and 590 kg of uranium. Chemical contaminants included cyanide, nitrate, sulfate, sodium, and phosphate. After operation was complete, the trench was backfilled with clean soil. In 1969, an additional 0.6 m (2 ft) of cover was added.

2.4.2.3 216-B-50 Crib

The 216-B-50 Crib is located west of the 216-B 46 Crib and north of the 216-B-49 Crib. The crib received approximately 54,800,000 L (14,500,000 gal) of waste storage tank condensate from the BY Tank Farms from 1965 to 1974. Inorganic compounds in the liquids disposed to the crib included ferrocyanide, nitrate, phosphate, sodium, and sulfate-based compounds. Radionuclides contained within the waste stream sent to this crib include Cs-137, Sr-90, Ru-106, and plutonium and uranium isotopes (RHO-CD-673, WHC-MR-0227, WHC-EP-0141-2). In 1991, the site was stabilized with 0.6 m (2 ft) of clean soil. The crib is constructed with the same design as that of the 216-B-43 through 216-B-49 Cribs).

2.4.3 Summary of Data Collection Activities

This section summarizes the data collection activities performed during the 200-TW-1, 200-TW-2, and 200-PW-5 OU RI. These activities are described in detail in BHI-01606, *Borehole Summary Report for Borehole C3102 in the 216-T-26 Crib, 200-TW-1 Scavenged Waste Group Operable Unit,* and BHI-01607, *Borehole Summary Report for Boreholes C3103 and C3104, and Drive Casing C3340, C3341, C3342, C3343, and C3344, in the 216-B-38 Trench and 216-B-7A Crib, 200-TW-2 Tank Waste Group Operable Unit.* The RI was conducted in accordance with DOE/RL-2000-38. Data were collected to characterize the nature and vertical extent of chemical and radiological contamination and the physical conditions in the vadose zone underlying the historical boundaries of three representative sites: the 216-T-26 Crib, the 216-B-7A Crib, and the 216-B-38 Trench. In addition, radionuclide logging system (RLS) data were collected to assess the lateral extent of gamma-emitting radionuclide contamination in and adjacent to the waste sites. The scope of the RI included drilling (cable tool and direct push), conducting surface and borehole geophysical surveys, and sampling and analysis of soil.

The RI Report (DOE/RL-2002-42) also summarized previous characterization efforts for the 216-B-46 Crib, 216-B-5 Reverse Well, and 216-B-57 Crib. The 216-B-46 and 216-B-57 Cribs, in addition to the 216-B-43, 216-B-44, 216-B-45, 216-B-47, 216-B-48, 216-B-49, and 216-B-50 Cribs, were characterized in 1991 and 1992, according to DOE-RL 88-32. DOE/RL-92-70, the 200-BP-1 RI, summarizes the data collection efforts and results, which are provided herein by reference. The scope of the 200-BP-1 RI included drilling, conducting borehole geophysical surveys, and sampling and analysis of soils. Characterization of the 216-B-5 Reverse Well is documented in RHO-ST-37. The scope of this effort included drilling, borehole geophysical surveys and the sampling and analysis of soil.

2.4.3.1 200-TW-1 and 200-TW-2 Operable Unit Remedial Investigation Drilling

Three boreholes (C3102, C3103, and C3104) were drilled and sampled during the 200-TW-1 and 200-TW-2 RI. Boreholes were drilled through the 216-T-26 Crib and 216-B-38 Trench from the ground surface to the water table at depths of approximately 69 m (226 ft) and 80 m (263 ft), respectively. Drilling at the 216-B-7A Crib terminated within a significantly thick silt horizon at a depth of 68 m (222.5 ft), approximately 7 m (23 ft) above the surface of the water table. Boreholes were drilled to better define stratigraphy and to assess the nature and vertical extent of chemical and radiological contamination, as well as the physical properties of the soil beneath these waste sites.

Boreholes were drilled using a cable-tool drill rig. The diesel hammer drill rig also was used to augment drilling and sampling at the 216-B-7A Crib. The boreholes were advanced to total depth using drive barrels and split-spoon samplers. Split-spoon samplers were used as the primary sampling device for collecting chemical, radiological, and physical property samples; however, the drive barrel occasionally was used to collect moisture samples. The three boreholes were decommissioned with bentonite and cement after reaching total depth, in accordance with *Washington Administrative Code* WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells."

Five direct-push holes were installed at the 216-B-38 Trench using an environmental diesel-hammer drill rig. The five direct-push holes were placed along the center axis of the trench and pushed to a depth of approximately 18.3 m (60 ft). The pushes were used in conjunction with the RLS to identify the area of highest gamma-emitting radionuclide contamination and the lateral extent of this contamination within the trench and to support placement of a deep vadose zone borehole. The five pushes were decommissioned with bentonite and cement after reaching total depth. Drive casing and abandonment activities were performed in accordance with WAC 173-160.

2.4.3.2 200-TW-1 and 200-TW-2 Operable Unit Remedial Investigation Sampling and Analysis

Soil samples collected from boreholes were screened in the field before the samples were collected for indications of contamination and to assist with determining of discrete sample locations or depths. Samples were screened for volatile organic contamination, beta-gamma activity, and alpha activity. Radiological activity greater than two times background was used as a screening indicator of contamination. Field screening data can be found in BHI-01606 and BHI-01607.

Soil samples were collected for chemical and radiological analysis and determination of physical properties. The sampling approach generally required a greater sample frequency near the bottom of the waste site, which is the area of highest suspected contamination. Several samples could not be collected or, in some cases, sample analysis was limited, because of poor sample recovery. Sample collection always was attempted at depths of 4.6 m and 7.6 m (15 and 25 ft) bgs. Sample frequency generally was reduced to 7.6 m to 15.2 m (25-ft to 50-ft) intervals below a depth of 7.6 m (25 ft) in the boreholes and included a sample from the capillary fringe zone at the water table. Between 12 and 15 soil samples were collected beneath each representative waste site.

Soil samples generally were analyzed for TBP, metals, diesel-range organic compounds, general chemistry parameters, and radionuclides. Surface soil samples also were analyzed for herbicides. Several samples at the 216-T-26 Crib also were analyzed for volatile organic compounds (VOC) to support the dispersed carbon tetrachloride investigation for the 200-PW-1 OU. Samples were analyzed selectively for field bulk density and moisture content. Soil descriptions were made according to CP-GPP-EE-01-7.0, *Geologic Logging*, to better define stratigraphic relationships in the OUs.

The waste site bottom samples from each borehole were analyzed for an expanded list of compounds to satisfy waste designation requirements that were identified as part of BHI-01492, *Data Quality Objectives Summary Report for 200-TW-1 and 200-TW-2 Waste Designation*. In addition, several samples were analyzed for a select list of toxicity characteristic leaching procedure (TCLP) (SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update III-A*, Method 1311) metals to assist with the waste designation.

2.4.3.3 200-TW-1 and 200-TW-2 Operable Unit Remedial Investigation Geophysical Logging

Borehole geophysical logging was performed in 12 boreholes and 5 direct-push holes during the 200-TW-1 and 200-TW-2 RI. Spectral gamma surveys were conducted in accordance with the work plan (DOE/RL-2000-38) at each of the new boreholes and drive casings and at existing monitoring well/borings near the waste sites. In addition to the wells/borings identified in the work plan, several additional wells/borings near the waste site were logged as part of the 200 Areas geophysical logging program performed by MACTEC-ERS, Inc. (MACTEC-Environmental Restoration Services, Inc.).

Neutron-neutron moisture surveys were conducted in each new borehole and in the drive casings. Logging was performed to determine the vertical and lateral extent of gamma-emitting radiological contamination and volumetric moisture content within the sediment profile. Detailed reports of logging operations are provided in BHI-01606 and BHI-01607. The reports include summaries of the calibration requirements, processing data, log plots, and results.

2.4.3.4 216-B-46 Crib Characterization

Three boreholes (299-E33-299, 299-E33-310, and 299-E33-311) were drilled through the 216-B-46 Crib with a cable tool rig in 1991 and 1992. The boreholes were placed in a triangular array and drilled to depths between 9 m (29.5 ft) and 10.7 m (35 ft) in the crib. The boreholes were decommissioned after being drilled to total depth in accordance with WAC 173-160.

Four samples were collected from each borehole and analyzed for CERCLA Target Compound List (TCL) and Target Analyte List (TAL) (SW-846) constituents, major anions, bismuth, cyanide (free, complex, and total), and selected radioisotopes. Physical property samples were not collected from this site; however, the data are available from nearby waste sites (e.g., 216-B-43 Crib). Analytical results are presented in DOE/RL-92-70. The subject boreholes also were logged with the RLS and neutron-moisture tools. In addition, boreholes 299-E33-4 and 299-E33-23, which are located adjacent to the waste site, were logged with the RLS and neutron-moisture tool in 2001.

2.4.3.5 216-B-5 Reverse Well Characterization

Four boreholes (299-E28-7, 299-E28-23, 299-E28-24, and 299-E28-25) were drilled and sampled during late 1970 to determine the distribution of gamma-emitting contaminants near the 216-B-5 Reverse Well. The boreholes also were logged with the RLS in 2001. These wells are located within 19 m (62 ft) of the reverse well.

Fifteen soil samples were collected at the 299-E28-23 borehole (RHO-ST-37). The samples were collected in the vadose zone from near the surface to a depth of 74.3 m (284 ft). Twenty-three saturated sediment samples also were collected from the water table at 74.3 m (284 ft) bgs in 1980 to a depth of 86.5 m (330.4 ft) (the top of the basalt). Soils were analyzed for Am-241, Pu-239/240, Sr-90, and Cs-137. A similar sampling scheme was employed at boreholes 299-E28-7, 299-E28-24, and 299-E28-25. Analytical results are presented in RHO-ST-37.

2.4.3.6 216-B-57 Crib Characterization

Three boreholes (299-E33-304, 299-E33-305, and 299-E33-306) were drilled through the 216-B-57 Crib in 1991. The boreholes were drilled to depths between 156.2 m and 71 m (50 ft and 233 ft) with a cable tool drill rig. The boreholes were decommissioned after they had been drilled in accordance with WAC 173-160.

Twenty-three samples were collected from the boreholes and analyzed for CERCLA TCL and TAL constituents, major anions, bismuth, cyanide (free, complex, and total), and radioisotopes. Several of these samples also were used in column leach-test experiments. In addition, 89 physical property samples were collected continuously with a split-spoon sampler from borehole 299-E33-304. Samples were analyzed for bulk density, moisture content, grain size, moisture retention, saturated and unsaturated conductivity, specific gravity, calcium carbonate, and porosity. Analytical results are presented in DOE/RL-92-70. The subject boreholes were logged with the RLS and neutron-moisture tool.

2.4.3.7 Characterization of 216-B-43, 216-B-44, 216-B-45, 216-B-47, 216-B-48, 216-B-49, and 216-B-50 Cribs

Similar to the 216-B-46 Crib, three boreholes were drilled through each of the 216-B-43, 216-B-44, 216-B-45, 216-B-47, 216-B-48, 216-B-49, and 216-B-50 Cribs in 1991 and 1992. The boreholes were placed in a triangular array and drilled to depths between 9.0 m (29.5 ft) and 68 m (223 ft) in the crib. The boreholes were decommissioned after they had been drilled to total depth in accordance with WAC 173-160.

Between four and twelve samples were collected from each borehole and analyzed for CERCLA TCL and TAL constituents, major anions, bismuth, cyanide (free, complex, and total), and selected radioisotopes. Fifty-eight physical property samples also were collected from the 216-B-43 and 216-B-49 Cribs. Analytical results are presented in DOE/RL-92-70. The subject boreholes also were logged with the RLS and neutron-moisture tools. In addition, boreholes adjacent to the site were logged with the RLS and neutron-moisture tool. Results of logging efforts for the BY Cribs were compiled in GJO-2003-458-TAC, *Hanford 200 Areas Spectral Gamma Baseline Characterization Project, 216-B-43 to -50, -57, and -61 Cribs and Adjacent Sites Waste Site Summary Report.*

2.4.3.8 216-B-58 Trench Characterization

Two boreholes (C4174 and C4304) were drilled at the 216-B-58 Trench in December 2003, each to a depth of 30 m (100 ft) bgs. Samples were collected and submitted for laboratory analysis as identified in DOE/RL-2001-66. The original plans for the 216-B-58 borehole were to drill to the water table. However, the regulators agreed to limit the depth of this borehole because the 216-B-26 borehole would provide data to the water table. Only a single borehole was originally planned; however, following geophysical logging of eight drive casings that were installed in the 216-B-58 Trench to locate the region of highest contamination, an anomaly was identified at the west end of the trench. Therefore, a second borehole was installed to provide additional information on contaminants at this location. The boreholes were decommissioned after they had been drilled to total depth in accordance with WAC 173-160. Analytical and geophysical logging results are presented in this document.

2.4.3.9 216-B-26 Trench Characterization

One borehole (C4191) was drilled in the 216-B-26 Trench in accordance with DOE/RL-2003-44, *BC Cribs and Trenches 200-TW-1 Operable Unit Borehole Sampling and Analysis Plan.* The borehole was drilled to the water table at a depth of 104 m (340 ft) bgs. Samples were collected and submitted for laboratory analysis in accordance with DOE/RL-2003-44. The borehole was decommissioned after it had been drilled to total depth in accordance with WAC 173-160. Soil samples were collected for chemical and radiological analysis and determination of physical properties. The sampling approach generally required a greater sample frequency near the bottom of the waste site, which is the area of highest suspected contamination. Analytical results are presented in this document.

2.5 NATURE AND EXTENT OF CONTAMINATION

This section describes the nature and extent of contamination at representative sites and at analogous sites with sufficient data to support risk evaluation in the 200-TW-1, 200-TW-2, and 200-PW-5 OUs. Contamination, as defined in this section, includes those constituents that are not essential nutrients and that were detected at concentrations above Hanford Site background threshold concentrations at the 90th percentile in DOE-RL-92-24, *Hanford Site Background: Part 1, Soil Background for Inorganics*, and in DOE-RL-96-12, *Hanford Site Background: Part 2, Soil Background for Radionuclides.* Ecology 94-115, *Natural Background Soil Metals Concentrations in Washington State,* also was used for background concentrations where no site-specific background concentrations were available. Comparison to background threshold concentrations was conducted to eliminate sample detects that represent naturally occurring constituents. Constituents with concentrations above background levels and with no available background concentrations also were subjected to a screening process against existing regulatory standards. Nonradiological constituents with concentrations above background were compared to risk-based standards in WAC 173-340-745, "Soil Cleanup Standards for Industrial Properties," and WAC 173-340-747, "Deriving Soil Concentrations for Ground Water Protection," as reported in or calculated per Ecology 94-145, *Cleanup Levels and Risk Calculations under the Model Toxics Control Act Cleanup Regulation; CLARC, Version 3.1.* Concentrations exceeding risk-based standards are regarded as evidence of contamination and potential risk, unless information is available that would justify eliminating contaminants from the screening process. Nonradiological constituents remaining after the screening process described above are considered potential contaminants of concern and are evaluated further.

Promulgated soil-based cleanup levels have not been developed for radionuclides. Therefore, radionuclides detected above background are considered potential contaminants of concern in this section and also are evaluated further in the risk evaluation.

Additional details regarding the screening process, including the number of detections, the identification of essential nutrients, and the comparison of concentrations to background risk-based standards, are presented in the RI Report for the representative sites and in Appendix C for analogous sites with sufficient data to support risk evaluations.

2.5.1 Nature and Extent of Contamination at the 200-TW-1 Operable Unit Representative Sites

2.5.1.1 216-T-26 Crib

In the RI, the following constituents were determined to exceed the initial screening criteria in the soil column beneath the 216-T-26 Crib:

- Am-241
- Cs-137
- Co-60
- Eu-154
- Eu-155
- K-40
- Pu-238
- Pu-239/240
- Ra-226
- Ra-228
- Sr-90
- Tc-99
- tritium
- total uranium
- U-233/234
- U-235
- U-238
- bismuth
- sodium
- ammonia
- cyanide
- fluoride
- nitrate
- nitrite
- phosphate
- sulfate.

Other than phosphate, contamination was not detected in the soil samples from the surface to a depth of 5.5m (18 ft) bgs. The main zone of radioactive contamination extends from 5.5 m to 11 m (18 ft to 36.5 ft) bgs. Potential contaminants of concern detected in this zone include Am-241, Cs-137, Sr-90, Eu-154, Eu-155, Pu-238, Pu-239/240, and total uranium. This zone is associated with the effluent release point at the waste-site bottom (i.e., contact between the backfill and the gravel-dominated sequence of the Hanford formation) and extends to the approximate top of the sand-dominated sequence of the Hanford formation. The maximum Cs-137 concentration occurs at the top of this zone and generally decreases with to 11 m (36.5 ft); however, the maximum concentrations of most contaminants occurred in the lower portion of this contaminated zone 10.4 m to 11 m (34ft to 36.5 ft) bgs.

In the 5.5 m to 11 m (18 ft to 36.5 ft) zone, the maximum concentrations for Cs-137 and Sr-90 were 47,900 and 49,100 pCi/g, respectively. The maximum concentrations for Am-241 and Pu-239/240 were 227 and 6,320 pCi/g, respectively. Eu-154, Eu-155, and Pu-238 concentrations were <86 pCi/g. Total uranium was the only metal in this zone above screening levels. Concentration ranged between 9 and 61 mg/kg.

The 11 m to 24.7 m (36.5 ft to 94.5 ft) zone contains Co-60 (<0.1 pCi/g), K-40 (18 pCi/g), Tc-99 (1.6 to 4.9 pCi/g), tritium (260 to 2,650 pCi/g), total uranium (<10 mg/kg), and actinide decay daughters (Ra-226 and Ra-228). The lower portion of this zone is the approximate top of the CCU.

Only Tc-99 (2.4 pCi/g) and tritium (3.8 pCi/g) were detected greater than 28.8 m (94.5 ft) bgs. Significant reduction in the levels of contamination is associated with the top of the sand-dominated sequence of the Hanford formation and the CCU.

Bismuth and sodium were the only metals that exceeded the initial screening. Maximum concentrations were 198 mg/kg and 1,510 mg/kg, respectively, in the 10.4 m to 11 m (34 ft to 36.5 ft) sample. Neither constituent has a cleanup level identified through WAC 173-340-745. Sodium was detected above the Hanford Site background; no background has been established for bismuth.

For the general chemistry constituents, ammonia, cyanide, fluoride, nitrate, nitrite, phosphate, and sulfate exceeded the initial screening. Detailed descriptions of these contaminant distributions may be found in the RI Report (DOE/RL-2002-42).

Cs-137 was detected with the RLS from the top of the waste zone 5.5 m (18 ft) to a depth of 39 m (128 ft) bgs. Log data indicate that most of the Cs-137 was detected from 5.5 m to 27.7 m (18 to 91 ft) bgs and is distributed deeper in the vadose zone toward the south end of the site. Contamination extends laterally beyond the 216-T-26 Crib boundary to the south and may intersect contamination associated with the 216-T-27 Crib. The contaminant profile suggests that little contamination is spreading to the north. The lateral and vertical extents of Cs-137 contamination detected in boreholes C3102, 299-W11-70, and 299-W11-82 with the RLS are shown in the RI Report, Figure 3-15. The revised contaminant distribution model for the 216-T-26 Crib is shown in Figure 2-10 of this document. Lines indicating uncertainty (i.e., lines with the "?" symbol) on this and other contaminant distribution models show the estimated extent of contamination based on the analytical data and the geophysical logging data.

2.5.1.2 216-B-46 Crib

The following constituents were determined to exceed the initial screening criteria in the soil column beneath the 216-B-46 Crib:

- Sb-125
- Cs-137
- Co-60
- Pu-238
- Pu-239
- Pu-239/240
- Ra-226
- Sr-90
- Tc-99
- tritium
- total uranium
- bismuth
- cadmium
- sodium
- cyanide
- nitrate
- nitrite
- phosphate
- sulfate.

Contamination is present throughout the vadose zone beneath the 216-B-46 Crib. For radionuclides, only low levels of Sr-90 (<3 pCi/g) and Ra-226 (< 1 pCi/g) are present from the surface to a depth of 5.5 m (18 ft) bgs.

The majority of contaminants and the highest concentrations were detected from 5.5 m to 14.9 m (18 ft to 49 ft) bgs. Contaminants in this zone include Sb-125, Cs-137, Co-60, Pu-238, Pu-239, Pu-239/240, Ra-226, Sr-90, Tc-99, tritium, and total uranium. The maximum concentrations of many of the contaminants were associated with the approximate bottom of the crib at a depth of about 5.5 m (18 ft) bgs. Cesium-137 and Sr-90 were the dominant radionuclides present, with maximum concentrations of 364,000 and 353,000 pCi/g, respectively. Other contaminants in this zone and their maximum concentrations are shown on Figure 2-11.

Cobalt-60, Ra-226, Tc-99, and total uranium were distributed more widely across the vadose zone and were detected at depths greater than 14.9 m (49 ft) bgs. Technetium-99, at concentrations ranging from 65 to 160 pCi/g, is the dominant radionuclide present in the zone from 14.9 m to 49.7 m (49 ft to 190 ft). The distribution of these contaminants deep in the vadose zone is associated with very low contaminant distribution coefficients (K_d) in contrast to Cs-137, Pu-239/240, and Sr-90, which have higher K_ds and remain in vadose zone soils close to the point of release to the environment.

Bismuth, cadmium, and sodium were the only metals detected that exceeded the initial screening. Bismuth was detected in one sample at a concentration of 31.3 mg/kg at a depth of 58 m (190.5 ft) bgs. Sodium was distributed throughout the vadose zone starting at a depth of about 5.5 m (18 ft) and had a maximum concentration of 4,360 mg/kg. Neither constituent has a cleanup level identified through WAC 173-340-745. Sodium was detected above the Hanford Site background; no background has been established for bismuth. Cadmium was detected at a maximum concentration of 2 mg/kg at depths from 0.9 m to 1.8 m (3 ft to 6 ft) bgs, which is only slightly above the background concentration of 1.0 mg/kg. Cadmium was not detected below 3.7 m (12 ft).

Cesium-137 was detected with the RLS from near the top of the waste zone to a depth of 27.4 m (90 ft), with significantly elevated levels from 4.9 m to 17.4 m (16 ft to 57 ft) bgs. The RLS data indicate a maximum estimated concentration of 1,400,000 pCi/g at a depth of 7.6 m (25 ft). A true maximum concentration was not determined because the tool saturated or exceeded the dead time in this zone. Very little cesium was detected in near-surface sediments and at depths greater than 22 m (72 ft) bgs. The data suggest that the deeper contamination may be attributed to the drag down of contamination during drilling. The RLS data from borehole 299-E33-4 indicate that Cs-137 contamination extends laterally from the crib several meters to the west. The revised contaminant distribution model for the 216-B-46 Crib is shown in Figure 2-11.

2.5.1.3 216-B-58 Trench

The following constituents were determined to exceed the initial screening criteria in the soil column beneath the 216-B-58 Trench:

- tritium
- K-40
- Cs-134/137
- Co-60
- Sr-90
- Eu-154
- Ra-228
- Th-232
- U-235
- Np-237
- Am-241
- Pu-239/240
- barium
- selenium
- nitrate
- phosphate
- Arochlor-1254
- diethlylphthalate
- grease.

Contamination is present primarily in the shallow portion of the vadose zone beneath the 216-B-58 Trench.

The majority of contaminants and the highest concentrations were detected from 4.1 to 6.1 m (13.5 to 20 ft) bgs. Radionuclide contaminants in this zone include Am-241, Cs-137, Co-60, Pu-239/240, Sr-90, and tritium. The maximum concentrations of many of the contaminants were associated with the soil just below the bottom of the crib at a depth of about 4.6 m (15 ft) bgs. Cesium-137 and Sr-90 were the dominant radionuclides present, with maximum concentrations of 14,600 and 18,400 pCi/g, respectively. Samples from the borehole at the west end of the trench revealed Co-60 concentrations to 1,700 pCi/g. The transuranic constituents Am-241 and Pu-239/240 were observed at the 4.6 m (15.0-ft) level at concentrations of 412 pCi/g and 310 pCi/g, respectively. Tritium was distributed more widely across the vadose zone and was detected to a depth of 16.8 m (55 ft) bgs. The distribution of this contaminant deeper in the vadose zone is associated with its very low contaminant K_d, in contrast to Am-241, Cs-137, and Sr-90, which have higher K_ds and remain in vadose zone soils close to the point of release to the environment. Other contaminants in this zone and their maximum concentrations are shown on Figures 2-12a and 2-12b.

Barium and selenium were the only metals detected that exceeded the initial screening. Barium was detected throughout the vadose zone with a maximum concentration of 150.0 mg/kg at a depth of approximately 8.4 m (27.5 ft) bgs. This concentration is only slightly higher than the background concentration of 132 mg/kg. Selenium was distributed throughout the vadose zone with a maximum concentration of 6.54 mg/kg at a depth of 5.3 m (17.5 ft).

Nitrate concentrations exceeded the screening level at depths corresponding to near the bottom of the trench (40.1 mg/kg as nitrate) and from 8.4 to 10.7 m (27.5 to 35.0 ft) bgs. The only other contaminant observed was diethylphthalate, also observed throughout the vadose zone with a maximum concentration of 0.60 mg/kg at a depth of 8.4 m (27.5 ft) bgs.

At the borehole in the middle of the trench, Cs-137 was detected with the RLS between 2.4 m (8 ft) and 9.4 m (31 ft) bgs, with a maximum estimated concentration of 32,000 pCi/g at a depth of 3.7 m (12 ft) bgs. Cobalt-60 was detected between 2.4 m (8 ft) and 5.5 m (18 ft) bgs, with a maximum of 84 pCi/g at a depth of 3.4 m (11 ft) bgs. At the borehole at the west end of the trench, Cs-137 was detected between 0.9 m (3 ft) and 4.3 m (14 ft) bgs, with a maximum concentration of approximately 943 pCi/g observed at a depth of 3.0 m (10 ft) bgs. Also at the west end of the trench, Co-60 was detected between 2.1 m (7 ft) and 10.4 m (24 ft) bgs, with a maximum concentration of approximately 1,655 pCi/g detected at a depth of 3.3 m (11 ft) bgs. At the borehole in the middle of the trench, neutron moisture logging showed higher moisture concentrations at the 9.1 m (30 ft), 13.7 m (45 ft), 15.2 m (50 ft), 16.1m (53 ft), 20.4 m (67 ft), and near 30.5 m (100 ft) levels bgs. From the west-end borehole, higher moisture concentrations were indicated at the 9.1 m (30 ft), 10.7 m (35 ft), 12.3 m (40 ft), 13.4 m (44 ft), 16.1 m (53 ft), 20.4 m (67 ft), 25.9 m (85 ft), and near 30.5 m (100 ft) levels bgs. The contaminant distribution models for the 216-B-58 Trench are shown in Figures 2-12a and 2-12b.

2.5.2 Nature and Extent of Contamination at other 200-TW-1 Operable Unit Sites

2.5.2.1 216-B-43 Crib

Potential contaminants of concern beneath the 216-B-43 Crib include the following:

- Cs-137
- Co-60
- Pu-238
- Pu-239
- Pu-239/240
- Ra-226
- Sr-90
- Tc-99
- Th-228
- Tritium
- total uranium
- nitrate
- nitrite
- total uranium
- pentachlorophenol.

The contaminant distribution model for the 216-B-43 Crib is shown in Figure 2-13. Contamination is present throughout the vadose zone beneath the 216-B-43 Crib. Only low levels of Cs-137, Pu-239, Pu-239, Ra-226, Sr-90, Tc-99, and Th-228 are present from the surface to a depth of 5.5 m (18 ft).

Higher concentrations of radiological COPCs generally are detected in two zones beneath the crib. The first zone is 5.5 m to 8 m (18 to 26 ft) bgs; the second is 8 m to 9.6 m (26 ft to 31.5 ft) bgs. Contaminants in the first zone include Cs-137, Pu-238, Pu-239/240, Sr-90, Tc-99, tritium, total uranium, nitrate, and nitrite. Cesium-137, Sr-90, and Pu-239/340 were the dominant radionuclides present, with maximum concentrations of 2,600,000 pCi/g, 5,000,000 pCi/g, and 405 pCi/g, respectively. Nitrate, nitrite, and total uranium concentrations were 432 mg/kg (as nitrogen), 43.3 mg/kg (as nitrogen), and 30.8 mg/kg, respectively. The upper zone of contamination is associated with the approximate bottom of the crib at a depth of about 5.5 m (18 ft).

Many of the contaminants in the first zone also are present in the second zone from 8 m to 9.6 m (26 ft to 31.5 ft) bgs, and concentrations generally decreased with depth to 9.6 m (31.5 ft), with the exceptions of Pu-238, tritium, and nitrate. The concentrations of Pu-238, tritium, and nitrate increased with depth to 6,700 pCi/g, 100 pCi/g, and 565 mg/kg, respectively, in this zone.

Cobalt-60, Cs-137, Ra-226, Sr-90, tritium, Th-228, Tc-99, and pentachlorophenol were present in the vadose beyond a depth of 9.6 m (31.5 ft) bgs. The concentrations of most of the radionuclides were <6 pCi/g; however, Co-60 is present at a concentration of 37 pCi/g. The maximum concentration of technetium (140 pCi/g) was present at depths greater than 9.6 m (31.5 ft) bgs. Pentachlorophenol (0.074 mg/kg) is the only semivolatile organic compound detected beneath the ditch; this constituent was detected only once, at a depth of 25.5 to 26.2 m (83.5 to 86 ft), and at a concentration less than the contract-required detection limit.

Borehole 299-E33-1 is about 7.6 m (25 ft) east of the engineered crib structure. Cesium-137 and Co-60 were the only man-made radionuclides detected in this borehole with the RLS. Cesium-137 was detected 13.7 m to 24.4 m (45 ft to 80 ft) bgs. The maximum concentration was 500 Ci/g. Concentrations decreased to <1 pCi/g at about 24.4 m (80 ft) bgs. Cobalt-60 was detected almost continuously throughout the vadose zone beyond a depth of 9.1 m (30 ft). The maximum concentration (37 pCi/g) was detected at a depth of 69.3 m (227.5 ft).

2.5.2.2 216-B-44 Crib

Potential contaminants of concern beneath the 216-B-44 Crib include the following:

- Cs-137
- Co-60
- Pu-238
- Pu-239/240
- Sr-90
- Tc-99
- Th-228
- tritium
- total uranium
- nitrate
- nitrate.

The contaminant distribution model for the 216-B-44 Crib is shown in Figure 2-14. Contamination is present at least to a depth of 9.6 m (31.5 ft) in the vadose zone beneath the 216-B-44 Crib. Soil data were not collected greater than 9.7 m (31.5 ft) below the crib. Very low levels (less than 3.7 pCi/g) of Cs-137, Sr-90, Th-228, and tritium are present from near surface to a depth of 5.8 m (19.0 ft) bgs.

The highest levels of contamination were detected from 5.8 m to 7.6 m to (19.0 ft to 25.0 ft) bgs. Contaminants in this zone include Cs-137, Co-60, Pu-238, Pu-239/240, Sr-90, Tc-99, tritium, nitrate, nitrite, and uranium. With the exception of Co-60, the highest concentrations of all these constituents occur in this zone. Cesium-137, Sr-90, and Pu-239/240 were the main radionuclides present in this zone of higher contamination. Maximum concentrations were 2,200,000 pCi/g; 4,900,000 pCi/g; and 626 pCi/g, respectively. The maximum concentrations of Tc-99, tritium, and Pu-238 in this zone are 200 pCi/g, 20 pCi/g, and 51 pCi/g, respectively. Maximum total uranium, nitrate, and nitrite concentrations were 95.3 mg/kg, 1,040 mg/kg, and 42.7 mg/kg, respectively.

Contaminant concentrations generally decreased with depth from 7.6 m to 9.7 m (25 ft to 31.5 ft). Contaminants present in this lower zone include Co-60, Cs-137, Pu-238, Pu-239/240, Sr-90, tritium, and uranium. Cesium-137, Sr-90, Pu-238, and Pu-239/240 concentrations remained significantly high with maximum concentrations at 1,100,000 pCi/g, 2,900,000 pCi/g, and 430 pCi/g, respectively. The Tc-99 concentration (200 pCi/g) remained unchanged in this zone, while cobalt concentrations increased to 11 pCi/g. Total uranium was the only metal in this zone above screening levels with concentrations ranging between 40.6 to 68.5 mg/kg. Nitrate concentrations were 289 to 860 mg/kg. The nitrite concentration was 16.1 mg/kg.

Twenty-eight feet west of the crib structure, Cs-137, Co-60, and Eu-154 were detected with the RLS in borehole 299-E33-02. Cesium-137 was detected at a maximum concentration of 1,280 pCi/g between depths of 15.2 m to 22.3 m (50 ft to 73 ft) bgs. A concentration of 26 pCi/g was present at 224 ft bgs. Cobalt-60 occurs almost continuously from 18.3 m to 72.6 (60 ft to 238 ft) bgs in concentrations from <1 to 5.4 pCi/g. Europium-154 was identified from 14.6 m to 19.2 m (48 ft to 63 ft) bgs at a maximum activity of 5.2 pCi/g.

2.5.2.3 216-B-45 Crib

Potential contaminants of concern beneath the 216-B-45 Crib include the following:

- Cs-137
- Co-60
- Pu-238
- Pu-239/240
- Ra-226
- Sr-90
- Tc-99
- Th-228
- tritium
- total uranium
- cadmium
- nitrate
- nitrite.

The contaminant distribution model for the 216-B-45 Crib is shown in Figure 2-15. Contamination was present at least to a depth of 9 m (29.5 ft) bgs in the vadose zone beneath the 216-B-45 Crib. Soil samples were not collected below a depth of 9 m (29.5 ft). Only low levels (<2.5 pCi/g) of Cs-137, Sr-90, and Th-228 are present from the surface to a depth of 5.3 m (17 ft).

The highest levels of contamination were detected from 5.3 m to 7.6 m (17 to 25 ft). Contaminants in this zone include Cs-137, Co-60, Pu-238, Pu-239/240, Ra-226, Sr-90, Tc-99, tritium, total uranium, nitrate, and nitrite. Cesium-137, Sr-90, and Pu-239/240 were the dominant radionuclides present, with maximum concentrations of 3,400,000 pCi/g, 2,200,000 pCi/g, and 2,350 pCi/g, respectively. Technetium-99 and Pu-238 concentrations did not exceed 200 pCi/g. Other radionuclide concentrations were less than 44 pCi/g. Total uranium was the only metal in this zone above screening levels. Concentrations ranged between 0.36 and 41.5 mg/kg. Maximum nitrate and nitrite concentrations were 681 and 38.1 mg/kg, respectively.

Contaminant concentrations decrease with depth from 7.6 m to 9 m (25 ft to 29.5 ft) bgs. Contaminants present in this lower zone include Cs-137, Co-60, Pu-238, Pu-239/240, Sr-90, tritium, Th-229, nitrate, and total uranium. Cesium-137, Sr-90, and Pu-239/240 were the dominant radionuclides present. Maximum concentrations were 130,000 pCi/g, 74,000 pCi/g, and 94.2 pCi/g, respectively. Other radionuclide concentrations ranged from <1 to 44 pCi/g. Total uranium was the only metal in this zone above screening levels. Maximum concentration was 54.5 mg/kg. The nitrate concentration was 151 mg/kg.

The RLS data were collected about 5.4 and 6.1 m (18 and 20 ft) from the crib structure in boreholes 299-E33-3 and 299-E33-22. Higher levels of contamination were present in borehole 299-E33-22, located south of the crib structure. Cesium-137 was detected at a maximum concentration of 7,000,000 pCi/g. Concentrations exceeded 1,000,000 pCi/g at depths between 6.4 m and 12.8 m (21 ft and 42 ft) bgs. Concentrations exceeded 1,000 pCi/g at depths of 2.1 m to 62.5 m (7 ft to 205 ft) bgs.

Cobalt-60 (<10 pCi/g) was detected sporadically throughout out the vadose zone. Europium-154 was detected from 15 m to 18.2 m (49 ft to 60 ft) bgs at concentrations of about 10 pCi/g.

Lower levels of Cs-137 (1,150 pCi/g) contamination were present in 299-E33-3. Cobalt-60, Eu-152, Eu-154, and Sb-125 concentrations ranged from <1 to 17.1 pCi/g.

2.5.2.4 216-B-47 Crib

Potential contaminants of concern beneath the 216-B-47 Crib include the following:

- Cs-137
- Pu-238
- K-40
- Pu-239/240
- Ra-226
- Sr-90
- Tc-99
- Th-228
- tritium
- total uranium
- pentachlorophenol.

The contaminant distribution model for the 216-B-47 Crib is shown in Figure 2-16. Contamination is present at least to a depth of 10.8 m (35.5 ft) in the vadose zone beneath the 216-B-47 Crib. Soil samples were not collected below a depth of 10.8 m (35.5 ft) bgs. Low levels (<10.4 pCi/g) of Cs-137, Sr-90, Th-228, Ra-226, and pentachlorophenol were present from the surface to a depth of 6.4 m (21.0 ft). Potassium-40 was present in this zone at a concentration of 155 pCi/g. The maximum concentration of pentachlorophenol was 0.15 mg/kg.

The highest levels of contamination were detected from 6.4 m to 7.6 m (21.0 ft to 25.5 ft) bgs. Contaminants in this zone include Cs-137, Pu-239/240, Sr-90, Tc-99, tritium, and total uranium. Cesium-137, Sr-90, and Pu-239/240 were the main radionuclides present, with maximum concentrations of 7,800,000 pCi/g, 11,000,000 pCi/g, and 5,850 pCi/g, respectively. Technetium-99 and tritium concentrations did not exceed 28 pCi/g. Total uranium was the only metal in this zone above screening levels. Concentrations ranged between 28.2 and 213 mg/kg.

Contaminant concentrations decrease with depth below 7.6 m (25.5 ft). Contaminants present in this lower zone include Cs-137, Pu-238, Pu-239/240, Sr-90, and tritium. Cesium-137, Sr-90, and Pu-239/240 were the main radionuclides present, with maximum concentrations of 7,800,000 pCi/g, 400,000 pCi/g, and 687 pCi/g, respectively. Other radionuclide concentrations ranged from 4.1 to 25 pCi/g.

Thirty-two feet southwest of the crib structure, Cs-137 and Sb-125 were detected with the RLS in borehole 299-E33-05. Cesium-137 was detected at a maximum concentration of 840 pCi/g between depths of 15.2 m and 19.8 m (50 and 65 ft) bgs. Approximately 10 to 20 pCi/g were present at depths <3 m, 28.6 m to 28.9 m, and 65.5 m (<10 ft, 94 to 95 ft, and 215 ft) bgs. Cobalt-60 (1 to 24.6 pCi/g) was detected sporadically throughout the vadose zone. Antimony-125 was identified from 28.6 m to 29.3 m (94 to 96 ft) bgs. The maximum activity was 9.0 pCi/g.

2.5.2.5 216-B-48 Crib

Potential contaminants of concern beneath the 216-B-48 Crib include the following:

- Cs-137
- Co-60
- Pu-238
- Pu-239/240
- Ra-226
- Sr-90
- Tc-99
- Th-228
- tritium
- total uranium
- nitrate
- nitrate.

The contaminant distribution model for the 216-B-48 Crib is shown in Figure 2-17. Contamination is present at least to a depth of 9.7 m (32.0 ft) in the vadose zone beneath the 216-B-48 Crib. Soil samples were not collected below a depth of 9.7 m (32 ft) bgs. Low levels of Cs-137, Co-60, Sr-90, Th-228, and Ra-226 are present from the surface to a depth of 5.4 m (17.5 ft) bgs.

The highest levels of contamination were detected from 5.4 m to 7.6 m to (17.5 ft to 25.0 ft) bgs. Contaminants in this zone include Cs-137, Pu-238, Pu-239/240, Sr-90, Tc-99, tritium, nitrate, and nitrite. With the exception of tritium, the maximum concentration of all these constituents occurs in this zone. Cesium-137, Sr-90, and Pu-239/240 were the main radionuclides present, with maximum concentrations of 9,800,000 pCi/g, 8,000,000 pCi/g, and 1,200 pCi/g, respectively. The maximum concentrations of Tc-99, tritium, and Pu-238 in this zone were 200 pCi/g, 16 pCi/g, and 59 pCi/g, respectively.

Contaminant concentrations decrease with depth from 7.6 m to 9.7 m (25 ft to 32 ft) bgs. Contaminants present in this lower zone include Cs-137, Pu-238, Pu-239/240, Sr-90, tritium, and uranium. Cesium-137, Sr-90, Pu-238, and Pu-239/240 maximum concentrations were 412,000 pCi/g, 55,000 pCi/g, 2.4 pCi/g, and 54.7 pCi/g, respectively. Tritium concentrations increase with depth in this zone to 32 pCi/g. Total uranium was the only metal in this zone above screening levels. Concentrations of uranium ranged between 11 and 36.7 mg/kg.

At a location 15.2 m (50 ft) northwest of the 216-B-48 Crib and 15.2 m (50 ft) southwest of the 216-B-49 Crib, Cs-137 and Co-60 were detected with the RLS in borehole 299-E33-05. Cesium-137 was detected at 5.2 m and 18 m (17 ft and 59 ft) bgs. Concentrations ranged between <1 to 2,700 pCi/g and generally decreased with depth. Cobalt-60 (1 to 60 pCi/g) was detected sporadically throughout the vadose zone. The maximum concentration was detected at 37.5 m (123 ft) bgs.

2.5.2.6 216-B-49 Crib

Potential contaminants of concern beneath the 216-B-49 Crib include the following:

- Cs-137
- Co-60
- Pu-238
- Pu-239/240
- Ra-226
- Sr-90
- Tc-99
- Th-228
- tritium
- total uranium.

The contamination distribution model for the 216-B-49 Crib is shown in Figure 2-18. Contamination is present throughout the vadose zone beneath the 216-B-49 Crib. Only low levels (<1.5 pCi/g) of Cs-137, Ra-226, Sr-90, and Th-228 are present from the surface to a depth of 5 m (16.5 ft) bgs.

Higher concentrations of radiological contaminants were detected at a depth of 5.0 m to 7.6 m (16.5 ft to 25 ft) bgs. Contaminants in this zone include Cs-137, Co-60, Pu-238, Pu-239/240, Sr-90, Th-228, tritium, and total uranium. Cesium-137, Sr-90, and Pu-239/340 were the dominant radionuclides present with maximum concentrations of 1,300,000 pCi/g, 1,600,000 pCi/g, and 588 pCi/g, respectively. The concentration of the remaining radiological contaminants ranged from <1 to 19 pCi/g. Uranium was the only metal detected in this zone. Uranium concentration ranged between 41 and 121 mg/kg.

Many of these same contaminants were present in the zone from 7.6 m to 15.2 m (25 ft to 50 ft) bgs. Cesium-137, Sr-90, and total uranium concentrations decreased with deep in this zone to 38 pCi/g, 14 pCi/g, and 14.7 mg/kg, respectively. Cobalt-60 and Th-228 concentrations increased slightly but remain below 1 pCi/g. The concentrations of all other radionuclides were <4 pCi/g.

Five contaminants (Co-60, Ra-226, Sr-90, Tc-99, and Th-228) were present above screening levels at depths greater than 15.2m (50 ft) bgs. With the exception of Tc-99, contaminant concentrations were <1 pCi/g. Technetium-99 concentrations ranged between 65 and 160 pCi/g.

At a location 15.2 m (50 ft) northwest of the 216-B-48 Crib and 15.2 m (50 ft) southwest of the 216-B-49 Crib, Cs-137 and Co-60 were detected with the RLS in borehole 299-E33-05. Cesium-137 was detected at 5.2 m and 18 m (17 ft and 59 ft) bgs at concentrations ranging between <1 and 2,700 pCi/g and generally decreased with depth. Cobalt-60 (1 to 60 pCi/g) was detected sporadically throughout the vadose zone. The maximum concentration was detected at 37.5 m (123 ft) bgs.

2.5.2.7 216-B-26 Trench

The following constituents were determined to exceed the initial screening criteria in the soil column beneath the 216-B-26 Crib:

- Tritium
- C-14
- K-40
- Ni-63
- Sr-90
- Tc-99
- Sb-125
- Sn-126
- Cs-137
- Eu-155
- Ra-226/228
- U-235
- Np-237
- Pu-239/240
- Am-241
- bismuth
- mercury
- cyanide
- nitrate
- phosphate.

The majority of contaminants and the highest concentrations were detected from 4.0 to 4.6 m (13 to 15 ft) bgs. Radionuclide contaminants in this zone include Cs-137, Co-60, Pu-239, Pu-239/240, Ra-226, Sr-90, Tc-99, tritium, and total uranium. The maximum concentrations of many of the contaminants were associated with the approximate bottom of the trench at a depth of about 4.0 m (13 ft) bgs. Cesium-137 and Sr-90 were the dominant radionuclides present, with maximum concentrations of 529,000 and 974,000 pCi/g, respectively. The transuranic radionuclides Am-241 and Pu-239/240 were detected at maximum concentrations of 41 pCi/g and 195 pCi/g, respectively, at a depth of approximately 4.3 m (14 ft) bgs. Other contaminants in this zone and their maximum concentrations are shown on Figure 2-19.

Technetium-99, at concentrations ranging from 65 to 92 pCi/g, is the dominant radionuclide present in the zone from 14.9 to 49.7 m (36 to 150 ft) bgs with the maximum concentration observed at 30 m (100 ft) bgs. A maximum uranium concentration of 56.9 mg/kg was observed at 4.3 m (14 ft) bgs; no uranium was observed below 9.1 m (30 ft). Tritium was detected at a concentration of 42.9 pCi/g at a depth of 30 m (100 ft) bgs. The distribution of these contaminants deeper in the vadose zone is associated with very low contaminant K_ds, in contrast to Cs-137, Pu-239/240, and Sr-90, which have higher K_ds and remain in vadose zone soils close to the point of release to the environment.

No metals were detected that exceeded the initial screening. Bismuth was detected in one sample at a concentration of 233 mg/kg at a depth of 3.8 m (12.5 ft) bgs. Bismuth does not have a cleanup level identified through WAC 173-340-745; no background has been established for bismuth. Also, manganese was detected at a concentration of 450 mg/kg at a depth of 9.1 m (30 ft).

Cyanide and nitrate were detected at a concentration of 2.14 mg/kg and 4,090 mg/kg (as nitrate), respectively, at a depth of 30 m (100 ft) bgs. Total organic carbon concentrations of 895 mg/kg and 2,140 mg/kg were detected at depths of approximately 4.3 m (14 ft) and 30 m (100 ft) bgs, respectively. Diethylphthalate was detected to a depth of 30 m (100 ft); the maximum concentration of 0.62 mg/kg was observed at a depth of approximately 16.8 m (55 ft) bgs.

Cesium-137 was detected with the RLS from near the top of the waste zone to a depth of 12.1 m (40 ft) bgs, with significantly elevated levels from 3.7 to 7.6 m (12 to 25 ft) bgs. The RLS data indicate a maximum estimated concentration of 1,700,000 pCi/g at a depth of 3.7 m (12 ft).

A true maximum concentration was not determined, because the tool saturated or exceeded the dead time in this zone. Very little cesium was detected in near-surface sediments.

Description of soils by the attendant geologist during borehole drilling indicated interspersed layers of silt within sand down the borehole. Distinct silt layers were observed at depths of 9.4 to 9.8 m (31 to 32 ft), 12.5 m (41 ft), 15.2 to 15.8 m (50 to 52 ft), 17.1 m (56 ft), 18.9 m (62 ft), 21.6 to 21.9 m (71 to 72 ft), 25.9 to 26.7 m (85 to 87.5 ft), 27.4 to 28.9 m (90 to92 ft), 34.1 m (112 ft), 38.1 to 39.0 m (125 to 128 ft), 39.6 m (130 ft), and 47.5 to 47.8 m (156 to 157 ft) bgs. Many of these regions of silt exhibited some degree of dampness or moisture. At depths greater than 56.7 m (186 ft) bgs, the soil was dry.

Analyses performed on "grab samples" collected throughout the borehole drilling activity showed significant presence of mobile contaminants from near surface to groundwater (RPP-20303, *Preliminary Data from 216-B-26 Borehole in BC Cribs Area)*. These analyses focused on the porewater associated with the soil samples, which is reflected by soil moisture values of approximately 10 percent from 9.1-12.2 m (30-40 ft) bgs, near 4 percent from 15.2 to 24.4 m (50 to 80 ft) bgs, approximately 8 percent from 27.4 to 30 m (90 to 100 ft) bgs, and decreasing to a minimum of approximately 1.5 percent near 94.5 m (310 ft) bgs. Then, as groundwater is approached, soil moisture content increases to approximately 10 percent at 103.6 m (340 ft) bgs. Technetium-99 concentration in porewater was least 1000 pCi/L throughout the entire borehole depth and increased to more than 1,000,000 pCi/L near 30.5 m (100 ft) bgs. Nitrate and nitrite concentrations peak at approximately 27.4 m (90 ft) bgs with values of approximately 150,000 mg/L and 70 mg/L, respectively. Other analytes that exhibited peak porewater concentrations in this depth range are sodium, potassium, magnesium, calcium, strontium, barium, sulphate, and chloride. Uranium-238 concentration peaked at 25,000 pCi/L near 6.9 m (22.5 ft) bgs and again at half that value near 12.5 m (41 ft) bgs.

2.5.3 Nature and Extent of Contamination at the 200-TW-2 Operable Unit Representative Sites

2.5.3.1 216-B-5 Reverse Well

Figure 2-20 shows the contaminant distribution model for the B-5 Reverse Well. Cesium-137 was detected in the vadose zone at the 216-B-5 Reverse Well in concentrations ranging between 0.11 pCi/g and 1,800 pCi/g. These concentrations were associated with the perforated interval in the reverse well from 74 m to 86.6 m (243 ft to 284 ft) bgs in the vadose zone. Concentrations generally increased with depth from near the top of the perforated zone to the 1980 water table at a depth of 86.6 m (284 ft) bgs. The maximum concentration of 1,800 pCi/g was at the water table.

Cesium-137 also was detected across the saturated thickness (26.5 m [87 ft]) of the aquifer. Within the aquifer, 11,400 pCi/g to 51,300 pCi/g were detected from depths of 86 m to 93.3 m (282 ft to 306 ft) bgs. Concentrations ranged from 124 to 1,800 pCi/g between 93.3 m (306 ft) bgs and the top of the basalt at a depth of 100 m (330 ft) bgs. The decrease in contamination is associated with the termination of the perforated zone in the reverse well at a depth of 92 m (302 ft) bgs, within the aquifer. The maximum activity in the vadose zone, based on the current depth of the groundwater of 87 m (286 ft) bgs, is 51,300 pCi/g. The maximum concentration is proximal to the groundwater/vadose zone interface.

Plutonium-239/240 was detected in the vadose zone at concentrations ranging between 0.00154 pCi/g and 26.5 pCi/g. Concentrations increased with depth to the top of the 1980 water table. Concentrations in the aquifer ranged between 32.9 and 75,000 pCi/g and generally decreased with depth to the bottom of the well. The maximum activity in the vadose zone, based on the current depth of the groundwater of 87 m (286 ft) bgs, is 70,200 pCi/g. The maximum concentration is proximal to the groundwater/vadose zone interface.

Americium-241 was detected in the vadose zone in concentrations ranging from 0.00236 pCi/g to 0.175 pCi/g. Concentrations generally increased with depth from near the top of the perforated zone at 74 m (243 ft) bgs to the 1980 water table at 86.6 m (284 ft) bgs. The maximum concentration at the water table was 0.175 pCi/g. Concentrations in the aquifer ranged between 0.589 and 2,540 pCi/g and generally decreased with depth to the bottom of the well. The maximum activity in the vadose zone, based on the current depth to water of 87 m (286 ft) bgs, is 1,330 pCi/g.

Strontium-90 was detected in the vadose zone in two samples. Concentrations were 145 and 209 pCi/g. Concentration in the aquifer ranged between 84.1 and 60,300 pCi/g and generally decreased with depth to the bottom of the well. The maximum activity in the vadose zone, based on the current depth of the groundwater of 87 m (286 ft) bgs, is 60,300 pCi/g.

2.5.3.2 Adjacent Wells 299-E28-7, 299-E28-24, and 299-E28-25

Lower levels of Cs-137, Am-241, Sr-90, and Pu-238/239 were detected in wells adjacent to the reverse well. Similar to well 299-E28-23, low levels of contamination were detected in the vadose zone relative to the 1980 water table. Higher concentrations were detected in the aquifer. The concentrations of contaminants in the vadose zone typically were less than 1,000 pCi/g. Concentrations in the aquifer were up to 16,000 pCi/g. The maximum activity at the groundwater/vadose zone interface, based on the current depth of the groundwater in these wells of 87 m (286 ft) bgs, is 170 pCi/g.

Wells 299-E28-7, 299-E28-23, 299-E28-24, and 299-E28-25 were geophysically logged with the spectral-gamma tool in 2001. Cesium-137 was the only gamma-emitting radionuclide detected in these wells. In well 299-E28-7, Cs-137 was only detected sporadically at the minimum detection level of the logging tool. In well 299-E28-23, Cs-137 was detected starting at about 76.2 ft (250 ft) bgs and extending to the water table (logging was discontinued before the saturated zone was reached because of waste management issues). The Cs-137 detected in this zone is associated with the perforated interval in the 216-B-5 Reverse Well. The log was saturated (i.e., dead time exceeds 40 percent) from 86 m (282 ft) bgs (approximate depth of 1980 water table) to the end of the log run at 87.5 m (287 ft) bgs. In this zone, the activity exceeds 1,000 pCi/g. In well 299-E28-24, Cs-137 was detected from 82.3 m to 87.5 m (270 ft to 287 ft) bgs, with a maximum concentration of 3,000 pCi/g at 83 m (272 ft) bgs. In well 299-E28-25, Cs-137 was detected from 76.9 m to 87.7 m (252.2 ft to 287.5 ft) bgs with a maximum concentration of 398 pCi/g at 77.6 m (254.5 ft) bgs.

2.5.3.3 216-B-7A Crib

In the RI, the following constituents were determined to exceed the initial screening criteria in the soil column beneath the 216-B-7A Crib:

- Am-241
- C-14
- Cs-137
- Eu-154
- Pu-238
- Pu-239/240
- K-40
- Sr-90
- Tc-99
- tritium
- total uranium
- U-233/234
- U-235
- U-238
- bismuth
- iron
- manganese
- sodium
- ammonia
- fluoride
- nitrate
- phosphate.

Figure 2-21 shows the contaminant distribution model for the 216-B-7A Crib. Radiological contaminants were detected the length of the borehole starting at 0.76 m (2.5 ft) bgs. Low levels of Cs-137, Sr-90, and C-14 were present from 0.76 to 5.5 m (2.5 ft to 18 ft) bgs. A portion of this zone is associated with UPR 200-E-144, where contaminated soils associated with the UPR were consolidated over the 216-B-7A Crib in 1992. The maximum activity in this zone was 42.5 pCi/g of Cs-137; Sr-90 concentrations ranged between 2.6 and 13.4 pCi/g. The C-14 concentration was 6.3 pCi/g.

The main zone of contamination extends from about 5.5 m to 11.4 m (18 ft to 37.5 ft) bgs. These contaminants were detected in the backfill material, the gravel-dominated sequence of the Hanford formation, and the upper portion of the sand-dominated sequence of the Hanford formation. The maximum concentrations of all the radionuclides detected were found in this zone. The main radionuclides in the zone are Am-241 (5,690 pCi/g), Cs-137 (153,000 pCi/g), Pu-239/240 (153,000 pCi/g), and Sr-90 (5,710,000 pCi/g). Other radiological contaminants were present at concentrations less than 200 pCi/g. Total uranium (147 pCi/g) was the only metal detected.

From 11.4 m to 67.5 m (37.5 ft to 221.5 ft) bgs, radionuclide concentrations were less than 1.0 pCi/g with only a few exceptions (e.g., Sr-90 was 98.3 pCi/g and Cs-137 was 5.06 pCi/g at 15.4 m [50.5 ft] bgs). In the upper 15.4 m (50.5 ft) of the soil column, contamination correlates to increases in silt and moisture contents. At depths greater than 15.4 m (50.5 ft) bgs, tritium was present with a maximum concentration of less than 0.3 pCi/g.

Cesium-137 was detected continuously with the RLS from the surface to a depth of 17.1 m (56 ft) bgs with the highest zone of contamination from 5.5 m to 11 m (18 ft to 36 ft) bgs. The maximum activity in this zone is approximately 300,000 pCi/g at a depth of 7 m (23 ft). Concentrations decreased with depth from 13.7 m (45 ft) bgs to the bottom of the borehole. Adjacent to the crib, lower levels of Cs-137 were detected with contamination extending to a depth of about 30 m (100 ft) bgs and a lateral extent greater than 21.3 m (70 ft). Cesium-137 concentrations measured in boreholes adjacent to the crib (wells 299-E33-19, 299-E33-20, 299-E33-58, 299-E33-60, and 299-E33-75) ranged from less than 2 pCi/g to 7,600 pCi/g.

2.5.3.4 216-B-38 Trench

In the RI, the following potential contaminants of concern were determined to exceed the initial screening criteria in the soil column beneath the 216-B-38 Crib:

- Am-241
- Cs-137
- Co-60
- Pu-238
- Pu-239/240
- K-40
- Sr-90
- Tc-99
- tritium
- total uranium
- U-233/234
- U-238
- ammonia
- fluoride
- nitrate
- nitrite
- phosphate
- sulfate
- sodium.

The contaminant distribution model for the 216-B-38 Trench is shown in Figure 2-22.

Cesium-137 was detected at low levels from 1.1 m to 4.6 m (3.5 ft to 15 ft) bgs with a maximum activity of 1.82 pCi/g.

The major zone of contamination extends from 4.6 m to 12 m (15 to 40 ft) bgs. The maximum concentrations of Am-241 (43.9 pCi/g), Cs-137 (226,000 pCi/g), Pu-238 (7.85 pCi/g), Pu-239/240 (159 pCi/g), Sr-90 (2,050 pCi/g), and uranium (32.5 mg/kg) were detected in this zone. Uranium isotope concentrations were less than 10 pCi/g. Contaminants in this zone were detected within the gravel-dominated sequence of the Hanford formation and the upper portion of the sand-dominated sequence of the Hanford formation.

Below 12 m to 61 m (40 ft to 200 ft) bgs, radionuclide concentrations were less than 2.0 pCi/g, with the exception of tritium. Tritium was detected at a maximum concentration of 28.7 pCi/g at a depth of 16.6 m (54.5 ft) bgs and decreased to less than 1 pCi/g at the groundwater/vadose zone interface.

The distribution of Cs-137 also was assessed with the RLS. Logs from one borehole and five direct-push holes installed along the axis of the trench indicate that the vertical extent of Cs-137 contamination is about 18.3 m (60 ft) bgs. However, most of the contamination is located at approximately 13.7 m (45 ft) bgs. Cesium-137 contamination extends more than 38 m (125 ft) from the east end of the ditch (i.e., half of the ditch) and 6.1 m to 7.6 m (20 ft to 25 ft) on either side of the ditch.

2.5.4 Nature and Extent of Contamination in the 200-PW-5 Operable Unit Representative Site

2.5.4.1 216-B-57 Crib

In the RI, the following constituents wee determined to exceed the initial screening criteria in the soil column beneath the 216-B-57 Crib:

- Cs-137
- Pu-238
- Pu-239/240
- Ra-226
- Sr-90
- Tc-99
- tritium
- nitrate
- nitrite
- phosphate.

The contaminant distribution model for the 216-B-57 Crib is shown in Figure 2-23. Depths are reported from the original ground surface and do not consider the 7.9 m (26 ft) thick, engineered cap that has been placed over the site as a treatability test and remedial action.

Contamination was detected from near the surface to a depth of 71.7 m (235.5 ft) beneath the crib. Only low levels (<1.1 pCi/g) of Pu-239, Ra-226, and Sr-90 are present near the surface to a depth of 4.6 m (15.0 ft) bgs.

The major zone of contamination extends from 4.6 m to 10.1 m (15 ft to 33 ft) bgs and is associated with the bottom of the waste site and the gravel- and sand-dominated sequences of the Hanford formation. The maximum concentrations of Cs-137 (67,000 pCi/g), Sr-90 (67 pCi/g), Pu-239 (0.01 pCi/g), Tc-99 (60 pCi/g), and tritium (16 pCi/g) were detected in this zone. Radium-226 (<1pCi/g) also is present in this zone. The maximum depth of contamination at levels greater than 1 pCi/g is 15.4m (50.5 ft) bgs (e.g., Cs-137 at 68.4 pCi/g). Technetium-99 and Ra-226 (both <1.0 pCi/g) were the only contaminants present at depths greater than 15.4 m (50.5 ft) bgs; concentrations were less than 1 pCi/g.

2.5.5 Nature and Extent of Contamination at other 200-PW-5 Operable Unit Sites

2.5.5.1 216-B-50 Crib

Potential contaminants of concern beneath the 216-B-50 Crib include the following:

- Cs-137
- Co-60
- Pu-238
- Pu-239
- Pu-239/340
- Ra-226
- Sr-90
- Tc-99
- Th-228
- tritium
- total uranium.

The contaminant distribution model for the 216-B-50 Crib is shown in Figure 2-24. Contamination was detected from near the surface to a depth of 9.3 m (30.5 ft) bgs beneath the crib, where sampling stopped. No soil data are available beyond a depth of 9.3 m (30.5 ft) bgs.

Only low levels of Cs-137, Pu-238, Ra-226, Sr-90, Tc-99, Th-228 (<3.7 pCi/g), and total uranium (1.6 mg/kg) are present near the surface to a depth of 4.9 m (16.0 ft) bgs.

The major zone of contamination extends from 4.9 m to 8.5 m (16 ft to 28.0 ft) bgs and is associated with the bottom of the waste site and the gravel- and sand-dominated sequences of the Hanford formation. The maximum concentrations of Cs-137 (1,500,000 pCi/g), Sr-90 (50,000 pCi/g), Pu-239/240 (249 pCi/g), tritium (16 pCi/g), and total uranium (22.6 mg/kg) were detected in this zone. Plutonium-238 (5.06 pCi/g), Pu-239/240 (249 pCi/g), and Tc-99 (132 pCi/g) also were present in this zone.

Contaminant concentrations decrease significantly from 8.5 m to 9.1 m (28 ft to 30 ft) bgs with the exception of Tc-99. Cobalt-60, Th-228, and Pu-239 were <1 pCi/g. Cesium-137 and Sr-90 concentrations were 780 pCi/g and 340 pCi/g, respectively. The Tc-99 concentration increased in this zone to 160 pCi/g. Total uranium (1.2 mg/kg) was the only metal present in this lower zone.

2.6 EVALUATION OF THE ANALOGOUS WASTE SITES

DOE/RL-96-81 describes the grouping of 200 Areas waste sites based on process. Sites that received waste associated with a certain process were grouped by waste category (e.g., process condensate). The waste categories then were grouped based on more specific process details (e.g., 200-TW-1 Tank Waste Group OU, 200-TW-2 Scavenged Waste Group OU, 200-PW-5 Fission Product Rich-Process Condensate Waste Group OU, 200-LW-1 300 Area Chemical Laboratory Waste Group OU). This streamlining approach is employed to reduce the amount of characterization and evaluation required to support remedial action decision-making. Application of the concept takes into account similarities between waste sites, such as waste stream type, discharge history, and geology, as well as the available characterization data, to assess the nature and extent of contamination. The concept builds on the knowledge gained from the characterization of a few waste sites (representative sites) that are indicative of worst case and typical OU conditions. Selection of representative sites generally is based on waste stream inventory, the volume of effluent discharged, and the knowledge gained from previous characterization efforts performed before the RI.

2.6.1 Assignment of Analogous Site

This section contains the rationale used to assign potential analogous waste sites to the representative sites and other sufficiently characterized waste sites. Key to the logic is the comparison of the physical framework between the representative and potential analogous sites as well as the identification of potential remedial alternatives that may apply. Important considerations of the physical system include the following:

- Waste stream received
- Volume of effluent received in relation to the available pore volume for the waste site
- Types and amounts of contaminants received; contaminant inventory
- Waste site size
- Waste site configuration and construction (e.g., crib, trench, UPR)
- Expected distribution of contaminants / nature and extent of contamination
- Neighboring waste sites, structures, or utilities
- Geologic setting
- Potential for hydrologic and contaminant impacts to groundwater.

Analogous waste sites are assigned to representative sites based on the physical framework and expected distribution of contamination after comparison. After assignments are made, preliminary assumptions regarding the potential use of remedial alternatives at both the representative and the analogous site are assessed. Where similar remedial alternatives appear to be applicable at both the representative site and the analogous site, there is a high probability that the sites are truly similar in terms of the physical framework and possible remedial alternatives that may be employed. Thus, the assignment of an analogous site to a representative site in this section suggests that the potential remedial alternatives selected have a high likelihood of being applicable to both site types. The four remedial alternatives considered in the assignment of analogous sites are No Action; Maintain Existing Soil Cover, Institutional Controls, and Monitored Natural Attenuation; Remove And Dispose; and Capping. Figure 2-25 show the process for evaluating the analogous sites against the representative sites for the RI/FS process through the confirmatory and design sampling processes. The rationale for assigning each waste site to a representative site is presented in Tables 2-2, 2-3, and 2-4.

2.6.2 Analogous Site Groupings

The waste sites included in the 200-TW-1, 200-TW-2, and 200-PW-5 OUs represent three of the 23 process-based OUs in the 200 Areas. Based on the analogous group assignment criteria above, seven analogous groups have been developed, with representative waste sites assigned to each group. Tables 2-2 through 2-4 provide a list of the representative sites and their associated analogous sites and include the rationale for assigning an analogous site to an appropriate representative site. The representative sites and analogous waste groups are described in the following sections.

2.6.2.1 200-TW-1 Operable Unit

The waste sites in this OU likely received the most highly contaminated wastes sent to the ground at the Hanford Site. These wastes are associated, directly or indirectly, with tank wastes collected from the bismuth-phosphate ($BiPO_4$) process. The URP and the ferrocyanide processes at the 221/224-U Plant Buildings were used to recover uranium from the metal waste streams at B Plant and T Plant. Both of these process waste streams are characterized by significant concentrations of both radionuclides and inorganic chemicals.

The 200-TW-1 OU sites are associated with certain uranium-rich $BiPO_4$ wastes generated by the URP at the 221-U Plant. The wastes were treated with the scavenging agent ferrocyanide, which precipitated out most of the fission products remaining after uranium extraction. Treatment was initiated at the tail end of the URP and also in the 241-CR Vault at the C Tank Farms. Scavenged wastes were sent to the ground in limited quantities at a number of 200 East Area cribs and trenches under a specific retention discharge philosophy that restricted the volume of liquids released at any one site.

Table 2-2 provides descriptions of waste sites included in this OU and the rationale for assigning analogous sites to the 216-B-46 and 216-T-26 Cribs and the 216-B-58 Trench.

2.6.2.1.1 216-B-46 Crib Representative Waste Site

The 216-B-46 Crib has been selected as a representative waste site for the following analogous sites:

- 216-B-14 Crib
- 216-B-15 Crib
- 216-B-16 Crib
- 216-B-17 Crib
- 216-B-18 Crib
- 216-B-19 Crib
- 216-B-20 Trench
- 216-B-21 Trench
- 216-B-22 Trench
- 216-B-23 Trench
- 216-B-24 Trench
- 216-B-25 Trench
- 216-B-26 Trench
- 216-B-27 Trench
- 216-B-28 Trench
- 216-B-29 Trench
- 216-B-30 Trench
- 216-B-31 Trench
- 216-B-32 Trench
- 216-B-33 Trench
- 216-B-34 Trench
- 216-B-42 Trench
- 216-B-43 Crib*
- 216-B-44 Crib*
- 216-B-45 Crib*
- 216-B-47 Crib*
- 216-B-48 Crib*
- 216-B-49 Crib*
- 216-B-51 French Drain
- 216-B-52 Trench
- 216-BY-201 Settling Tank
- 200-E-114 Pipeline
- 200-E-14 Siphon Tank
- UPR-200-E-9.

* Analogous to 216-B-46; however, sufficient data are available for stand-alone evaluation.

These analogous sites can be grouped into three distinct categories:

- The 216-B-14 through 216-B-19 Cribs are located in the same general vicinity, are constructed the same, operated during the same period of time and duration, and accepted waste from the same source. The 200-E-14-Siphon Tank, 200-E-114 Pipeline, and UPR-E-9 are included in this category. The 200-E-14 Siphon Tank was an intermediate stop for liquid waste being transferred to the 216-B-14 through 216-B-19 Cribs, and 200-E-114 was the pipeline line upstream of 200-E-14. UPR-E-9 is included because this UPR was caused by an overflow of the 200-E-14 Siphon Tank. Because this tank, piping, and UPR contributed very little contamination, compared to the trenches, a specific description will not be included below but is included in Table 2-2. This waste site grouping will be included and described below as 216-B-14 Series Cribs.

- The 216-B-20 through 216-B-34, 216-B-52, and 216-B-42 Trenches, except for 216-B-42, located in the same area, are constructed the same, operated during the same period of time and duration, and accepted waste from the same source. This waste site grouping will be described below as 216-B-20 Series Trenches.

- The 216-B-43 to 216-B-49 Cribs and 216-B-51 French Drain are located in the same general vicinity, are constructed the same, operated during the same period of time and duration, and accepted waste from the same source. The 216-BY-201 Settling Tank is included in this category. The 216-BY-201 Settling Tank was an intermediate stop for liquid waste being transferred to the 216-B-43 series Cribs. This waste site grouping will be described below as the 216-B-43 Series Cribs.

The following general discussion of the rationale for assigning the 216-B-46 Crib as a bounding site for this group of analogous waste sites includes criteria and evaluations.

1. *Waste site configuration and construction*: The 216-B-46 Crib consists of four concrete culverts buried vertically, with the centers spaced 3.9 m (15 ft) apart. Construction data indicate that the crib is in a 9.1 x 9.1 x 4.6 m (30 x 30 x 15-ft) excavation.

   The 216-B-14 Series Cribs are wood, cinder block, and steel on a bed of gravel, and site dimensions are 24 x 24 x 4 m (80 x 80 x 13 ft). The 216-B-20 Series Trenches are backfilled unlined ditches. Waste site dimensions are 153 x3 x 4 m (500 x 10 x 13 ft). The 216-B-43 Series Cribs have construction similar to that of the representative site (216-B-46 Crib) described above.

2. *Volume of effluent received in relation to the available pore volume*: The 216-B-46 Crib received approximately 6,700,000 L of scavenged supernatant waste from the 221-U Canyon Building over a 4-month period in1955.

   The 216-B-14 Series Cribs each received waste quantities ranging from 8,700,000 to 3,400,000 L. The 216-B-20 Series Trenches each received waste quantities ranging from 8,500,000 to 1,500,000. The 216-B-43 Series Cribs each received waste quantities ranging from 6,700,000 to 2,100,000 L (the 216-B-51 French Drain is included, but received less than 0.1 percent of the volume received by the other cribs in this grouping).

3. *Contaminant inventory*: The 216-B-46 Crib received scavenged URP supernatant waste from the 221-U Canyon Building. The waste cascaded through the BY Tank Farm tanks before being discharged to the crib. The waste was originally bismuth-phosphate/lanthanum-fluoride metal waste from the 221-B Canyon Building. The 216-B-46 Crib has significant inventories of Cs-137 (88.9 Ci), plutonium (20 g), uranium (190 kg), Sr-90 (631 Ci), ferrocyanide (4,000 kg), and nitrate (1,200,000 kg).

   The 216-B-14 Series Cribs received inventories for the following contaminants and ranges of concentrations: Cs-137 (296 to 92 Ci), plutonium (25 to 5 g), uranium (350 to 100 kg), Sr-90 (172 to 68.9 Ci), ferrocyanide (5,000 to 1,800 kg), and nitrate (1,500,000 to 900,000 kg). The 216-B-20 Series Trenches received inventories for the following contaminants and ranges of concentrations: Cs-137 (1,570 to 42.7 Ci), plutonium (77 to 1.1 g), uranium (680 to 10 kg), Sr-90 (475 to 18.1 Ci), ferrocyanide (3,100 to 800 kg), and nitrate (2,100,000 to 210,000 kg). The 216-B-43 Series Cribs received inventories for the following contaminants and ranges of concentrations: Cs-137 (660 to 66 Ci), plutonium (15 to 0.5 g), uranium (320 to 2.3 kg), Sr-90 (1,200 to 261 Ci), ferrocyanide (3,000 to 1,100 kg), and nitrate (1,500,000 to 90,000 kg).

4. *Depth of waste discharge*: Sample data collected in 1993 confirms that the bottom of the excavation of the 216-B-46 Crib after stabilization (i.e., addition of 0.9 m (3 ft) of clean soil) is about 5.5 m (18 ft) bgs. Maximum contaminant concentrations were detected near the bottom of the crib at a depth of 5.5 m (18 ft bgs) and generally decreased with depth. Table 2-5 provides the depths to the top of the contamination, and thusly, the thickness of the clean cover, at each of the 200-TW-1, 200-TW-2, and 200-PW-5 OU waste sites.

The 216-B-14 Series Cribs and 216-B-43 Series Cribs have a maximum recorded discharge depth that is similar to that of the 216-B-43 Crib. The 216-B-20 Series Trenches have a maximum recorded discharge depth of 14.6 m (48 ft) bgs.

5. *Expected distribution of contaminants*: Most of the contamination detected at the 216-B-46 Crib was within a 9.1 m (30-ft) zone extending from the bottom of the crib at 5.5 to 15 m (18 to 49 ft) bgs. The Cs-137 and Sr-90 exceed 350,000 pCi/g. With the exception of Tc-99 and nitrate, little contamination was detected greater than 15 m (49 ft) bgs. The maximum Tc-99 concentration below 15 m (49 ft) bgs is 160 pCi/g.

   The expected distribution of contaminants at the 216-B-14, 216-B-20, and 216-B-43 series sites all are less than or equal to the representative site (216-B-46 Crib).

6. *Potential for hydrologic and contaminant impacts to groundwater*: The results of the 216-B-46 Crib modeling indicate that all of the mobile contaminants, except tritium and nitrite, are expected to reach the groundwater with concentrations exceeding their maximum contaminant levels (MCL).

   Impact to groundwater is similarly expected from the analogous waste sites because of the similar waste streams received.

2.6.2.1.2 216-T-26 Crib Representative Waste Site

The 216-T-26 Crib has been selected as a representative waste site for analogous site 216-T-18 Crib.

The following general discussion of the rationale for assigning 216-T-26 Crib as the representative site for the 216-T-18 Crib includes criteria and evaluations.

1. *Waste site configuration and construction*: The 216-T-26 Crib has a 1.2-m (4-ft) diameter x 1.2-m (4-ft) length concrete culvert, buried vertically with the centers spaced 4.6 m (15 ft) apart in a 9.1 x 9.1 x 4.6-m (30 x 30 x 15-ft) excavation. The site received TY Tank Farm/T Plant (bismuth-phosphate/lanthanum-fluoride) waste from 1955 to 1956. The crib received first-cycle scavenged supernatant waste from the 221-T Canyon Building via an underground pipeline and the 216-TY-201 Flush Tank after cascading through Tanks 241-TY-101, 241-TY-103, and 241-TY-104. The crib also received scavenged $BiPO_4$ solvent extraction waste.

   The waste site construction is the same as that for the 216-T-18 Crib.

2. *Volume of effluent received in relation to the available pore volume*: The 216-T-26 Crib received approximately 12,000,000 L of scavenged supernatant waste from the 221-U Canyon Building for a 4-month period in 1955.

   The waste site volume for the 216-T-18 Crib was much lower, at 1,000,000 L.

3. *Contaminant inventory*: The 216-T-26 Crib received scavenged URP supernatant waste from the 221-U Canyon Building. The waste cascaded through the BY Tank Farm tanks before being discharged to the crib. The waste was originally bismuth-

phosphate/lanthanum-fluoride metal wastes from the 221-B Canyon Building. The 216-T-26 Crib contains significant inventories of Cs-137 (75.6 Ci), plutonium (59 g), uranium (150 kg), Sr-90 (282 Ci), ferrocyanide (6,000 kg), and nitrate (1,200,000 kg).

The 216-T-18 Crib received significant inventories of Cs-137 (24.2 Ci), plutonium (1,800 g), uranium (26.8 kg), Sr-90 (2.8 Ci), and nitrate (80,000 kg). The 216-T-18 Crib has been identified as a potential site with concentrations of transuranic constituents above levels of concern.

4. *Depth of waste discharge*: Soil data indicate that most of the contamination in the 216-T-26 Crib is in a 5.6 m (18.5-ft) zone below the bottom of the crib at 5.5 m (18 ft) bgs. RLS data indicate that contamination adjacent to the crib may extend to a depth of about 27.4 m (90 ft) bgs.

   The depth of waste discharge for the 216-T-18 Crib is about 3.4 m (11 ft) bgs.

5. *Expected distribution of contaminants*: Most of the contamination detected in the 216-T-26 Crib is within a 5.6 m (18.5 ft) zone extending from the bottom of the crib at 5.5 m (18 ft) to 11 m (36.5 ft) bgs. Maximum concentration of Cs-137 is 47,900 pCi/g; maximum concentration of Sr-90 is 49,100 pCi/g. With the exception of Tc-99 and nitrate, little contamination was detected greater than 11 m (36.5 ft) bgs. The maximum Tc-99 concentration below 11 m (36.5 ft) bgs is 4.9 pCi/g.

   Distribution of contaminants for the 216-T-18 Crib is expected to be similar to that for the 216-T-26 Crib, with the zone of highest contamination extending from about 3.4 m (11 ft) to 9.5 m (31 ft) bgs. Contamination levels are expected to be lower than those of the 216-T-26 Crib because of the lower contaminant loads received.

6. *Potential for hydrologic and contaminant impacts to groundwater*: Based on the results of the 216-T-26 Crib modeling, cyanide, nitrate, nitrite, Tc-99, and U-233/234/238 are predicted to reach the groundwater with concentrations exceeding their respective MCLs.

   A similar impact to groundwater is assumed for the 216-T-18 Crib.

2.6.2.1.3 216-B-58 Trench Representative Waste Site

Four sites (216-B-53A, 216-B-53B, 216-B-54, and 216-B-58 Trenches), that were originally in the 200-LW-1 OU but are now part of the 200-TW-1 OU, are located in the BC Cribs and Trenches Area south of the 200 East Area. Because these waste sites are in close physical proximity to many of the 200-TW-1 OU cribs and trenches and have similar design, they have been included in this FS to support the accelerated cleanup of the BC Cribs and Trenches Area.

The four trenches from 200-LW-1 OU received liquid waste from the 300 Area. Three 200-LW-1 OU trenches (216-B-53B, 216-B-54, and 216-B-58) received liquid laboratory waste from the 340 Facility. The 216-B-53A Trench received liquid waste from cleanup of a process tube failure at the Plutonium Recycle Test Reactor. Liquid quantities at all four sites were limited to well within the specific retention capacity of each trench.

Contaminants in the waste at these four sites included uranium, plutonium, Cs-137, Sr-90, and nitrate. Contaminants identified during characterization of the 216-B-58 Trench are identified and discussed in Section 2.5.1.3.

The 216-B-58 Trench has been selected as a representative waste site for the following analogous sites:

- 216-B-53A Trench
- 216-B-53B Trench
- 216-B-54 Trench.

All four sites are located side-by-side in the same area, are of approximately the same design, and were used for the same purpose (disposal of liquid laboratory waste from the 340 Waste Neutralization Facility). The only significant difference is that the 216-B-53A Trench received liquid waste from a process tube failure at the Plutonium Recycle Test Reactor.

The rationale for assigning 216-B-58 Trench as the representative site for these analogous waste site is as follows:

1. Waste site configuration and construction: All four trenches are of approximately the same size (60 to 200 ft long, 10 ft wide, 8 to 10 ft deep). 216-B-58 Trench is the largest of these four trenches (200 ft long, 10 ft deep, 10 ft wide)

2. Volume of effluent received in relation to the available pore volume: The 216-B-58 Trench received 413,000 L (413 m^3) of liquid waste, which is 7 percent of the estimated available soil pore volume. The three analogous waste sites received between 15,000 L and 999,000 L of waste liquid and between 0.4 percent and 34 percent of estimated available soil pore volume

3. Contaminant inventory: The 216-B-58 Trench received 4.4 Ci of Cs-137, 5.6 Ci of Sr-90 (both decayed to 1989), 9.1 kg of uranium, 6.7 g of plutonium, and 10 kg of nitrate. The analogous waste sites received between 0.05 to 3.7 Ci of Cs-137, 0.05 to 5.1 Ci of Sr-90, 9.1 to 23 kg of uranium, 5 to 100 g of plutonium, and 1 to 100 kg of nitrate. The 100 g of plutonium was received at the 216-B-53A Trench; this also may have concentrations of transuranic constituents at levels of concern (100 nCi/g)

4. Depth of waste discharge: Waste at the 216-B-58 Trench was discharged at an original depth of 3 m (10 ft). Waste at the analogous sites was discharged at a depth of 2.4 to3 m (8 to 10 ft)

5. Expected distribution of contaminants: Based on DOE/RL-2001-66, very little contamination is expected below a depth of about 10.7 m (35 ft) in any of these sites, and none is expected to have reached groundwater. Characterization of the 216-B-58 Trench indicates that tritium is the only radionuclide detected below this depth (measured at 16.8 m [55 ft]). Nitrate was detected to 16.8 m (55 ft) bgs, and selenium was detected to 30 m (100 ft) bgs.

6. Potential for hydrologic and contaminant impacts to groundwater: Based on DOE/RL-2001-66, contamination in these four sites is not expected to reach

groundwater. Waste discharges were considerably less than the vadose zone soil column pore volume beneath the footprint of the trench (0.4 to 34 percent).

2.6.2.2 200-TW-2 Operable Unit

The 200-TW-2 OU consists of cribs and trenches that received lower activity liquids from two of the less contaminated $BiPO_4$ high-activity tank farm waste streams. In addition, a medium-level waste stream derived from process vessel rinses and drainage was sent to cribs and reverse wells. Fission products in the waste were precipitated out during cooling and storage in the tanks, and the residual liquid was released to the ground in small to moderate quantities.

The 200-TW-2 OU contains waste sites from the 200 East Area (216-B sites) as well as sites from the 200 West Area (216-T sites). These sites are placed in the same OU, based on similar waste streams associated with similar plant histories. The following is an excerpt from the Work Plan (DOE/RL-2000-38):

> "The T and B Plants were constructed in 1944. The T and B Plants are composed of several buildings, including the 221-T and 221-B Buildings (also known as the "canyon buildings" due to their shape and appearance) and the 224-T and 224-B Buildings (also known as the concentration buildings due to the operational procedures performed there). The T and B Plants received and processed irradiated fuel rods from the 100 Area reactors. The fuel rods were subject to several chemical separation and purification steps to produce the desired plutonium product. The plutonium separation and purification operations ceased in 1956 at T Plant and in 1952 at B Plant."

The 200-TW-2 OU waste sites are generally similar in construction, type and level of contaminants, geology, volumes of effluents, and potential for impacts to groundwater.

Table 2-3 provides the background and a description of the waste sites included in this OU, including the rationale for assigning analogous sites to the representative sites for the group. A general discussion of the rationale for the representative site and analogous groupings is based on the following criteria.

2.6.2.2.1 216-B-5 Reverse Well Representative Site

One analogous site was assigned to the 216-B-5 Reverse Well site:

- 216-T-3 Reverse Well.

Characterization of the 216-B-5 Reverse Well originally was described in RHO-ST-37. An overview of the 216-B-5 Reverse Well is as follows:

1. *Waste site configuration and construction*: This reverse well extends to a depth of 92 m (302 ft) bgs. The 20 cm (8-in.) borehole is perforated from 63.6 to 92 m (243 to 302 ft) bgs. Contaminants were injected directly into the aquifer. The site received the liquid waste from the 221-B Canyon Building and the 224-B Concentration Facility via overflow of the 241-B-361 Settling Tank between 1945 and 1947.

2. *Volume of effluent received in relation to the available pore volume*: 30,600,000 L of effluents were injected into the well. Pore volume is not applicable because of the operational nature of the well.

3. *Contaminant inventory*: The reverse well received waste from the 221-B Canyon Building and the 224-B Concentration Facility via overflow of the 241-B-361 Settling Tank, with the following inventories: Cs-137 (29.2 Ci), plutonium (4,270 g), Sr-90 (25.5 Ci), and nitrate (40,000 kg).

4. *Depth of waste discharge*: The data indicate contamination at a depth of about 73 to 86.6 m (243 to 284 ft) bgs at the 216-B-5 Reverse Well.

5. *Expected distribution of contaminants*: Cs-137, Sr-90, Am-241, and Pu-239/240 were the only constituents analyzed and detected. The maximum concentrations of Cs-137, Sr-90, Pu-239/240, and Am-241 range from 1,800 to 75,000 pCi/g.

6. *Potential for hydrologic and contaminant impacts to groundwater:* Contaminants were injected directly into the aquifer. Contaminants remain in the soils at and just above the current water table level.

2.6.2.2.2 216-B-7A Crib Representative Waste Site

The 216-B-7A Crib has been selected as a representative waste site for the following analogous sites (the 216-B-7B Crib is included with the 216-B-7A Crib because the sites are duplicates, are located side -by side, and accepted the same waste stream; however, only 216-B-7A Crib was characterized):

- 200-E-45 Shaft
- 216-B-8 Crib
- 216-B-9 Crib
- 241-B-361 Settling Tank
- 216-T-5 Crib
- 216-T-6 Crib
- 216-T-7 Crib
- 216-T-32 Crib
- 241-T-361 Settling Tank
- UPR-200-E-7 Unplanned Release Area.

These analogous sites can be grouped into two categories:

- The 216-B-8 and 216-B-9 Cribs, 241-B-361 Settling Tank, 200-E-45 Shaft, and UPR-E-7 all are located in the same general vicinity, operated during approximately the same duration and period of time, and accepted waste from the same sources. This waste site grouping will be included and described below as the 216-B-8 Series.

- The 216-T-5 Crib, 216-T-6 and 216-T-7 Cribs, 216-T-32 Crib, and 241-T-361 Settling Tank are located adjacent to the T Tank Farm, operated during approximately the same duration and period of time, and accepted waste from the same sources. This waste site grouping will be described below as the 216-T-6 Series.

The following criteria were used to evaluate whether the 216-B-7A Crib is representative of the analogous waste sites listed above.

1. *Waste site configuration and construction*: The 216-B-7A and 216-B-7B Cribs are wooden cribs, 3.7 x 3.7 x 1.2 m (12 x 12 x 4 ft) each, located north of the-B Tank Farm.

The southeast crib is 216-B-7A and the northwest crib is 216-B-7B. The cribs are about 8.5 m (28 ft) apart from each other. Contaminated soils from UPR-200-E-144 were consolidated on the cribs, and then the area was stabilized with clean backfill. The site received liquid waste from the 221-B Canyon Building and the 224-B Concentration Facility via overflow of 241-B-361 Settling Tank.

In the 216-B-8 Series, the 216-B-8 and 216-B-9 Cribs are of construction similar to that of the representative site but have attached tile fields. The 241-B-361 Settling Tank has a different (a settling tank versus a crib) but is analogous because of the same waste stream; its discharge was sent to the 216-B-8 and 216-B-9 Cribs and the representative site (216-B-7A and 216-B-7B Cribs). The 200-E-45 Shaft has a different construction but is analogous because of similar waste stream; it was constructed and used to take samples from the 216-B-8 Crib. UPR-200-E-7 is analogous to the representative site, because it was caused by a release from analogous site 216-B-9 Crib.

In the 216-T-6 Series, the 216-T-6 Crib, 216-T-7 Crib, and 216-T-32 Crib (of similar design) are of construction similar to that of the representative site (216-B-7A Crib) but the sizes are larger. The 216-T-5 Crib is a retention trench and is not of similar construction but is analogous because the source and contaminants are similar. The 241-T-361 Settling Tank is not of similar construction but is analogous because the source and contaminants are similar.

2. *Volume of effluent received in relation to the available pore volume*: Approximately 4,360,000 L of liquid process effluent were received at the 216-B-7A and 216-B-7B Cribs between 1946 and 1967 (active for 21 years). The combined pore volume of the 216-B-7A and 216-B-7B Cribs was 32,200 L.

   The B-8 Series ranged from 36,000,000 to 27,200,000 L of waste received. The 216-T-3 Series ranged from 170,000,000 to 2,600,000 L of waste received.

3. *Contaminant inventory*: The 216-B-7A and 216-B-7B Cribs received waste from the 221-B Canyon Building and the 224-B Concentration Facility via overflow of the 241-B-361 Settling Tank and included significant inventories of Cs-137 (43.2 Ci), plutonium (4,300 g), uranium (180 kg), Sr-90 (2,200 Ci), and nitrate (1,800,000 kg).

   The inventories and ranges of contaminant concentrations for the 216-B-8 Series are: Cs-137 (19.8 to 3.92 Ci), plutonium (174 to 30 g), uranium (45 to 45 kg), Sr-90 (5.58 to 5.52 Ci), and nitrate (1,400,000 to 1000 kg). The inventories and ranges of contaminant concentrations for the 216-T-3 Series are: Cs-137 (150 to 14 Ci), plutonium (3,350 to 130 g), uranium (23 to 4.54 kg), and Sr-90 (172 to 0.635 Ci). Contaminants and ranges are analogous to or bound by the representative site.

   The 216-T-3 Reverse Well, 216-T-6 Crib, 216-T-32 Crib, 241-B-361 Settling Tank, and 241-T-361 Settling Tank have been identified as potential sites with transuranic constituents above levels of concern (100 nCi/g).

4. *Depth of waste discharge*: Soil data indicate that contamination is associated with the point of release at about 5.5 m (18 ft) bgs and extends to a depth of about 11.4 m (37.5 ft) bgs. Very little contamination is present beyond a depth of 11.4 m (37.5 ft) bgs.

   With the exception of the 216-T-3 Reverse Well, depth of waste discharged for the analogous sites is equivalent to or less than that of the representative site (Table 2-5 shows the depth to the top of the contamination). Contaminants from the 216-T-3 Reverse Well start at 105 ft bgs, and groundwater contamination has occurred at the site.

5. *Expected distribution of contaminants*: Borehole data indicate that Cs-137 contamination extends to a depth of about 17.1 m (56 ft) bgs with the highest concentration (300,000 pCi/g) at 7 m (23 ft) bgs.

   The analogous sites are equivalent to or below the contamination levels of the representative site. Contaminants are expected to be distributed similarly to those of the representative site, with an area of higher concentrations at the point of release, followed by a decrease in concentration with depth.

6. *Potential for hydrologic and contaminant impacts to groundwater*: Based on the results of the 216-B-7A Crib modeling, fluoride, nitrate, and U-233/234/238 are predicted to reach the groundwater with concentrations exceeding their MCLs.

   A similar impact to groundwater is expected from the analogous sites.

2.6.2.2.3 216-B-38 Trench Representative Waste Site

The 216-B-38 Trench has been selected as a representative waste site for the following analogous sites:

- 216-B-35 Trench
- 216-B-36 Trench
- 216-B-37 Trench
- 216-B-39 Trench
- 216-B-40 Trench
- 216-B-41 Trench
- 216-T-14 Trench
- 216-T-15 Trench
- 216-T-16 Trench
- 216-T-17 Trench
- 216-T-21 Trench
- 216-T-22 Trench
- 216-T-23 Trench
- 216-T-24 Trench
- 216-T-25 Trench.

These analogous sites can be grouped into two distinct categories.

- The 216-B-35 through 216-B-41 Trenches are located in the same general vicinity, are of the same construction, operated during approximately the same duration and period of time, and accepted waste from the same source. This waste site grouping will be included and described below as the 216-B-35 Series Cribs.

- For the 216-T-14 through 216-T-17 and 216-T-21 through 216-T-25 Trenches, 216-T-14 through 216-T-17 are located in the same area, and 216-T-21 through 216-T-25 are located in the same area, are of the same construction, operated during approximately the same duration and period of time, and accepted waste from the same source. This waste site grouping will be described below as the 216-T-14 Series Trenches.

The following criteria were used to evaluate whether the 216-B-38 Trench is representative of the analogous waste sites listed above.

1. *Waste site configuration and construction*: The 216-B-38 Trench is an open, unlined ditch 77 x 3 x 77 m (10 x 10 x 250 ft) long. It was used as a specific retention trench in July 1954. The site was backfilled and stabilized in 1982 with 0.6 m (2 ft) of clean fill. Remedial investigation data suggest that the bottom of the trench is at 4.3 m (14 ft) bgs.

   The B-35 Series Trenches are of similar construction, with trench dimensions 3.1 x 3.1 x 76.9 m (10 x 10 x 250 ft) long (except the 216-B-35 Trench, which is only 23.5 m (77 ft) long). The 216-T-14 Series Trenches are of similar construction, and have trench dimensions of 3.1 x 3.7 m (10 x 12 ft) with a length that ranges from 54.9 to 83.8 m (180 to 275 ft).

2. *Volume of effluent received in relation to the available pore volume*: The 216-B-38 Trench site received 1,300,000 L (380,000 gal) of high-salt, neutral/basic first-cycle supernatant waste from the 221-B Canyon Building. The estimated pore volume of the 216-B-38 Trench was 993,300 L.

   The B-35 Series Cribs received volumes ranging from 4,300,000 to 1,060,000 L. The T-14 Series Trenches received volumes ranging from 3,000,000 to 465,000 L.

3. *Contaminant inventory*: The 216-B-38 Trench received significant inventories of Cs-137 (221 Ci), plutonium (1.2 g), uranium (42 kg), Sr-90 (759 Ci), and nitrate (120,000 kg).

   Inventories and ranges of contaminant concentrations for the B-35 Series Cribs are: Cs-137 (1,780 to 203 Ci), plutonium (1.51 to 0.3 g), uranium (35 to 3.63 kg), Sr-90 (269 to 8.87 Ci), and nitrate (1,700,000 to 90,000 kg). Inventories and ranges of contaminant concentrations for the T-14 Series Trenches are: Cs-137 (5,700 to 0.061 Ci), plutonium (2 to 0.53 g), uranium (30 to 0.91 kg), and Sr-90 (28.3 to 1.66 Ci).

4. *Depth of waste discharge*. Soil data from the 216-B-38 Trench indicate that contamination is associated with the point of release at about 4.6 m (15 ft) bgs and extends to a depth of about 12.2 m (40 ft) bgs. Very little contamination is present beyond a depth of 12.2 m (40 ft) bgs.

   The B-35 Series Cribs and T-14 Series Trenches have discharge depths and contaminant depth profiles that are similar to those of the representative site (216-B-38 Trench) (Table 2-5 shows depths to the top of the contamination).

5. *Expected distribution of contaminants*: RLS data indicate that contamination extends to a depth of about 25.9 m (85 ft) bgs near the crib.

   The B-35 Series Cribs and T-14 Series Trenches have an expected distribution of contaminants that is similar to that of the representative site (216-B-38 Trench).

6. *Potential for hydrologic and contaminant impacts to groundwater*: Based on the results of the 216-B-38 Trench modeling, nitrate, nitrite, and U-233/234/238 are predicted to reach the groundwater with concentrations exceeding their MCLs.

   Similar impacts to groundwater are expected from the B-35 Series Cribs and T-14 Series Trenches.

2.6.2.3 200-PW-5 Operable Unit

Sites containing a minimum inventory of 20 Ci of either cesium or strontium isotopes, but low levels of plutonium from process condensate/process waste, are included in the 200-PW-5 OU. Process condensate is generally water condensed from the closed process system that was in direct contact with radioactive and chemical materials. Process waste is low-level and/or hazardous waste that directly contacted radioactive material and may contain organic compounds that could enhance their mobility. Because of the small quantities of radionuclides, this waste was disposed to underground sites such as cribs, reverse wells, and trenches. The primary contaminants noted in this category include H-3, I-129, Cs-137, Sr-90, Ru-106, Tc-99, U-238, Pu-239/240, organics, nitrates, and a number of inorganic components.

Table 2-4 provides the background and description of the waste sites included in this group and the rationale for assigning analogous sites to the representative sites for the group.

2.6.2.3.1 216-B-57 Crib Representative Waste Site

The 216-B-57 Crib has been selected as a representative waste site for the following analogous sites:

- 216-B-62 Crib
- 216-B-11A&B French Drains
- 216-C-6 Crib
- 216-S-9 Crib
- 216-S-21 Crib
- UPR-200-W-108
- UPR-200-W-109
- 216-B-50 Crib (sufficient data are available for stand-alone evaluation).

The following general discussion of the rationale for assigning 216-B-57 Crib as a bounding site for this group includes criteria and evaluations (UPR sites are not discussed below because of the relatively low amount of waste released):

1. *Waste site configuration and construction*: The 216-B-57 Crib is a gravel crib that received condensate from the ITS #2 unit in the BY Tank Farm. This crib was filled to 1.2 m (4 ft) above the bottom with gravel (approximately 474.3 m^3 (620 yd^3). A perforated, (12-in.) corrugated pipe runs the length of the crib, 0.9 m (3 ft) above the bottom. The side slope of the original crib construction is 1.5:1. The overall dimensions are 107.8 x 64.7 x 15.1 m (350 x 210 x 49 ft).

   The waste sites analogous to the 216-B-57 Crib received similar waste (i.e., process condensate) and also are similar in that a bed of gravel was installed where waste was discharged.

2. *Volume of effluent received in relation to the available pore volume*: The 214-B-57 Crib received 84,400,000 L (84,400 m^3) of mixed liquid waste, which is lower than the estimated available soil pore volume (108,000 m^3 compared to 84,400 m^3).

   The waste sites analogous to the 216-B-57 Crib received between 530,000 and 282,000,000 L of waste liquid.

3. *Contaminant inventory:* The 216-B-57 Crib received significant inventories of Cs-137 (221 Ci), plutonium (1.2 g), uranium (42 kg), Sr-90 (759 Ci), and nitrate (120,000 kg).

   The waste sites analogous to the 216-B-57 Crib received between 0.05 and 33 kg of uranium, 0.1 to 4 g of plutonium, 0.46 to 226 Ci of Cs-137, and 0.183 to 75 Ci of Sr-90. One site was contaminated with nitrates (216-B-50 Crib at 1,500 kg), and one site was contaminated with Am-241 at 0.103 Ci (216-B-62 Crib).

4. *Depth of waste discharge*: Soil data indicate that contamination is associated with the point of release about 4.6 m (15 ft) below original grade and extends to a depth of about 10.6 m (33 ft) bgs. Very little contamination is present beyond a depth of 10.6 m (33 ft) bgs.

   The waste sites analogous to the 216-B-57 Crib, with exception of the 216-B-62 Crib, indicate contamination to a depth of 26.8 m (88 ft) bgs. The 216-B-62 Crib is an exception because of the high volume of liquid discharged (282,000,000 L) and a measured contaminant depth of 44.7 m (146.5 ft) bgs.

5. *Expected distribution of contaminants*: Very little contamination is present beyond a depth of 10 m (33 ft) from original grade.

   The waste sites analogous to the 216-B-57 Crib, with exception of the 216-B-62 Crib, are similar in contaminant distribution and distribution of radionuclides.

6. *Potential for hydrologic and contaminant impacts to groundwater*: Plume geometry and soil characterization data indicate a lower potential for impacts to groundwater from the 216-B-57 Crib.

   The waste sites analogous to the 216-B-57Crib, with the exception of the 216-B-62 Crib, are not expected to impact groundwater. The 216-B-62 Crib, because of the higher amount of liquid waste discharged, is expected to impact groundwater.

Sites UPR-200-W-108 and UPR-200-W-109 are analogous to the 216-B-57 Crib based on the source of contamination (the 216-S-9 Crib). These UPR sites were caused by a break in the line used to transfer waste liquid from the 216-S-9 Crib to the 216-S-23 Crib. The amount of liquid waste spilled is unknown but is estimated at 113 L (30 gal) for UPR-200-W-108. These sites are analogous to the 216-B-57 Crib, based on the relationship with the source (216-S-9 Crib).

2.7 SUMMARY OF RISK ASSESSMENT

The Tri-Parties recently undertook the task of developing a risk framework to support risk assessments in the 200 Areas Central Plateau. This included a series of workshops with representatives from the Tri-Parties, the Hanford Advisory Board (HAB), the Tribal Nations, the State of Oregon, and other interested stakeholders. The workshops focused on the different programs involved in activities in the 200 Areas Central Plateau and the need for a consistent application of risk assessment assumptions and goals. The results of the risk framework are documented in HAB 132, "Exposure Scenarios Task Force on the 200 Area," in the Tri-Parties response to the HAB advice (Klein et al. 2002, "Consensus Advice #132: Exposure Scenarios

Task Force on the 200 Area"), and in the *Report of the Exposure Scenarios Task Force* (HAB 2002). The following items summarize the risk framework description from the Tri-Parties' response to the HAB.

1. The core zone (200 Areas including B Pond [main pond] and S Ponds) will have an industrial scenario for the foreseeable future. The core zone is depicted in Figure 2-26.

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

3. DOE will follow the required regulatory processes for groundwater remediation (including public participation) to establish the points of compliance and RAOs. It is anticipated that groundwater contamination under the core zone will preclude beneficial use for the foreseeable future, which is at least the period of waste management and institutional controls (150 yr). It is assumed that the tritium and I-129 plumes beyond the core zone boundary will exceed the drinking water standards for the period of the next 150 to 300 yr (less for the tritium plume). It is expected that other groundwater contaminants will remain below, or will be restored to, drinking water levels outside the core zone.

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

5. Waste sites outside the core zone but within the Central Plateau will be remediated and closed based on an evaluation of multiple land-use scenarios to optimize land use, institutional control cost, and long-term stewardship.

6. An industrial land-use scenario will set cleanup levels in the 200 Areas core zone. Other scenarios (e.g., residential, recreational) may be used for comparison purposes to support decision-making, especially for the following:
   - The post-institutional controls period (>150 yr)
   - Sites near the core zone perimeter, to analyze opportunities to "shrink the site"
   - Early (precedent-setting) closure/remediation decisions.

7. This framework does not address the tank retrieval decision.

This description serves as the basis for the risk assessment activities performed as part of this FS. The human health and ecological risk assessments can be found in DOE/RL-2002-42 and in Appendix C of this document and are summarized in the following subsections.

2.7.1 Human Health Risk Assessment

The human health risk assessment (HHRA) included the evaluation of nonradiological and radiological constituents from six[2] of the seven representative waste sites plus eight analogous sites for which characterization data were available. The assessment includes analysis of direct human and ecological exposure using a dose and risk assessment for the shallow zone (0 to 4.6 m [0 to 15 ft] bgs) and analysis of the protection of groundwater, which was based on analysis of deep-zone soil (surface to the groundwater table) samples. Analytical results were screened in accordance with the Tri-Parties' guidance to identify the contaminants of potential concern (COPC). The purpose of the HHRA is to identify and prioritize the COPCs that are estimated to pose an unacceptable risk (or dose) and should be addressed by the FS. The results of the risk evaluation for five of the representative sites are presented in the RI Report (DOE/RL-2002-42); however, results for the 216-B-58 Trench are provided in this section, because the 216-B-58 Trench was added after the RI Report was prepared. The results for the analogous sites with characterization data are included in Appendix C of this FS.

All of the representative waste sites are located in the core zone. All shallow-zone soil samples were evaluated under an industrial exposure scenario. A hypothetical Native American subsistence scenario also was evaluated for the analogous sites, to provide a basis of comparison (assuming unrestricted land use) to the site-specific industrial exposure scenario. The Tri-Parties have interacted with the stakeholder Tribes over the past several years to obtain their input on developing a Native American exposure scenario or scenarios, including key parameters for the 200 Areas Central Plateau risk assessment models. The Tribes were involved in the risk assessment framework workshops during the summer of 2002; in October 2002, they were asked to provide written suggestions on specific risk-assessment parameters (exposure assumptions) for tribal-use scenarios (letters without title, DOE-RCA-2002-0584, 2002a; 2002b; 2002c). This request culminated in a workshop in December 2002 that included the Tri-Parties and representatives from the Confederated Tribes of the Umatilla Indian Reservation, the Confederated Tribes and Bands of the Yakama Nation, and the Nez Perce Tribe. The Yakamas and the Nez Perce participated in the workshop, but felt they needed additional time to provide input. The Umatillas asked that the information from Harris and Harper 1997, "A Native American Exposure Scenario" be used to calculate risk estimates for a Native American subsistence scenario. Additional discussion regarding the hypothetical Native American scenario is provided in Appendix C of this report.

Local groundwater is not a current source of drinking water and is being addressed under the 200-UP-1 Groundwater OU. However, the potential for contaminants to migrate from soil to groundwater was evaluated.

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[2] Site 216-B-5 Reverse Well was not modeled because contaminants were injected directly into the aquifer and the nearby vadose zone. Accordingly, the industrial scenario is not applicable and the groundwater protection assessment is not needed, given that the groundwater already is contaminated.

2.7.1.1 Nonradiological Results

CERCLA prescribes a risk range of 10^{-6} to 10^{-4} for evaluating the need for remedial action for carcinogens and noncarcinogenic constituents that pose a chronic toxic effect to human health. Noncarcinogenic constituents that pose a chronic toxic effect to human health shall not exceed a hazard quotient of 1.0. Risk-based standards based on an industrial scenario are identified in WAC 173-340-745; they equate to a risk of 1.0×10^{-5}. These standards are evaluated in the risk assessment. A summary of the HHRA results for nonradiological constituents is presented below.

Shallow Zone

All nonradiological COPCs from the shallow zone were compared to the WAC 173-340-745 Method C direct-contact and the WAC 173-340-750, "Cleanup Standards to Protect Air Quality," Method C ambient air risk-based standards for the industrial-exposure scenario. For the five representative sites identified in the RI Report (DOE/RL-2002-42), the mean concentrations of all shallow-zone COPCs from each representative waste site were less than their respective direct-contact and ambient-air Method C risk-based standards. A summary of these comparisons is provided in the RI Report (DOE/RL-2002-42). The maximum detected concentrations from the 216-B-58 Trench were used for comparison because there were insufficient samples to perform a statistical analysis. As presented in Tables 2-5 and 2-6, no constituents exceeded the direct contact risk-based standards. None of these waste sites exceeded the ambient air risk based standards (Appendix C). Appendix C contains the comparisons for the analogous sites with characterization data.

Deep Zone

All nonradiological COPCs from the deep zone were compared to the WAC 173-340-747 Method B risk-based standards for the groundwater protection pathway. For the representative sites, the five sites analyzed during the RI all experienced some nonradiological contaminants in excess of the groundwater-protection screening levels. Depending on the site, these contaminants include antimony, cadmium, chromium (III), selenium, cyanide, fluoride, nitrate and nitrite (as nitrogen), sulfate, iron, and manganese. These contaminants are considered in this FS. Tables 3-3 and 3-4 of the RI Report provide the details of this assessment for all sites except the 216-B-58 Trench, which is reported in Table 2-5.

For the analogous sites, contaminants exceeding groundwater-protection screening levels include nitrate and nitrate (as nitrogen), sulfate, pentachlorophenol, aluminum, cadmium, manganese, and uranium, depending on the specific site. Appendix C provides details on the analogous site nonradiological groundwater-protection assessment.

2.7.1.2 Radiological Results

The HHRA for radiological constituents was performed using the RESidual RADioactivity (RESRAD) code Version 6.21 analysis (ANL 2002, *RESRAD for Windows*, Version 6.21). The RESRAD model was used to obtain risk and dose estimates from direct-contact exposure to radiological constituents present in the shallow zone under an industrial-exposure scenario.

All the representative sites currently have some amount of clean soil, associated either with clean backfill or with stabilization material, over the contamination. The 216-B-57 Crib site has a Hanford barrier that is up to 7.9 m (26-ft) thick that was constructed as a treatability test to gain information on the cost and performance of the barrier.

Radiological constituents in the shallow zone are evaluated using two different methods. The first evaluation method is considered representative of current site conditions, because it accounts for the depth of clean cover (i.e., clean backfill or stabilization material) that is currently over the waste site. The maximum concentration in the 0 to 4.6 m (0 to 15-ft) zone, including the clean cover material, was used to evaluate risk in this method. Radiological constituents are encountered only at depths greater than the clean cover, which accounts for protective shielding effects. Table 2-7 identifies the thickness of the clean material over the waste sites.

The second evaluation method is considered representative of worst-case conditions, because it assumes that there is no clean cover over the representative waste site. The absence of clean cover assumes that the radiological constituents are distributed evenly throughout the shallow zone and that there are no protective effects from shielding. As described in the HHRA, the exposure-point concentrations for each of the radiological constituents were calculated as the lesser of either the maximum value or the 95th percentile upper confidence limit (UCL) of all results. This method uses either the maximum value or the 95th UCL for the entire 4.6 m (15-ft) zone.

The RESRAD modeling was performed using both methods for the 216-B-7A Crib, 216-B-38 Trench, and 216-B-58 Trench, assuming clean soil covers of 0.3 m (1 ft) for the 216-B-7A Crib, 3 m (10 ft) for the 216-B-38 Trench, and 2.4 m (8 ft) for the 216-B-58 Trench. The 216-B-7A Crib was used to consolidate a UPR before stabilization, so a zone of low-level contamination exists near the surface of the waste site. The liquid effluents to the crib were disposed of at a depth of approximately 5.5 m (18 ft) bgs. Only the second method was used for the 216-B-46 Crib and 216-B-57 Crib because the dose from the contaminants in the 0 to 4.6 m (0 to 15-ft) bgs zone for these sites was below 15 mrem/yr under this worst case scenario. The 216-T-26 Crib was not modeled, because no contaminants in the 0 to 4.6 m (0 to 15-ft) bgs shallow zone exceeded background.

The RESRAD model (ANL 2002) was used to obtain screening risk and dose estimates for the groundwater protection pathway for deep zone soils. The screening analysis serves to focus attention on those sites with the potential to contaminate groundwater and to identify the radionuclides of concern.

For comparative purposes, risk and dose estimates were evaluated in context with the following scenario assumptions:

- 50 yr is the estimated time that the DOE will have an on-site presence
- 150 yr is the estimated time that institutional controls are assumed to be effective.

For this remedial action, the CERCLA risk range of 1×10^{-4} to 1×10^{-6} was used to evaluate risks from radionuclides. The RESRAD model calculates a radiation dose using an industrial scenario that is then converted to risk in accordance with EPA guidance (EPA/540/R-99/006, *Radiation Risk Assessment At CERCLA Sites: Q & A* [OSWER Directive No. 9200.4-31P]). A dose of 15 mrem/yr roughly equates to a risk of 1 X 10^{-4}. For the groundwater protection pathway, the average annual activity of beta particles and photon radioactivity from manmade radionuclides in drinking water shall not produce an annual dose equivalent to the total body or any internal organ of greater than 4 mrem/yr (40 CFR 141.66, "Maximum Contaminant Levels for Radionuclides"). Both of these values are approximately equivalent to an excess lifetime cancer risk (ELCR) of 1 x 10^{-4}. The actual ELCR is dependent on which radionuclides are involved.

Shallow Zone[3] – Industrial Scenario – Clean Cover

For those representative sites modeled with a clean cover, none have a total dose rate exceeding the target dose level of 15 mrem/yr at any of the exposure times evaluated. Similarly, the ELCR does not exceed 1 x 10^{-5} at any of the exposure times evaluated. The ELCR for all sites is also within the CERCLA target risk range of 1 x 10^{-6} to 1 x 10^{-4}. The results of this evaluation are provided in the RI Report (DOE/RL-2002-42). Table 2-8 provides the maximum year dose and ELCR for each site.

Shallow Zone[4] – Industrial Scenario – Without Clean Cover

For the industrial scenario without clean cover, four of the representative sites and two of the analogous sites exceeded the 15 mrem/yr dose standard as indicated in Table 2-8.

216-T-26 Crib (Representative Site). No radionuclides in the shallow zone exceeded background. Accordingly, no RESRAD modeling was performed.

216-B-46 Crib (Representative Site). The maximum total dose rate at the 216-B-46 Crib is 1.9 mrem/yr at years 0 to 30. After 30 years, the dose rate decreases. The maximum ELCR is 4.3 x 10^{-5} for the first 30 years. The ELCR under this exposure scenario is less than the target risk level of 1.0 x 10^{-5} only at 1,000 years. Additionally, the ELCR under this scenario is within or less than the CERCLA target risk range of 1 x 10^{-6} to 1 x 10^{-4} for all times analyzed. The primary contributor to total dose and risk is Ra-226. The results of this evaluation are provided in the RI Report (DOE/RL-2002-42).

216-B-58 Trench (Representative Site). The maximum total dose rate at the 216-B-58 Trench is 13,000 mrem/yr at year 0 and decreasing thereafter. The maximum ELCR is 0.13 at year 0. The ELCR under this exposure scenario is never below the target risk level of 1.0 x 10^{-5}. The primary contributor to total dose and risk is initially Cs-137 and then Th-232 as the cesium decays. The results of this evaluation are provided in Table 2-9.

216-B-7A Crib (Representative Site). The maximum total dose rate at the 216-B-7A Crib is 15.1 mrem/yr at year 0. The maximum ELCR is 2.5 x 10^{-4} for the first year. The ELCR under this exposure scenario is less than the target risk level of 1.0 x 10^{-5} only after 150 years. Additionally, the ELCR under this scenario is within or less than the CERCLA target risk range of 1 x 10^{-6} to 1 x 10^{-4} only for years 100 to 1,000. The primary contributor to total dose and risk is Cs-137. The results of this evaluation are provided in the RI Report.

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[3] Shallow zone soils are defined as those collected from zero to 15 ft bgs.

216-B-38 Trench (Representative Site). The maximum total dose rate at the 216-B-38 Trench is 128,300 mrem/yr at year 0. The maximum ELCR is greater than 1×10^{-2} for the first 150 years. The ELCR under this exposure scenario is less than the target risk level of 1.0×10^{-5} only at 1,000 years. Additionally, the ELCR under this scenario is within or less than the CERCLA target risk range of 1×10^{-6} to 1×10^{-4} only for years 467 through 1,000. The primary contributor to total dose and risk is Cs-137. The results of this evaluation are provided in the RI Report.

216-B-57 Crib (Representative Site). The maximum total dose rate at the 216-B-57 Crib is 26.1 mrem/yr at year 0. The maximum ELCR is 4.4×10^{-4} at year 0. The ELCR under this exposure scenario is never less than the target risk level of 1.0×10^{-5}. Additionally, the ELCR under this scenario is within or less than the CERCLA target risk range of 1×10^{-6} to 1×10^{-4} only for 100 years or greater. The primary contributor to total dose and risk is Cs-137 for the first 100 years and Ra-226 after that. The results of this evaluation are provided in the RI Report.

216-B-43 Crib (Analogous Site). The maximum total dose rate at the 216-B-43 Crib is 3.85 mrem/yr at year 0. The maximum ELCR is 7.7×10^{-5} at year 0. The ELCR under this exposure scenario is never less than the target risk level of 1.0×10^{-5}. Additionally, the ELCR under this scenario is within or less than the CERCLA target risk range of 1×10^{-6} to 1×10^{-4} for all times analyzed. The primary contributors to total dose and risk are Cs-137 and Ra-226. The results of this evaluation are provided in Appendix C, Tables C-49 and C-50.

216-B-44 Crib (Analogous Site). The maximum total dose rate at the 216-B-44 Crib is 4.58 mrem/yr at year 0. The maximum ELCR is 9.0×10^{-5} at years 0 and 1. The ELCR under this exposure scenario is never less than the target risk level of 1.0×10^{-5}. Additionally, the ELCR under this scenario is within or less than the CERCLA target risk range of 1×10^{-6} to 1×10^{-4} for all times analyzed. The primary contributors to total dose and risk are Cs-137 and Ra-226. The results of this evaluation are provided in Appendix C, Tables C-49 and C-50.

216-B-45 Crib (Analogous Site). The maximum total dose rate at the 216-B-45 Crib is 3.11 mrem/yr at year 0. The maximum ELCR is 6.1×10^{-5} at year 0. The ELCR under this exposure scenario is never less than the target risk level of 1.0×10^{-5}. Additionally, the ELCR under this scenario is within or less than the CERCLA target risk range of 1×10^{-6} to 1×10^{-4} for all times analyzed. The primary contributors to total dose and risk are Cs-137 and Ra-226. The results of this evaluation are provided in Appendix C, Tables C-49 and C-50.

216-B-47 Crib (Analogous Site). The maximum total dose rate at the 216-B-47 Crib is 51.2 mrem/yr at year 0. The maximum ELCR is 9.6×10^{-4} at year 0. The ELCR under this exposure scenario is never less than the target risk level of 1.0×10^{-5}. Additionally, the ELCR under this scenario is never within or less than the CERCLA target risk range of 1×10^{-6} to 1×10^{-4}. The primary contributors to total dose and risk are Cs-137 and Ra-226. The results of this evaluation are provided in Appendix C, Tables C-49 and C-50.

216-B-48 Crib (Analogous Site). The maximum total dose rate at the 216-B-48 Crib is 4.68 mrem/yr at year 0. The maximum ELCR is 9.5×10^{-5} at year 0. The ELCR under this exposure scenario is never less than the target risk level of 1.0×10^{-5}. Additionally, the ELCR under this scenario is within or less than the CERCLA target risk range of 1×10^{-6} to 1×10^{-4} for all times analyzed. The primary contributors to total dose and risk are Cs-137 and Ra-226. The results of this evaluation are provided in Appendix C, Tables C-49 and C-50.

216-B-49 Crib (Analogous Site). The maximum total dose rate at the 216-B-49 Crib is 0.921 mrem/yr at year 0. The maximum ELCR is 1.5×10^{-5} at year 0. The ELCR under this exposure scenario is less than the target risk level of 1.0×10^{-5} for years 50 through 1,000. Additionally, the ELCR under this scenario is within or less than the CERCLA target risk range of 1×10^{-6} to 1×10^{-4} for all times analyzed. The primary contributor to total dose and risk is Cs-137. The results of this evaluation are provided in Appendix C, Tables C-49 and C-50.

216-B-50 Crib (Analogous Site). The maximum total dose rate at the 216-B-50 Crib is 4.37 mrem/yr at year 0. The maximum ELCR is 8.5×10^{-5} at year 0. The ELCR under this exposure scenario is never less than the target risk level of 1.0×10^{-5}. Additionally, the ELCR under this scenario is within or less than the CERCLA target risk range of 1×10^{-6} to 1×10^{-4} for all times analyzed. The primary contributors to total dose and risk are Cs-137 and Ra-226. The results of this evaluation are provided in Appendix C, Tables C-49 and C-50.

216-B-26 Trench (Analogous Site). The maximum total dose rate at the 216-B-26 Trench is 310,000 mrem/yr at year 0 and decreasing thereafter. The maximum ELCR is 4.3 at year 0. The ELCR under this exposure scenario exceeds the target risk-level of 10×10^{-5} until year 1,000. The primary contributors to total dose and risk are Cs-137 and Pu-239. The results of this evaluation are provided in Appendix C, Tables C-49 and C-50.

Deep Zone[4] – Groundwater Protection (RESRAD Modeling)

Of the five representative sites modeled for groundwater protection (DOE/RL-2002-42), the 216-B-46 Crib and the 216-T-26 Crib did not indicate any dose to groundwater during the 1,000 years of the analysis. The other three representative sites, the 216-B-7A Crib, the 216-B-38 Trench, and the 216-B-58 Trench indicated low doses (within the drinking water standard) from contamination by Tc-99 and tritium. The 216-B-57 Crib site was not modeled, because it was extensively evaluated in the 200-BP-1 OU RI/FS (DOE/RL-88-32). The 216-B-5 Reverse Well site was not modeled, because the groundwater was already contaminated by direct injection. Seven analogous sites indicated small doses from groundwater from 50 to 1,000 years, primarily from Tc-99 and Pu-238. The 216-B-26 Trench exceeded the drinking water standard.

For two of the three modeled representative sites with groundwater contamination, the doses are less than the target dose level of 4 mrem/yr, and the ELCR is less than or equal to the target risk level of 1.0×10^{-6} at all exposure times evaluated. The results of this evaluation are provided in the RI Report. The groundwater doses and risks for the 216-B-58 Trench are presented in Table 2-10. As indicated in the table, the dose at 66 years reaches 1.7 mrem/yr with an ELCR slightly less than 1.0×10^{-5}. For the eight analogous sites, only one had a dose rate exceeding the 4 mrem/yr target. The 216-B-26 Trench indicated a dose at 68 years of 360 mrem/yr; however, the contamination quickly dissipated. The evaluation results for analogous sites are provided in Appendix C, Tables C-53 and C-54.

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[4] Deep zone soils are defined as those collected from the soil surface to the groundwater table.

Deep Zone – Groundwater Protection (STOMP Modeling)

Vadose zone contaminant fate and transport modeling was conducted in the RI using PNNL-12034, *STOMP, Subsurface Transport Over Multiple Phases, Version 2.0, User's Guide.* Modeling was performed for the 216-B-38 Trench, the 214-B-46 Crib, the 216-T-26 Crib, and the 216-B-7A Crib. The 216-B-57 Crib site was not modeled because it was extensively evaluated in the 200-BP-1 OU RI/FS (DOE/RL-88-32). The 216-B-5 Reverse Well site was not modeled because the groundwater was already contaminated by direct injection. The 216-B-58 Trench was not modeled because it was added to this OU after the subsurface transport over multiple phases (STOMP) modeling had been performed.

The results of the modeling indicate that the moderately mobile contaminants (cyanide, Co-60, nitrate, nitrite, sulfate, Tc-99, and uranium isotopes) already observed in the groundwater are expected to continue to impact groundwater. The modeling indicates that certain of the other long-lived contaminants (Pu-239 and Ra-226) also may reach the groundwater at concentrations exceeding their MCLs in the future.

2.7.2 Ecological Risk Assessment

For the ecological risk assessment (ERA), the eight-step ERA process developed for the Superfund program in EPA/540/R-97/006, *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments (Interim Final)*, was followed (see Appendix C). The process starts with a screening-level ERA (SLERA), which uses conservative screening values provided by Ecology (WAC-173-340-900, "Tables," Table 749-3) for nonradionuclides and by the Biota Dose Assessment Committee (BDAC) in DOE-STD-1153-2002, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota*, for radionuclides. This corresponds to Steps 1 and 2 of the EPA guidance (EPA/540/R-97/006). The SLERA process followed is as described in DOE/RL-2001-54 and is further outlined in Appendix C. The SLERA intentionally is conservative and serves to eliminate analytes and sites from further evaluation that do not pose a risk to the environment despite the SLERA's bias toward overestimating risk. The SLERA is used to determine whether further evaluation (i.e., baseline ERA) or remedial actions are necessary. The results of the screening are presented separately in the following subsections for nonradionuclides and radionuclides.

2.7.2.1 Results of the Screening-Level Ecological Risk Assessment – Nonradionuclides

For each of the representative sites, exposure point concentrations for each nonradionuclide constituent were screened against the wildlife screening values presented in WAC 173-340-900, Table 749-3, to determine if any chemical concentrations exceeded their respective screening values. For the representative sites, the 216-B-58 Trench exceeded a wildlife screening value for Aroclor-1254 (see Table 2-5). Similarly, for the analogous sites with data, the 216-B-26 Trench exceeded the terrestrial wildlife screening values for manganese (see Appendix C). The other representative sites and analogous sites with data did not exceed wildlife screening values.

2.7.2.2 Results of the Screening-Level Ecological Risk Assessment – Radionuclides

The 216-B-38 Trench, the 216-B-7A Crib, the 216-B-57 Crib, and the 216-B-58 Trench had concentrations of Cs-137 and Sr-90 in the 0 to 4.6 m (0 to 15-ft) bgs zone that exceeded the biota concentration guides (BCG) (DOE-STD-1153-2002) for these constituents. Of the analogous sites evaluated, only 216-B-26 Trench had concentrations in this zone above the BCGs. Concentrations of Cs-137 and Sr-90 exceeded their respective BCGs at the 216-B-26 Trench. The results of the ecological screening for the representative sites are presented in DOE/RL-2002-42, except for the 216-B-58 Trench, which is shown in Appendix C. The results of the ecological screening for the analogous sites with data are presented in Appendix C.

2.7.3 Intruder Risk Assessment

Inadvertent intruder scenarios are based on the possibility that an individual unwittingly (through human error or loss of knowledge concerning the location of contaminants) engages in an activity that results in contact with wastes left in place. After a period of 50 years, all DOE operations are assumed to have ceased; however, public entry to the site will be restricted for an additional 100 years by enforcement of institutional controls. For purposes of evaluating risk, an intruder has an assumed ability to obtain access to the waste site areas. Of the three intruder scenarios proposed for evaluation (see Appendix E for additional details on the intruder risk assessment), the third is considered to be the worst-case scenario because exposure time would be the greatest. Therefore, the third scenario is the focus of the analysis presented in this FS and is assumed to bound scenarios 1 and 2:

1. Future Construction Trench Worker Intruder Scenario
2. Future Well Driller Intruder Scenario (drill cuttings)
3. Future Rural Residential Intruder Scenario (drill cuttings).

The rural residential intruder scenario is based on the resident utilizing drill cuttings from a well drilled through the waste site to augment garden plot soil. Table 2-8 summarizes the future rural residential intruder scenario for the representative and analogous waste sites with data. This table shows that almost all these sites are predicted to have unacceptable dose and risk (i.e., greater than 15 mrem/yr and an ELCR of greater than 1×10^{-4}). The 216-B-58 Trench actually meets the dose goal but slightly exceeds the risk goal at 150 yr for the intruder.

2.7.4 Representative and Analogous Waste Sites Risk Assessment Synopsis

Table 2-5 summarizes the risks at the representative sites, based on the HHRA and SLERA found in the RI Report (DOE/RL-2002-42) and for the 216-B-58 Trench, in Appendix C of this FS. Table 2-6 summarizes the risks at the analogous sites with characterization data based on the risk assessment in Appendix C. Tables 2-9 and 2-10 summarize the timeframes to reach human health and ecological preliminary remediation goals (PRG) (PRGs are discussed in Chapter 3.0; comparisons to risk-based standards [which become PRGs in Chapter 3.0] are performed in the RI Report and in Appendix C) through natural radioactive decay at each representative site. The tables supports the determination of appropriate alternatives to be evaluated for each representative site and its associated analogous waste sites.

2.7.4.1 Application to the 216-B-46 Crib and Its Analogous Waste Sites

Risks associated with 216-B-46 Crib were evaluated in the RI Report. The bottom of the waste site was identified at 5.5 m (18 ft). Only minor contamination was located in the shallow zone. However, significant concentrations of Cs-137 and Sr-90 are located in the zone from 5.5 to 9.6 m (18 to 31.5 ft); approximately 410 yr would be required for these contaminants to decay below PRGs. As shown in Table 2-5, the following are applicable to vadose contamination at the 216-B-46 Crib.

- With respect to radiological contaminants in the 0 to 4.6 m (0 to 15-ft) zone, human health is protected, because dose does not exceed the PRGs (15 mrem/yr).
- With respect to nonradionuclides, human health is protected, because no contaminant concentrations in this zone exceed WAC 173-340-745 risk-based standards.
- Groundwater is not protected, because antimony, cadmium, cyanide, nitrate, total *uranium, Co-60, Ra-226, Tc-99, and U-238 are predicted to reach the groundwater above* MCLs, either through modeling or through comparison to groundwater protection standards.
- Ecological receptors are protected, because contaminant concentrations are below screening levels.
- With respect to intruders to the waste site past the 150-yr institutional control period, human health is not protected, because significant concentrations of contamination would remain in the 5.5 to 9.6 m (18 to 31.5-ft) bgs zone for up to 410 yr.

The analogous waste sites that have sufficient characterization data (216-B-43, 216-B-44, 216-B-45, 216-B-47, 216-B-48, 216-B-49, and 216-B-50 Cribs) are included in the discussion above based on location, similar construction, receipt of the same waste stream at the same timeframe, the same cover materials, and similar depth of cover. The risks from these analogous sites are summarized in Table 2-6.

2.7.4.2 Application to the 216-T-26 Crib and Its Analogous Waste Site

Neither radiological nor nonradiological contaminants were encountered in the shallow zone above background at the 216-T-26 Crib. The bottom of the waste site was identified at 5.5 m (18 ft). Significant concentrations of Cs-137 and Sr-90 are located in the zone from 5.5 to 11 m (18 to 36.5 ft); approximately 330 yr would be required for these contaminants to decay below PRGs. As shown in Table 2-5, the following are applicable to vadose contamination at the 216-T-26 Crib.

- With respect to radiological contaminants in the 0 to 4.6 m (0 to 15-ft) zone, human health is protected, because contaminants in this zone were below background.
- With respect to nonradionuclides, human health is protected, because no contaminant concentrations in this zone exceed WAC 173-340-745 risk-based standards.

- Groundwater is not protected, because antimony, cadmium, cyanide, nitrate, total uranium, Co-60, Ra-226, Tc-99, and U-238 are predicted to reach the groundwater above MCLs, either through modeling or through comparison to groundwater protection standards.

- Ecological receptors are protected, because contaminant concentrations are below screening levels.

- With respect to intruders to the waste site past the 150-yr institutional control period, human health is not protected, because significant concentrations of contamination would remain in the 5.5 to 11 m (18 to 36.5-ft) zone for up to 330 yr.

2.7.4.3 Application to the 216-B-38 Trench and Its Analogous Waste Sites

Risks associated with the 216-B-38 Trench were evaluated in the RI Report (DOE/RL-2002-42) for two conditions: (1) assuming no clean cover or cap (worst case assuming the maximum contamination in the 0 to 4.6 m [0 to 15-ft] zone) and (2) assuming a 3 m (10-ft) clean cover, which is representative of actual site conditions. The bottom of the waste site was identified at 4.4 m (14.5 ft) through sampling; however, the geophysical logging results indicated that the contamination may start a little higher (BHI-01607). The 3 m (10-ft) cover was assumed as a conservative assumption. Significant concentrations of Cs-137 are located in the zone from 4.4 to 15 m (14.5 to 50 ft) bgs; approximately 400 yr would be required for these contaminants to decay below PRGs. As shown in Table 2-5, the following are applicable to vadose contamination at the 216-B-38 Trench.

- With respect to radiological contaminants in the 0 to 4.6 m (0 to 15-ft) bgs zone, human health is not protected for the worst case assumption of no existing cover, because a 128,000 mrem/yr dose under an industrial scenario is associated with contaminants in this zone. This dose is reduced to negligible levels under the existing conditions of a 3 m (10-ft) soil cap; however, the longevity of the contaminants would exceed the 150-yr institutional controls period. Therefore, for radiological contaminants, human health is not protected at this site under existing conditions.

- With respect to nonradionuclides, human health is protected, because no contaminant concentrations in this zone exceed WAC 173-340-745 risk-based standards.

- Groundwater is not protected, because nitrate, nitrite, total uranium, Tc-99, U-233/234, and U-238 are predicted to reach the groundwater above MCLs, either through modeling or by comparison to groundwater protection standards.

- Ecological receptors are not protected, because Cs-137 and Sr-90 concentrations exceed screening levels in the 0 to 4.6 m (0 to 15-ft) zone.

- With respect to intruders to the waste site past the 150-yr institutional control period, human health is not protected, because significant concentrations of contamination would remain in the 4.4 to 15 m (14.5 to 50-ft) zone for up to 400 yr.

2.7.4.4 Application to the 216-B-7A Crib and Its Analogous Waste Sites

Risks associated with the 216-B-7A Crib were evaluated for two conditions: (1) assuming no clean cover or cap (worst case assuming the maximum contamination in the 0 to 4.6 m [0 to 15-ft] bgs zone) and (2) assuming a 0.3 m (1-ft) clean cover, which is representative of actual site conditions. The bottom of the waste site was identified at 5.6 m (18.5 ft) through sampling; however, slightly contaminated materials from an unplanned release were consolidated over the 216-B-7A and 216-B-7B Cribs before stabilization. The 0.3 m (1-ft) cover is consistent with the first indication of contamination from the logging. Significant concentrations of Cs-137, Sr-90, and Pu-239/240 are located in the zone from 5.6 to 13.7 m (18.5 to 45 ft); up to 380 yr would be required for the Cs-137 and Sr-90 concentrations to decay below PRGs. The Pu-239/240 would remain in the soils for thousands of years. As shown in Table 2-5, the following are applicable to vadose contamination at the 216-B-7A Crib.

- With respect to radiological contaminants in the 0 to 4.6 m (0 to 15-ft) zone, human health is protected for the worst case assumption of no existing cover, because the maximum dose is 15 mrem/yr under an industrial scenario. This dose is reduced to negligible levels under the existing conditions of a 0.3 m (1-ft) soil cap.
- With respect to nonradionuclides, human health is protected, because no contaminant concentrations in this zone exceed WAC 173-340-745 risk-based standards.
- Groundwater is not protected, because cyanide, fluoride, nitrate, Sr-90, Tc-99, U-233/234, and U-238 are predicted to reach the groundwater above MCLs, either through modeling or by comparison to groundwater protection standards.
- Ecological receptors are not protected, because Cs-137 and Sr-90 concentrations exceed screening levels in the 0 to 4.6 m (0 to 15-ft) zone.
- With respect to intruders to the waste site past the 150-yr institutional control period, human health is not protected, because significant concentrations of contamination would remain in the 5.6 to 13.7 m (18.5 to 45-ft) zone for thousands of years.

2.7.4.5 Application to the 216-B-5 Injection/Reverse Well and Its Analogous Waste Sites

Samples were not collected in the shallow zone at the 216-B-5 Reverse Well, because contaminants were injected directly into the deep zone near the water table. As shown in Table 2-5, the following are applicable to vadose contamination at the 216-B-5 Injection/Reverse Well.

- With respect to radiological and nonradiological contaminants in the 0 to 4.6 m (0 to 15-ft) zone, human health and ecological receptors are protected because no contaminants are present in this zone.
- Groundwater may not be protected, because contaminants are located just above the groundwater table and may continue to impact groundwater in the area. However, the contaminants of concern at this site (Cs-137, Sr-90, and Pu-239/240) tend to be highly immobile.

2.7.4.6 Application to the 216-B-57 Crib and Its Analogous Waste Sites

Risks associated with 216-B-57 Crib were evaluated in the RI Report (DOE/RL-2002-42). The bottom of the waste site was identified at 4.6 m (15 ft). Only minor contamination was located in the shallow zone. However, more significant concentrations of Cs-137 are located in the zone from 4.6 to 10.4 m (15 to 34 ft); approximately 330 yr would be required for this contaminant to decay below PRGs. A 7.9 m (26-ft) thick Hanford Barrier has been constructed over the crib as a treatability test. As shown in Table 2-5, the following is applicable to vadose contamination at the 216-B-57 Crib.

- With respect to radiological contaminants in the 0 to 4.6 m (0 to 15-ft) zone, human health is not protected for the worst case assumption of no existing cover, because the maximum dose is 26.1 mrem/yr under an industrial scenario. This dose is reduced to negligible levels under the existing conditions of a 7.9 m (26-ft) thick barrier.

- With respect to nonradionuclides, human health is protected, because no contaminant concentrations in this zone exceed WAC 173-340-745 risk-based standards.

- Groundwater is not protected under the worst case scenario, because cadmium, nitrate, and Tc-99 are predicted to reach the groundwater above MCLs. However, the Hanford Barrier reduces the infiltration to the vadose zone, thereby significantly reducing the driving force that would mobilize contaminants to the groundwater (CP-14873, *200-BP-1 Prototype Hanford Barrier Annual Monitoring Report for Fiscal Year 2002)*. In the current site configuration, groundwater is protected.

- Ecological receptors are not protected in the worst case scenario, because concentrations of Cs-137 and Sr-90 exceed screening levels in the 0 to 4.6 m (0 to 15-ft) zone. However, in the current site configuration (with the barrier), ecological receptors are protected because the design prevents bio-intrusion.

- With respect to intruders to the waste site past the 150-yr institutional control period, human health is not protected if the Hanford Barrier is not considered, because significant concentrations of contamination would remain in the 9.1 to 10.4 m (30 to 34-ft) zone for up to 330 yr. The Hanford Barrier provides intrusion deterrents through the different layers used to construct the barrier.

2.7.4.7 Application to the 216-B-58 Crib and Its Analogous Waste Sites

Risks associated with the 216-B-58 Crib are evaluated in this FS (Appendix C). Significant contamination was located in shallow-zone soils consisting of primarily Cs-137 and Sr-90 within the 4.1 to 4.9 m (13.5 to 16 ft) bgs. Over 287 yr would be required for the shallow-zone contamination to decay below PRGs. As shown in Table 2-5, the following are applicable to vadose zone contamination at the 216-B-58 Crib.

- With respect to radiological contaminants in the 0 to 4.6 m (0 to 15-ft) zone, human health is not protected for the worst case assumption of no existing cover because the maximum dose is 13,000 mrem/yr under an industrial scenario. This dose is reduced to negligible levels under the existing conditions of a 3.1-m (10-ft) thick barrier.

- With respect to nonradionuclides, human health is protected, because no contaminant concentrations in this zone exceed WAC 173-340-745 risk-based standards.
- RESRAD modeling indicates that radionuclides would not adversely impact groundwater in the future.
- Groundwater is not protected, because nitrate and selenium are predicted to reach the groundwater above MCLs, based on comparison to groundwater protection standards.
- With respect to ecological protection, concentrations of Aroclor-1254, selenium, Co-60, Cs-137, and Sr-90 exceed ecological screening criteria.
- With respect to intruders to the waste site past the 150-yr institutional control period, human health is not protected because the risk level slightly exceeds 1×10^{-4} at 150 yr for an intruder. Dose at 150 yr is at acceptable levels.

Figure 2-1a. Major Processes and Waste Sites of the 200-TW-1, 200-TW-2, and 200-PW-5 Operable Units.

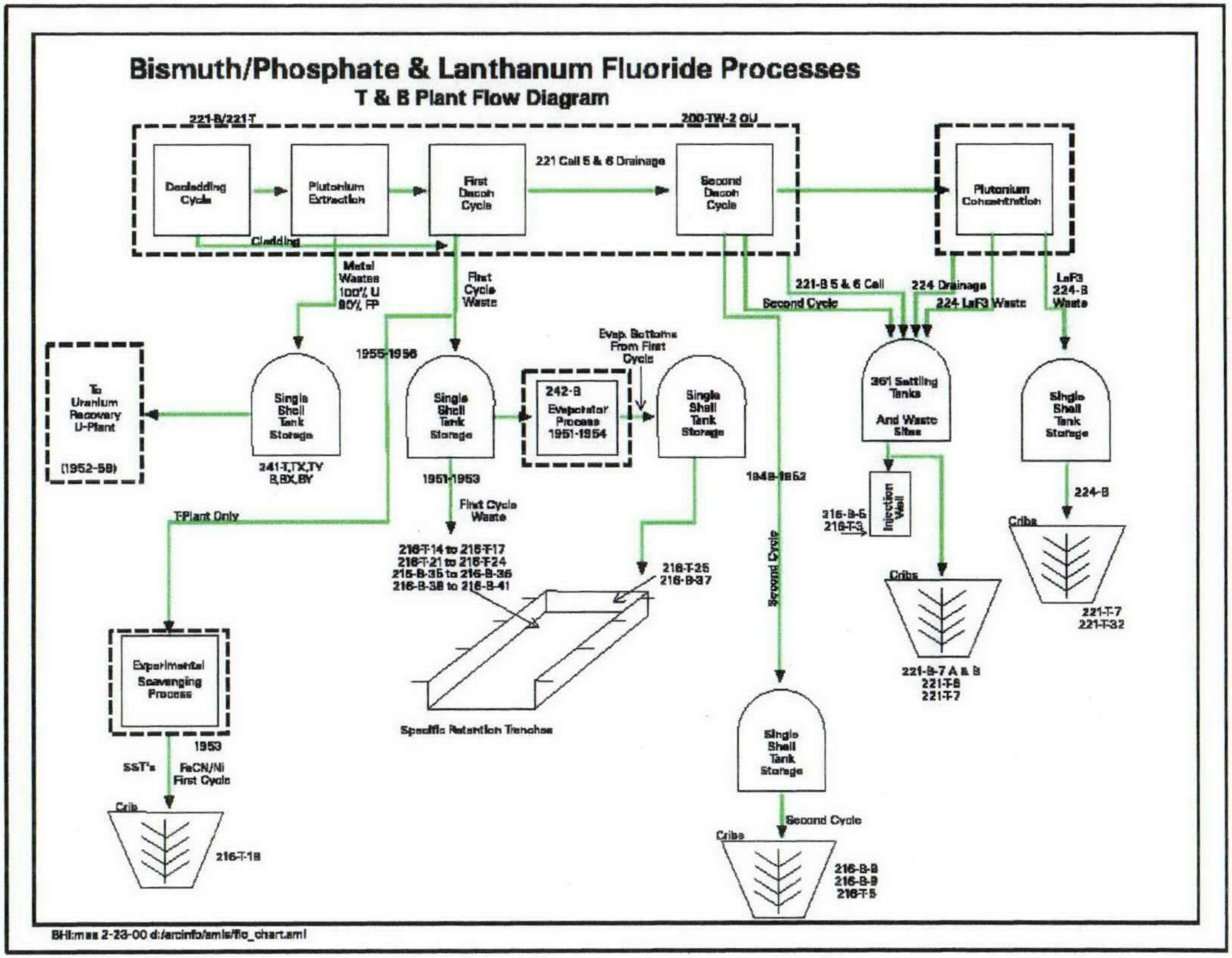
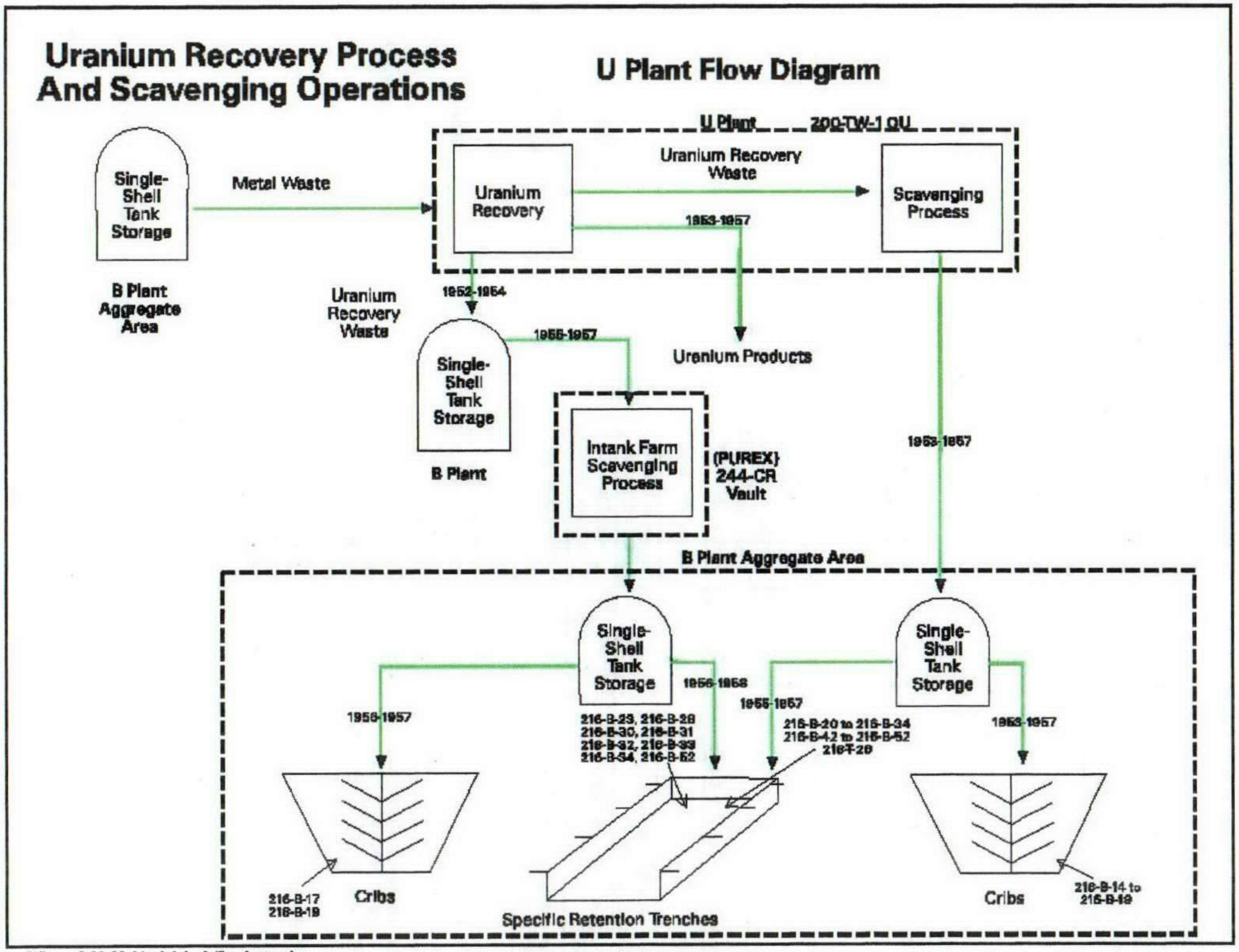


Figure 2-1b. Major Processes and Waste Sites of the 200-TW-1, 200-TW-2, and 200-PW-5 Operable Units.



BHI:maa 2-23-00 dt/srcinfo/amls/flo_chart.aml

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

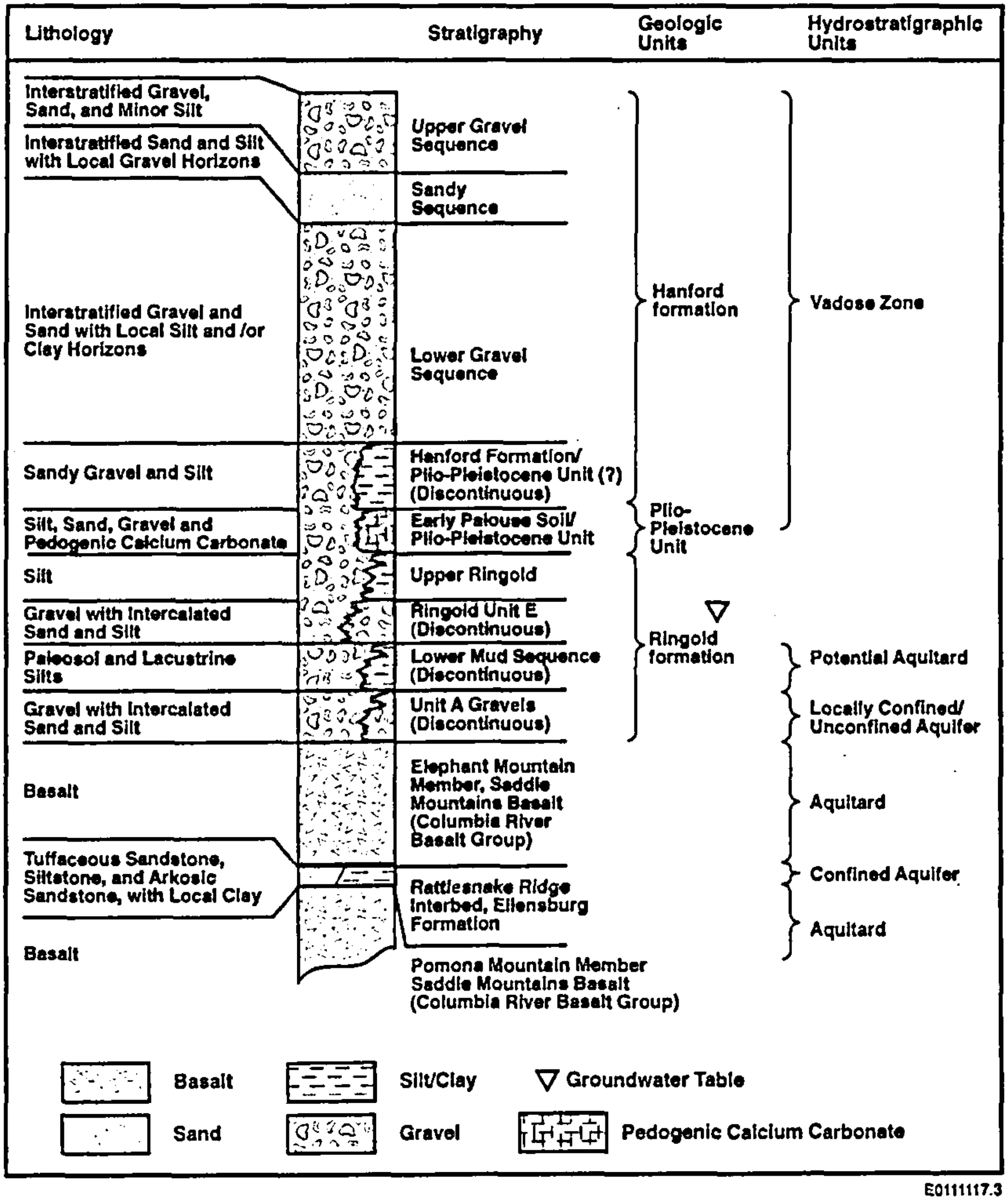


Figure 2-3. Cross-Section Location Map for the 200-TW-1 Operable Unit Representative Site in the 200 West Area.

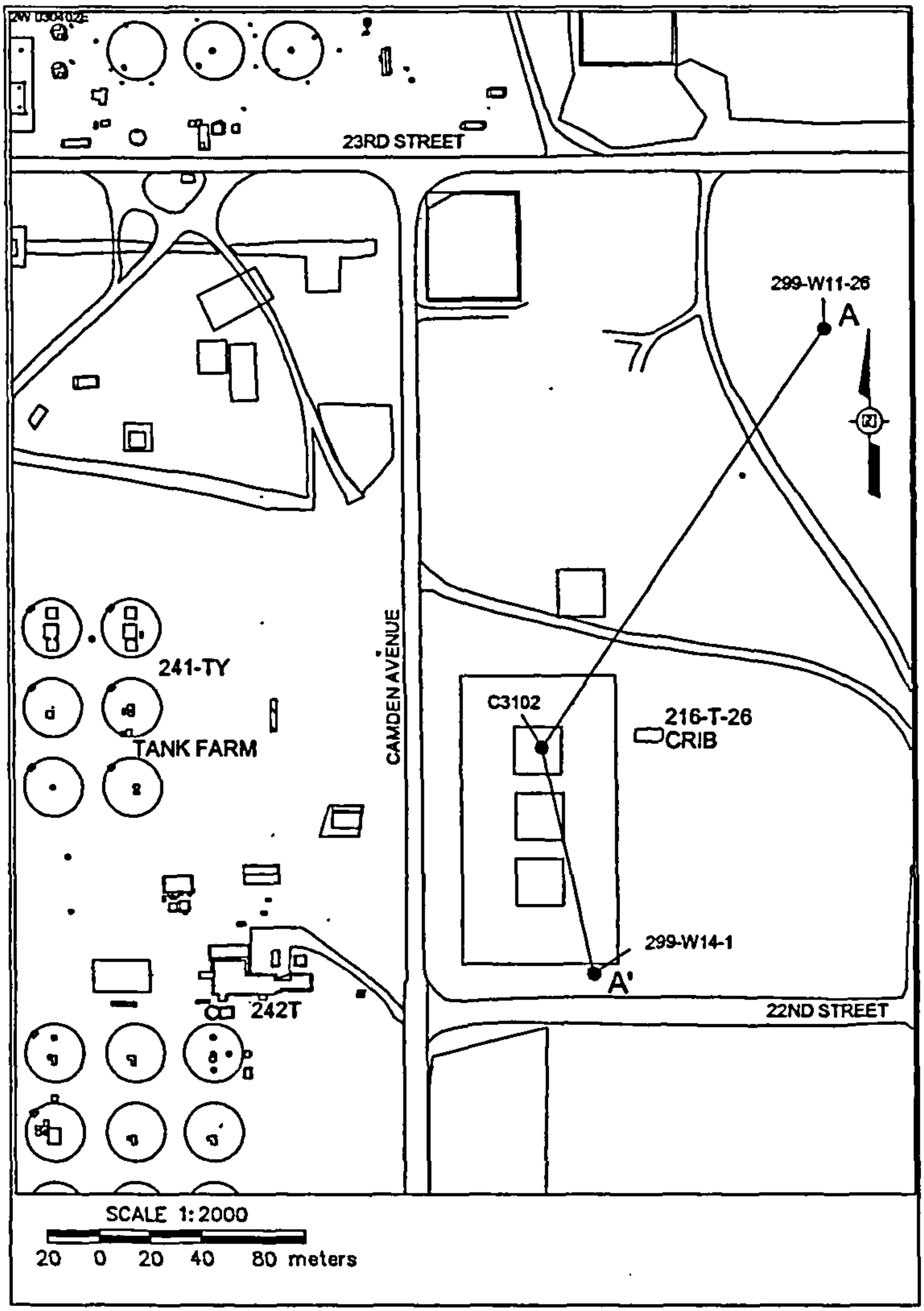


Figure 2-4. Cross-Section Location Map for 200-TW-1, 200-TW-2, and 200-PW-5 Operable Unit Representative Sites in 200 East Area.

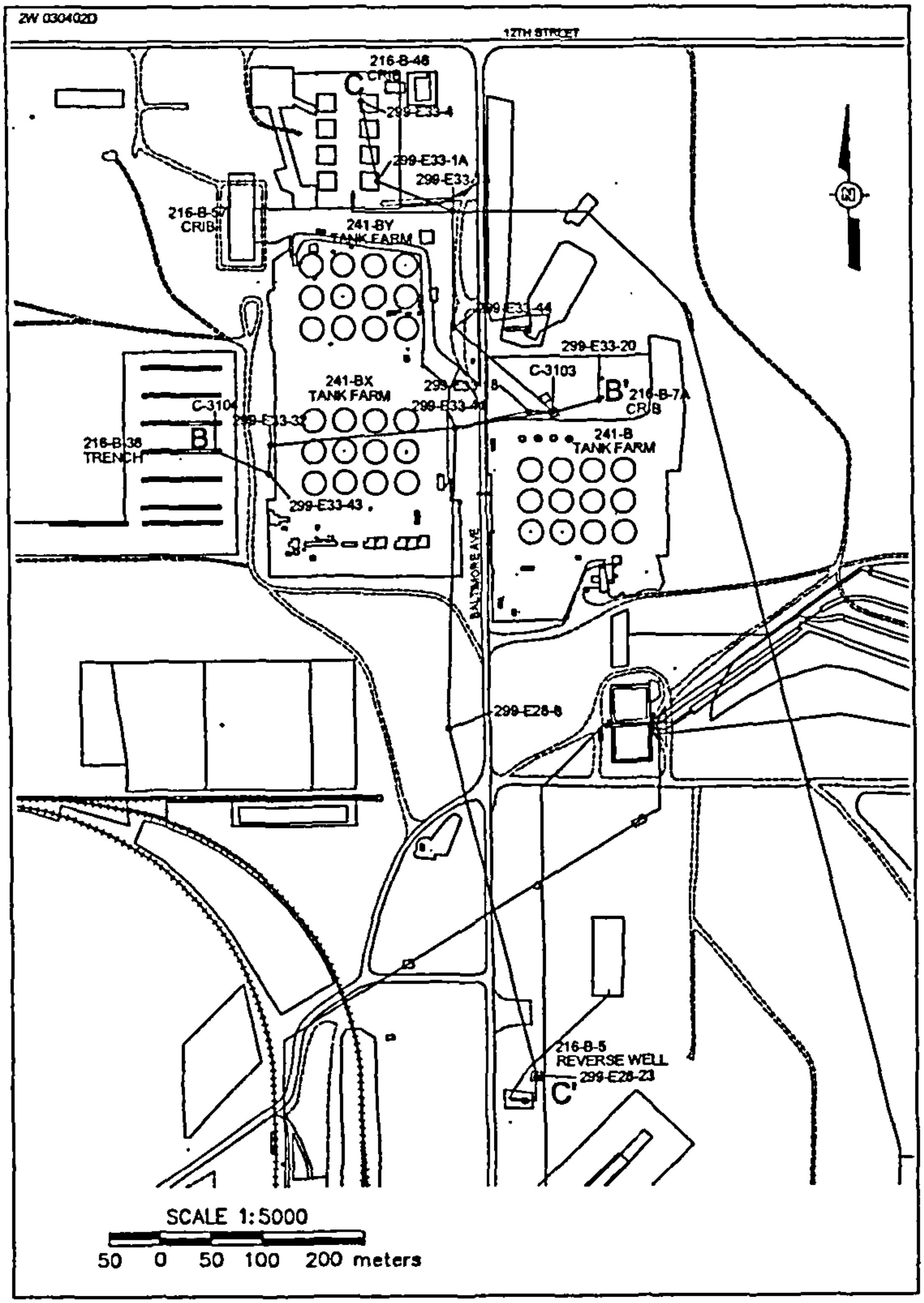


Figure 2-5. North-South Geologic Cross Section through the 216-T-26 Crib.

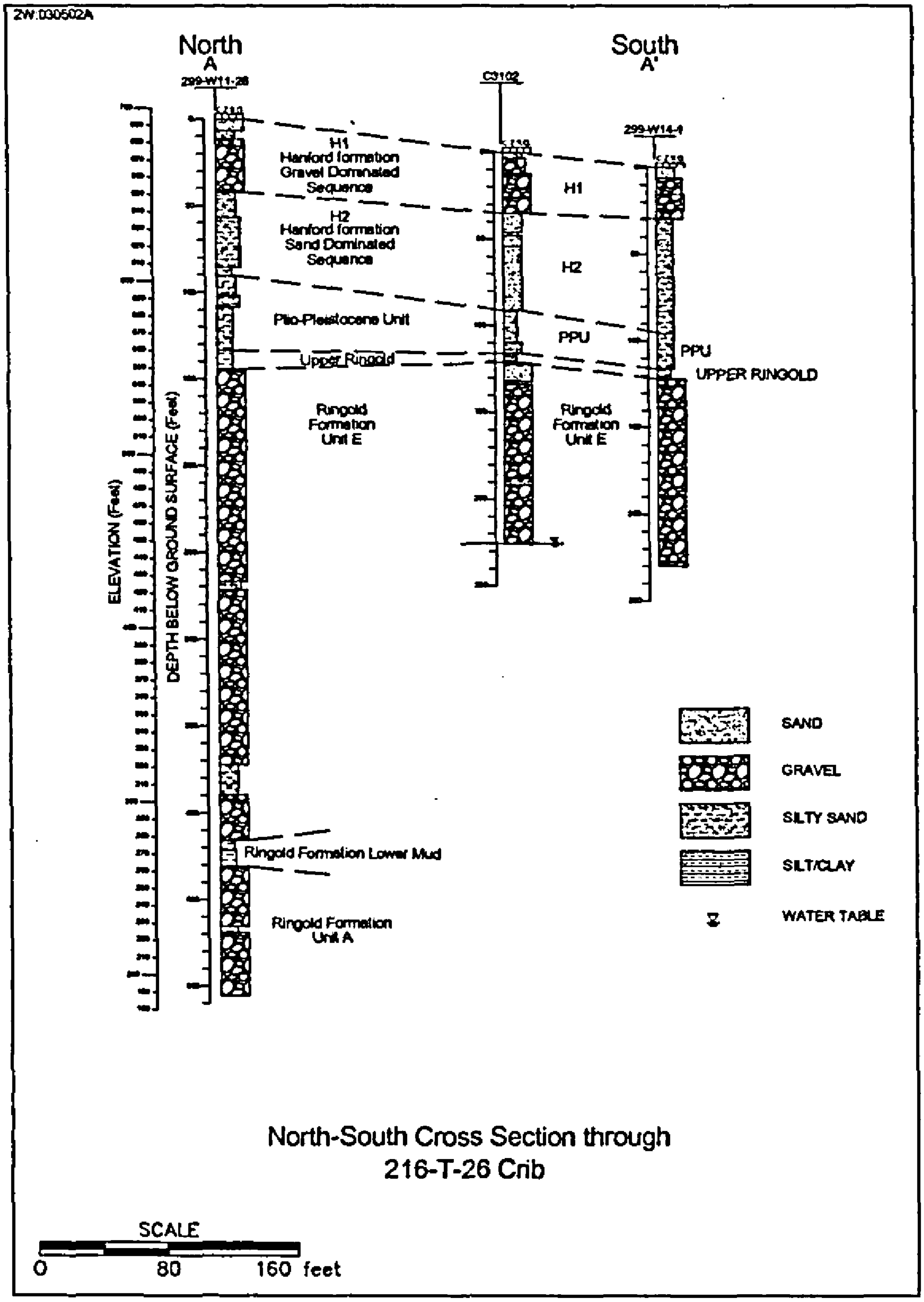


Figure 2-6. North-South Geologic Cross Section from the 216-B-46 Crib to the 216-B-5 Reverse Well.

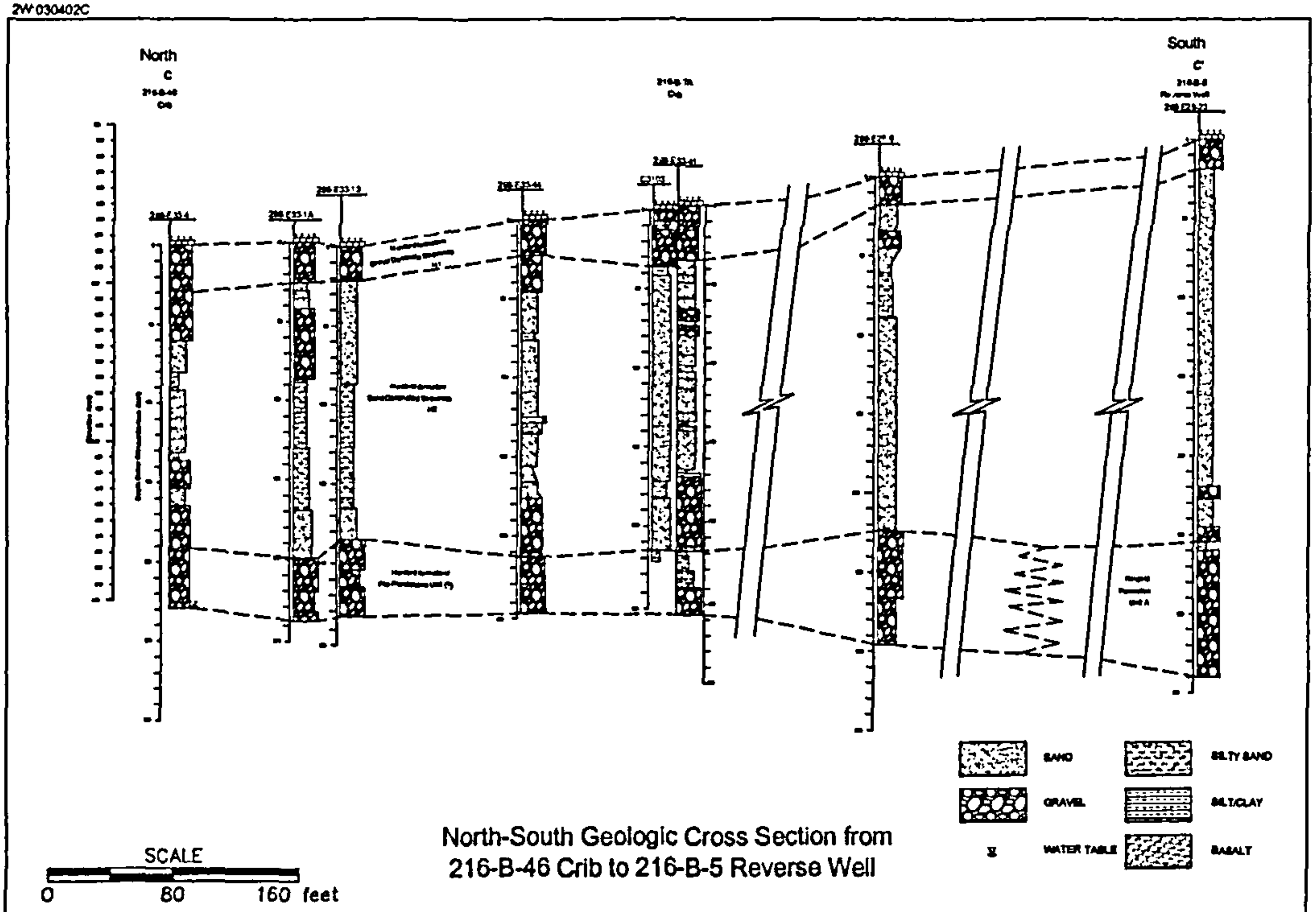


Figure 2-7. West-East Geologic Cross Section Through the 216-B-38 Trench to the 216-B-7A Crib.

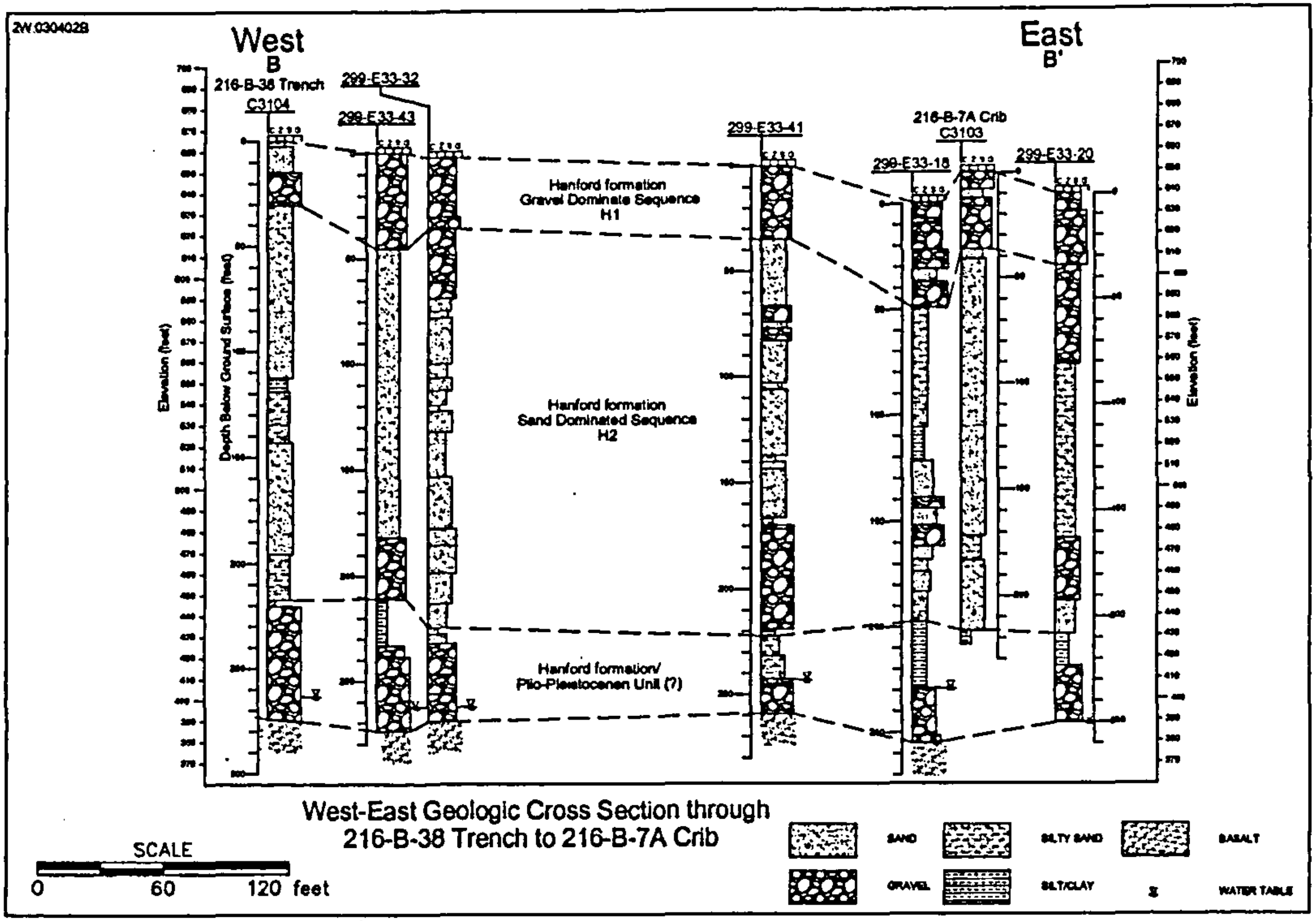


Figure 2-8. 216-T-26 and 216-B-46 Cribs Construction Diagram.

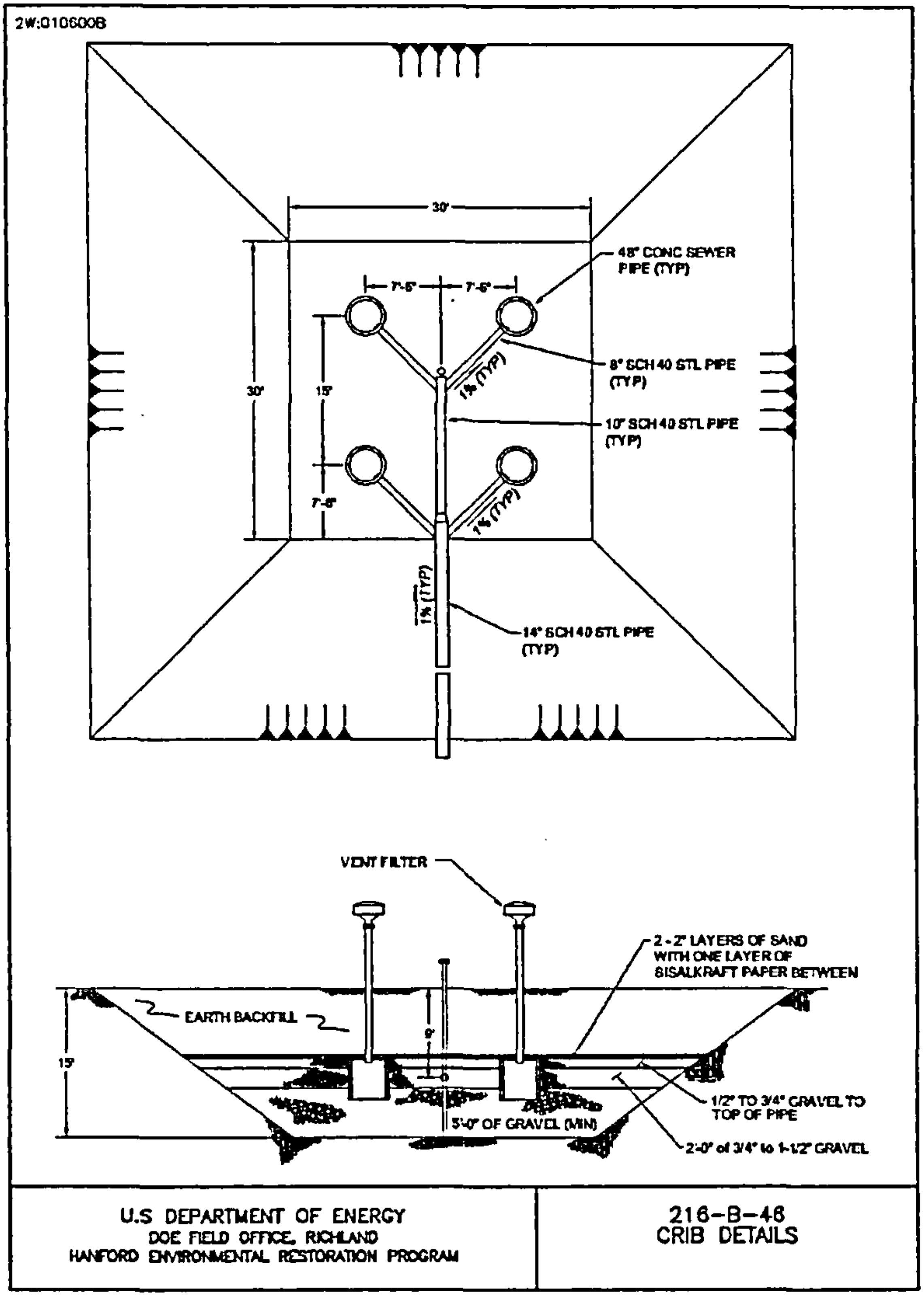


Figure 2-9. 216-B-7A Crib Construction Diagram.

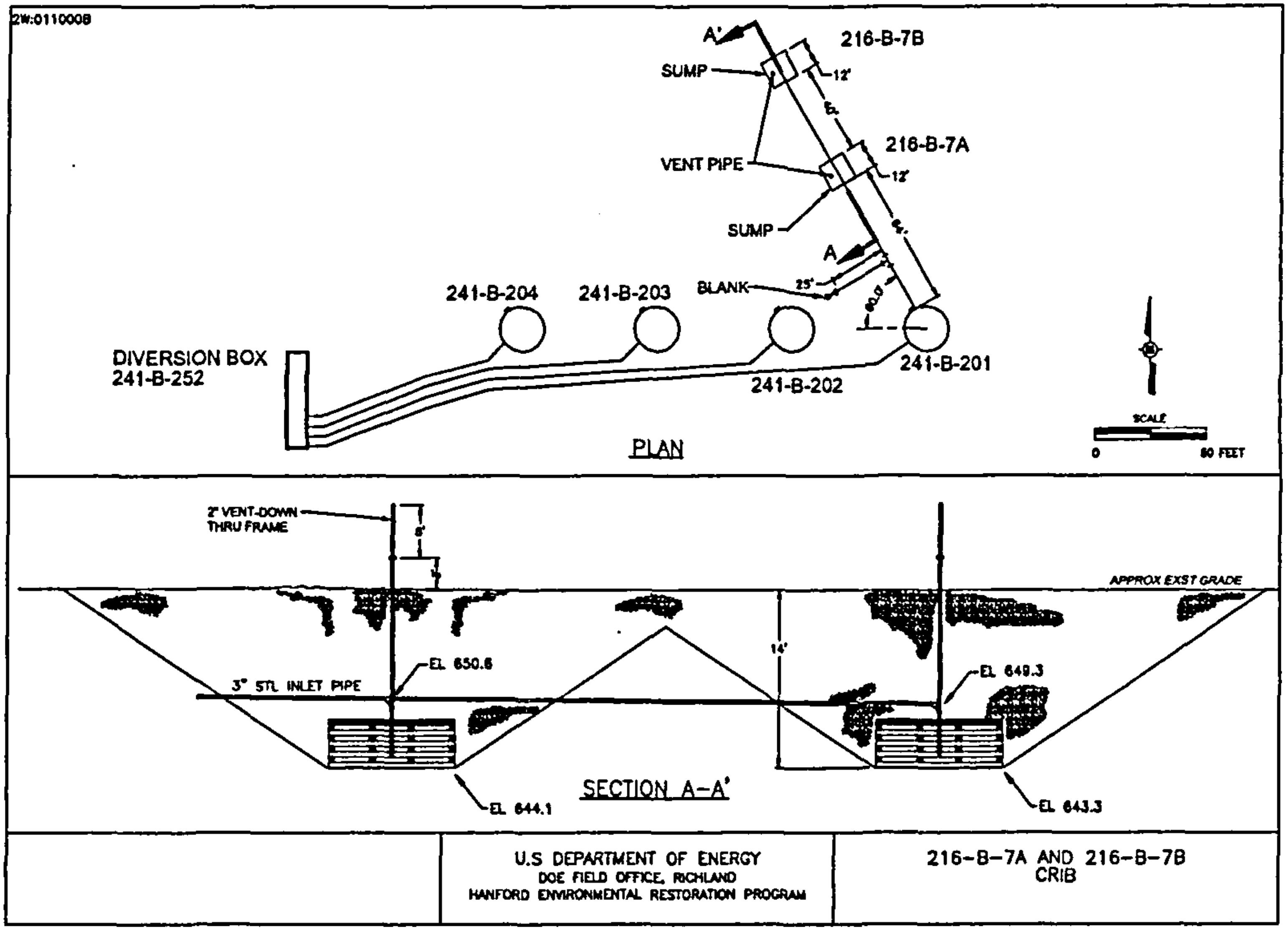


Figure 2-10. 216-T-26 Crib Contaminant Distribution Model of Contaminants of Potential Concern.

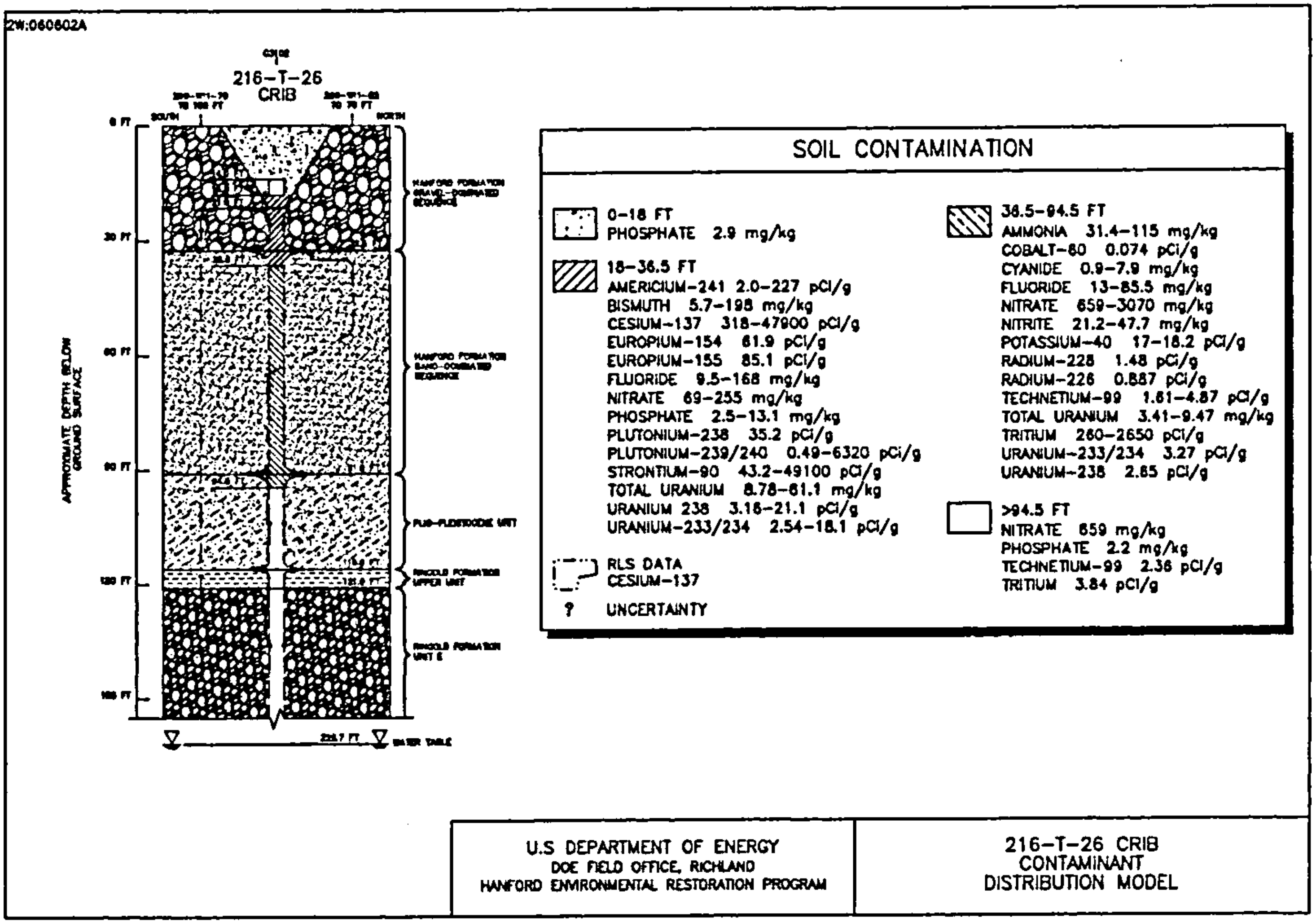


Figure 2-11. 216-B-46 Crib Contaminant Distribution Model of Contaminants of Potential Concern.

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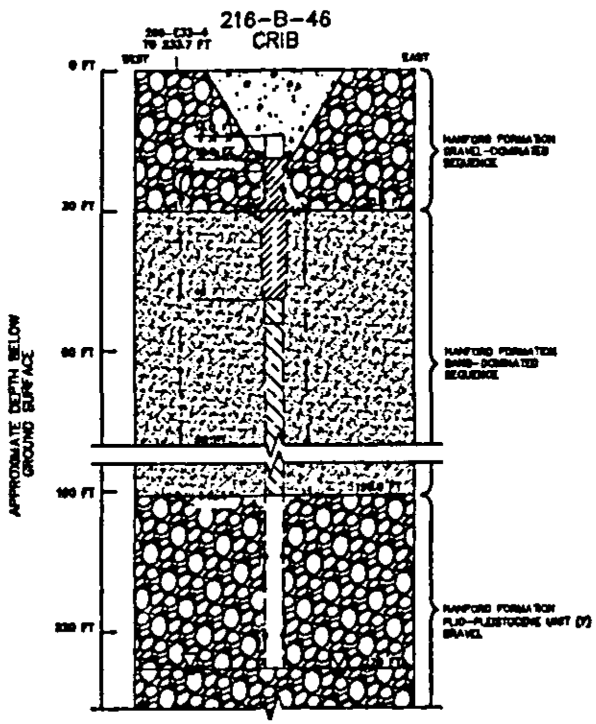


SOIL CONTAMINATION

0-18 FT
NITRATE 60.3-135 mg/kg
PHOSPHATE 1.3-3.0 mg/kg
STRONTIUM-90 0.6-2.9 pCi/g
SULFATE 268-477 mg/kg
RADIUM-226 < 1.0 pCi/g

18-49 FT
ANTIMONY-125 22.7-50.4 pCi/g
CESIUM-137 50.1-364,000 pCi/g
COBALT-60 0.685 pCi/g
CYANIDE 3.2-7.1 mg/kg
PHOSPHATE 14-42 mg/kg
NITRATE 316-4840 mg/kg
NITRITE 2.8-12.2 mg/kg
PLUTONIUM-238 0.115-6.94 pCi/g
PLUTONIUM-239 < 1.0 pCi/g
PLUTONIUM-239/240 3.53-227 pCi/g
RADIUM-226 0.872-2.44 pCi/g
SODIUM 1590-4390 mg/kg
STRONTIUM-90 2.6-353000 pCi/g
SULFATE 264-1080 mg/kg
TECHNETIUM-99 90-120 pCi/g
TRITIUM 21-53 pCi/g
TOTAL URANIUM 4.1-35.3 mg/kg

49-190 FT
COBALT-60 1.24-4.03 pCi/g
CYANIDE 1.5 mg/kg
NITRATE 2220-5470 mg/kg
RADIUM-226 < 1.01 pCi/g
SODIUM 1370-2410 mg/kg
STRONTIUM-90 < 1.0 pCi/g
SULFATE 362-822 mg/kg
TECHNETIUM-99 65-160 pCi/g
TOTAL URANIUM 2.4 mg/kg

>190 FT
BISMUTH 31.3 mg/kg
COBALT-90 1.45-1.65 pCi/g
CYANIDE 1.2 mg/kg
NITRATE 3760-3710 mg/kg
SODIUM 2750 mg/kg
SULFATE 722 mg/kg
TECHNETIUM-99 100-140 pCi/g

RLS DATA
CESIUM-137

? UNCERTAINTY

U.S DEPARTMENT OF ENERGY DOE FIELD OFFICE, RICHLAND HANFORD ENVIRONMENTAL RESTORATION PROGRAM	216-B-46 CRIB CONTAMINANT DISTRIBUTION MODEL

Figure 2-12a. 216-B-58 Trench Contaminant Distribution Model of Contaminants of Potential Concern (Middle of Trench).

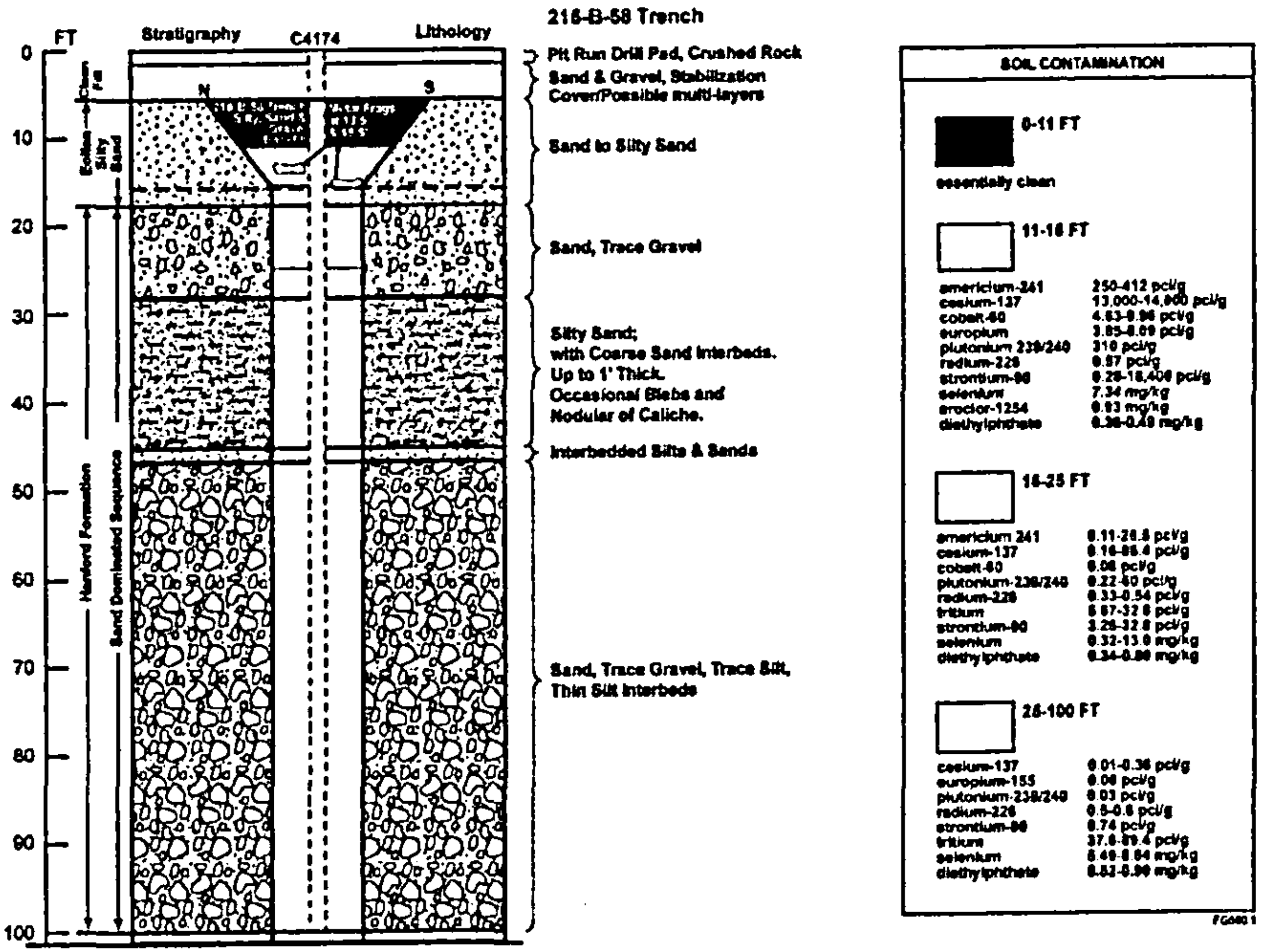
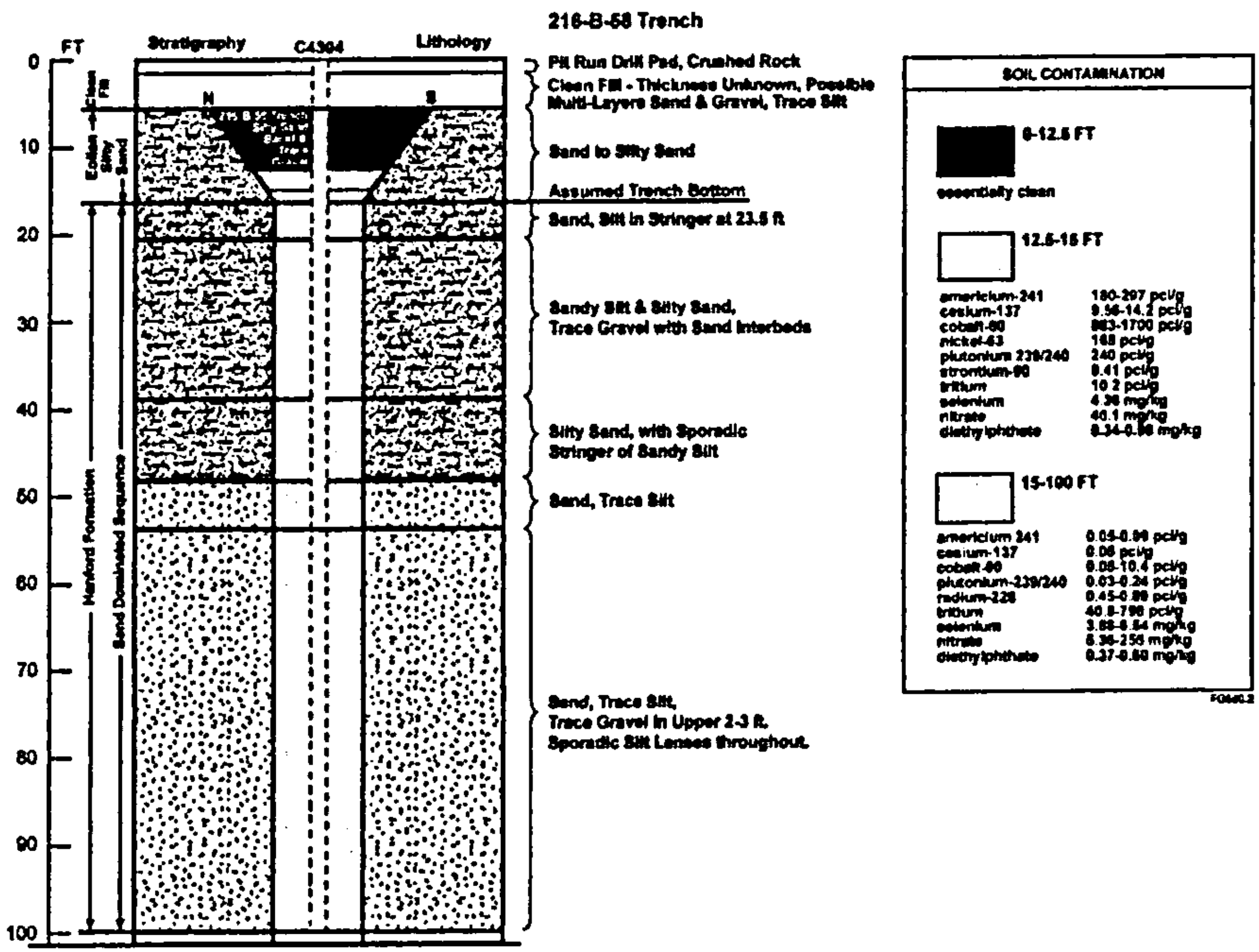


Figure 2-12b. 216-B-58 Trench Contaminant Distribution Model of Contaminants of Potential Concern (West End of Trench).



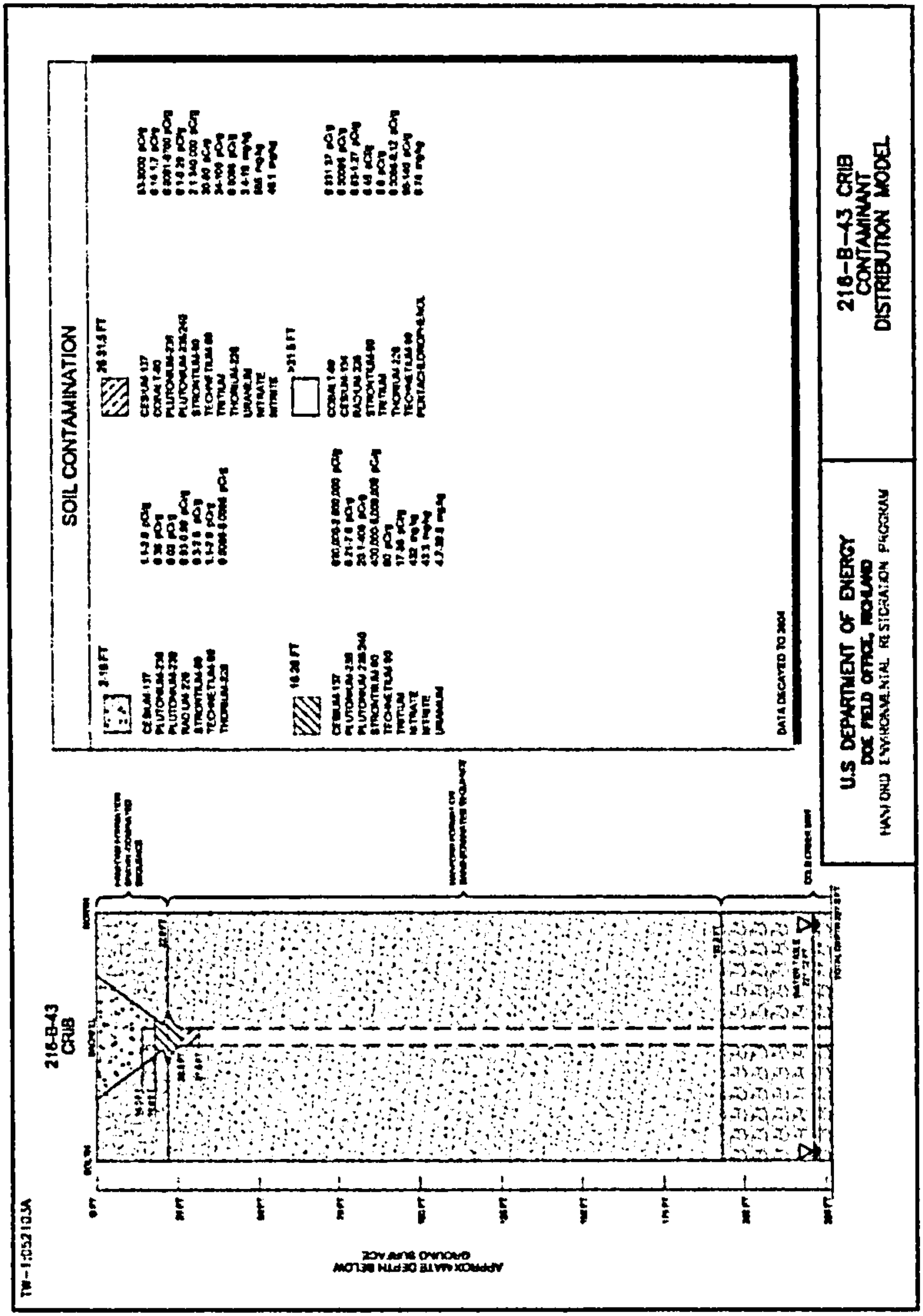


Figure 2-13. 216-B-43 Crib Contaminant Distribution Model of Contaminants of Potential Concern.

Figure 2-14. 216-B-44 Crib Contaminant Distribution Model of Contaminants of Potential Concern.

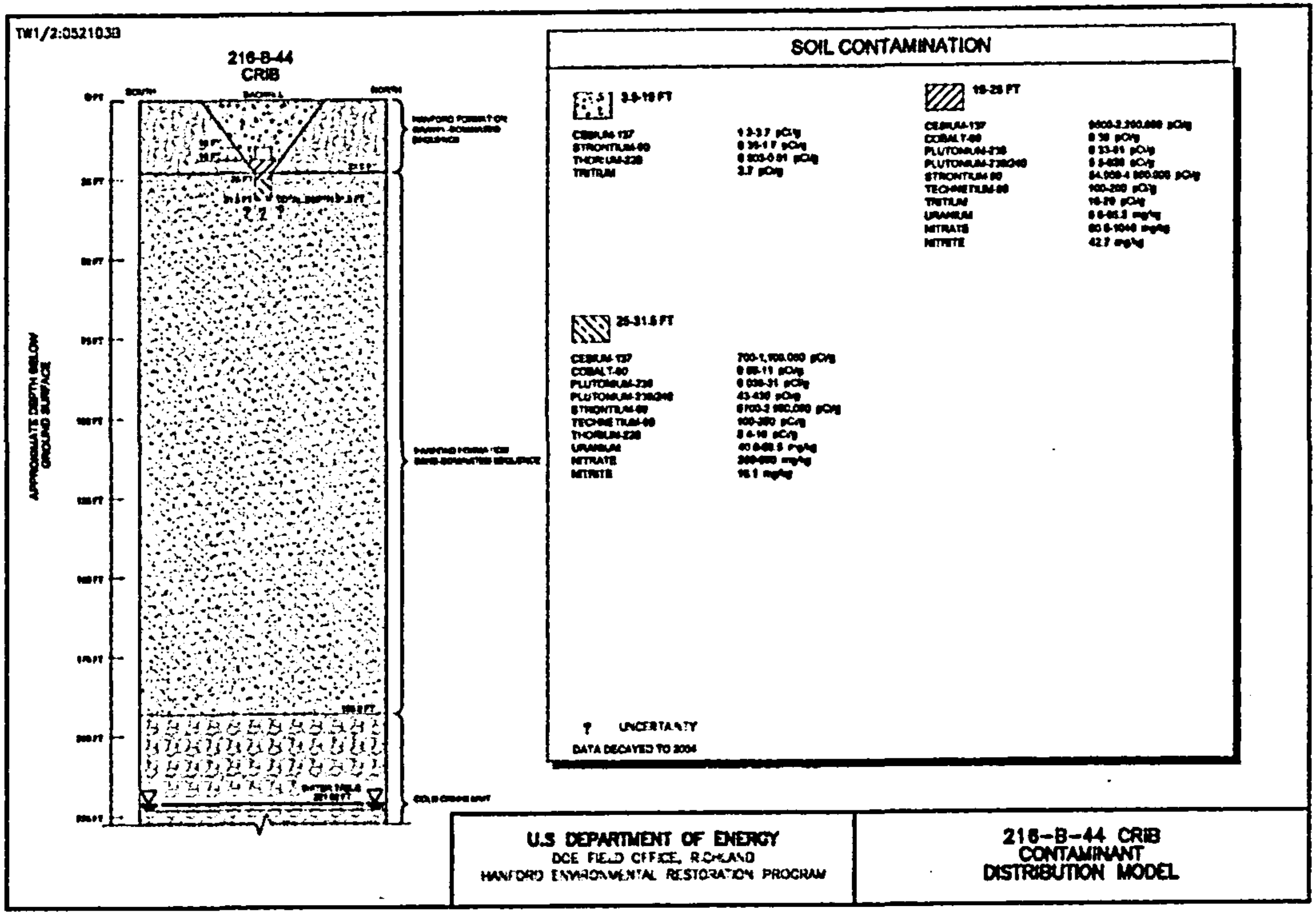
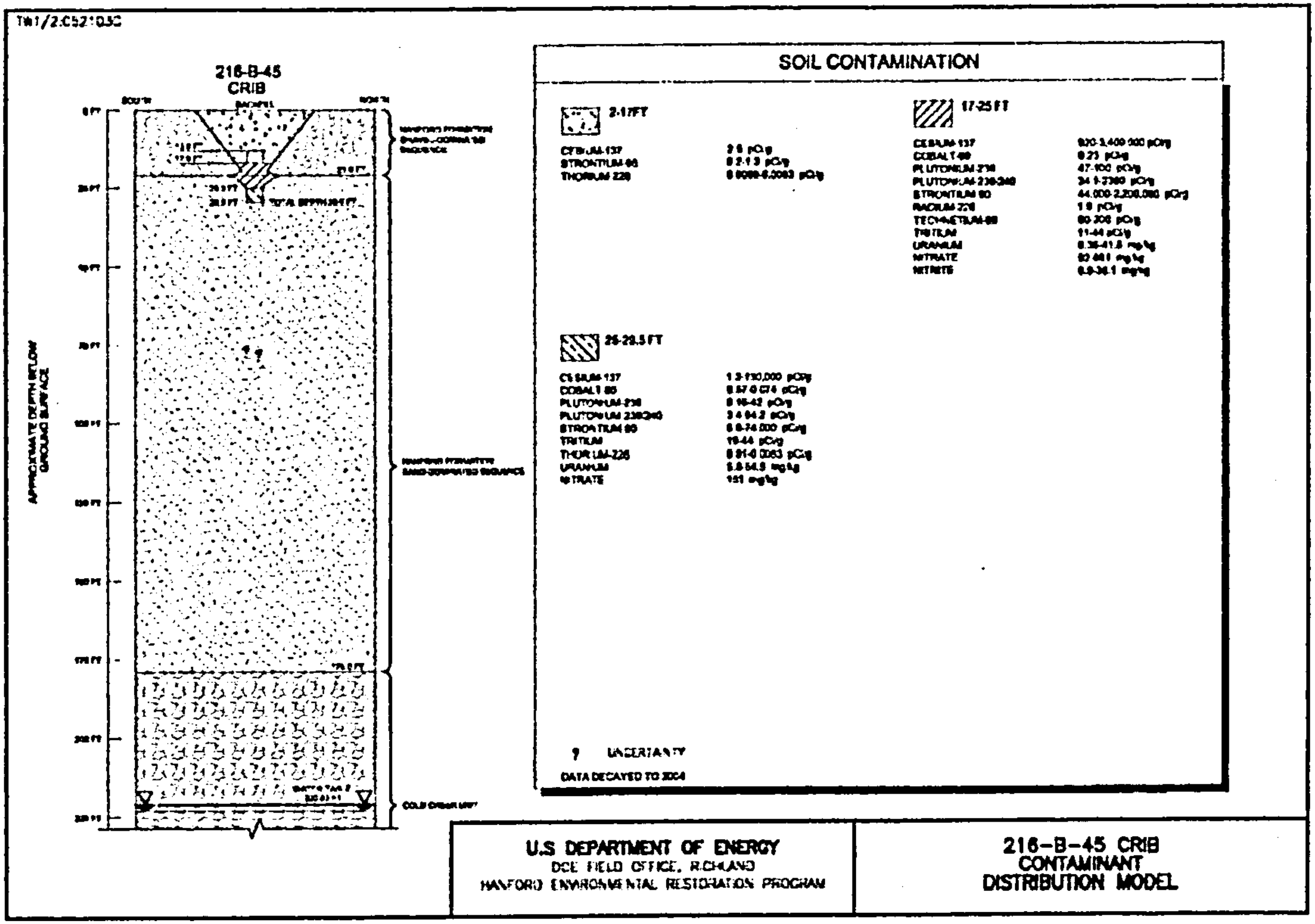


Figure 2-15. 216-B-45 Crib Contaminant Distribution Model of Contaminants of Potential Concern.



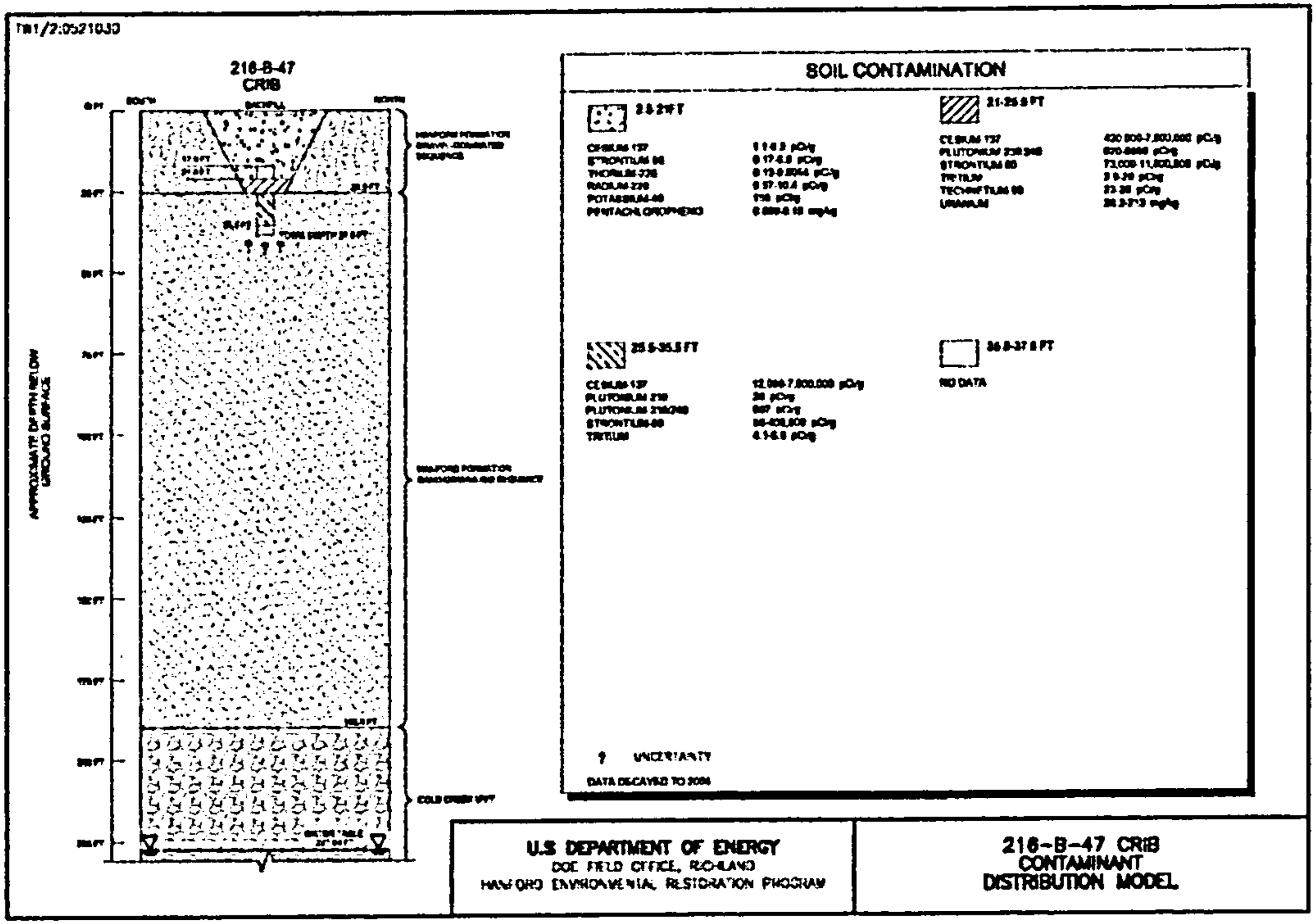
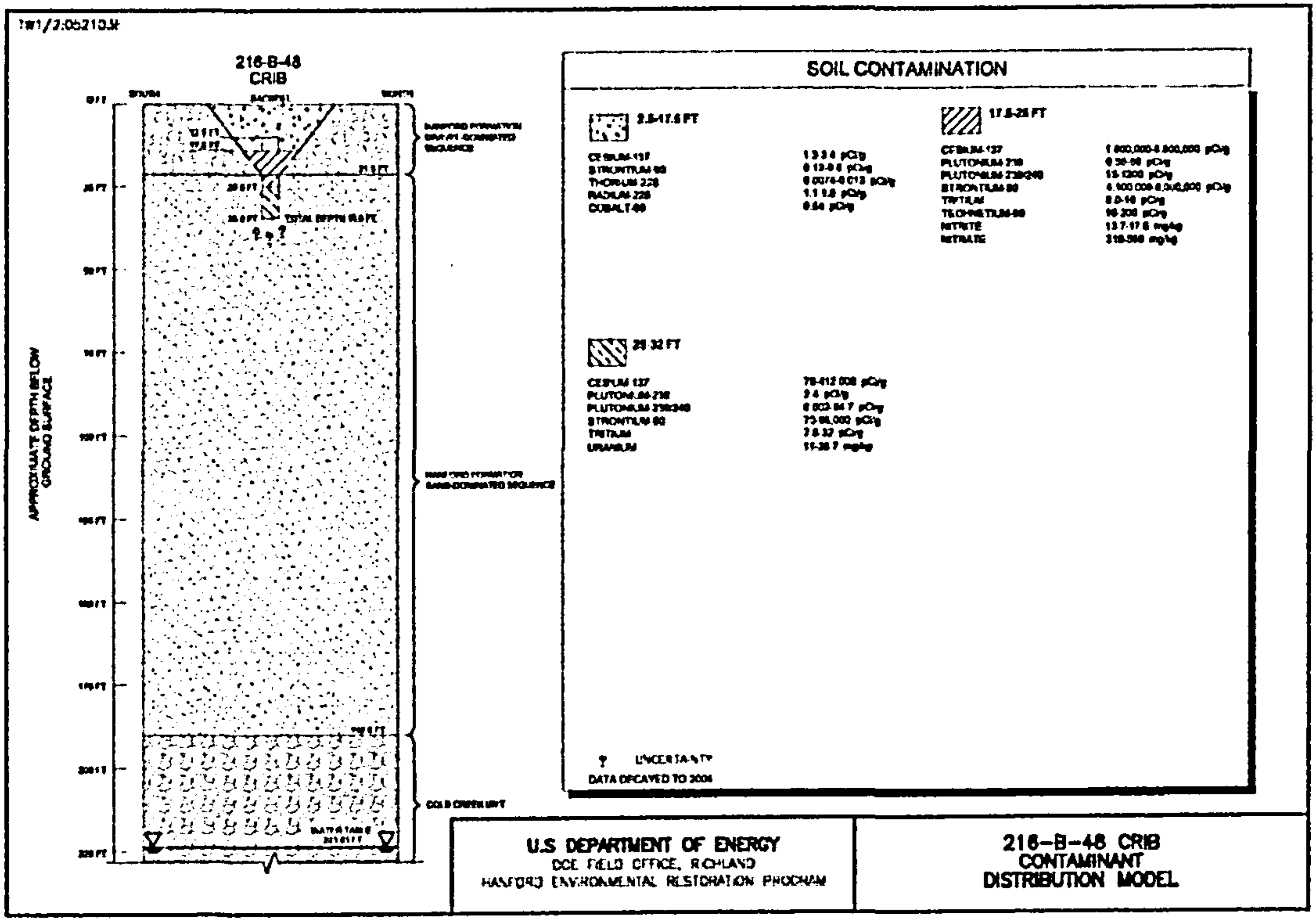


Figure 2-16. 216-B-47 Crib Contaminant Distribution Model of Contaminants of Potential Concern.

Figure 2-17. 216-B-48 Crib Contaminant Distribution Model of Contaminants of Potential Concern.



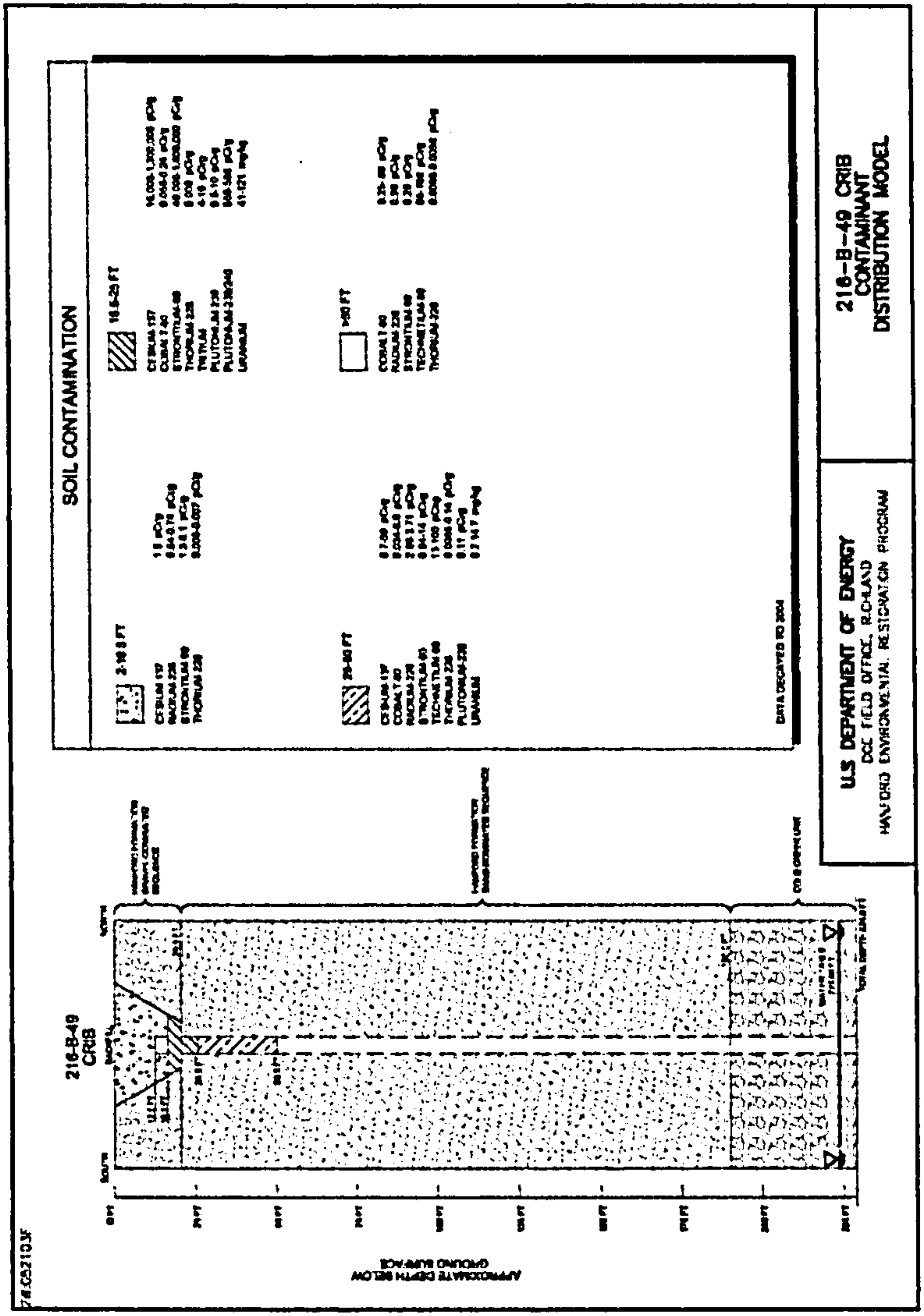


Figure 2-18. 216-B-49 Crib Contaminant Distribution Model of Potential Concern.

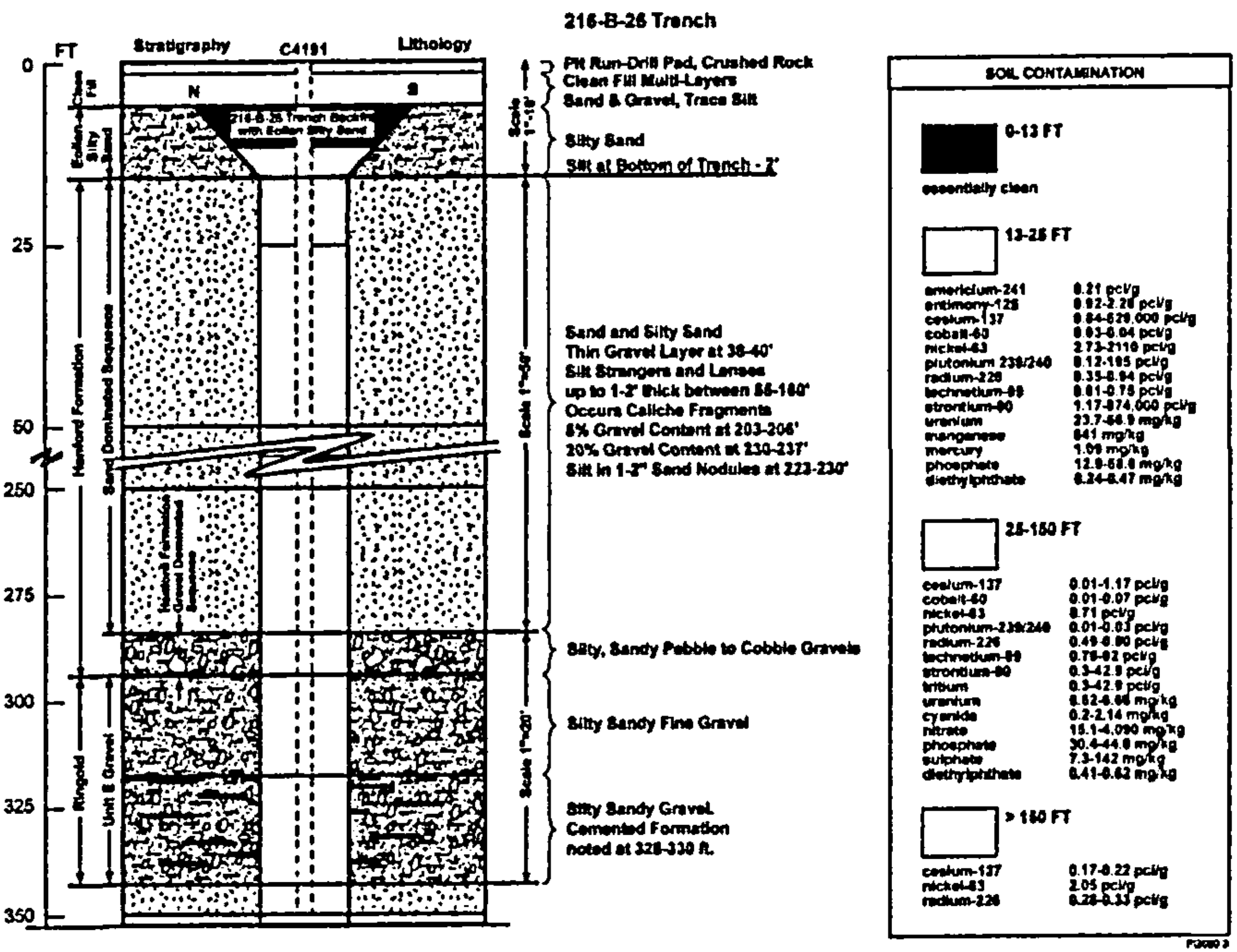
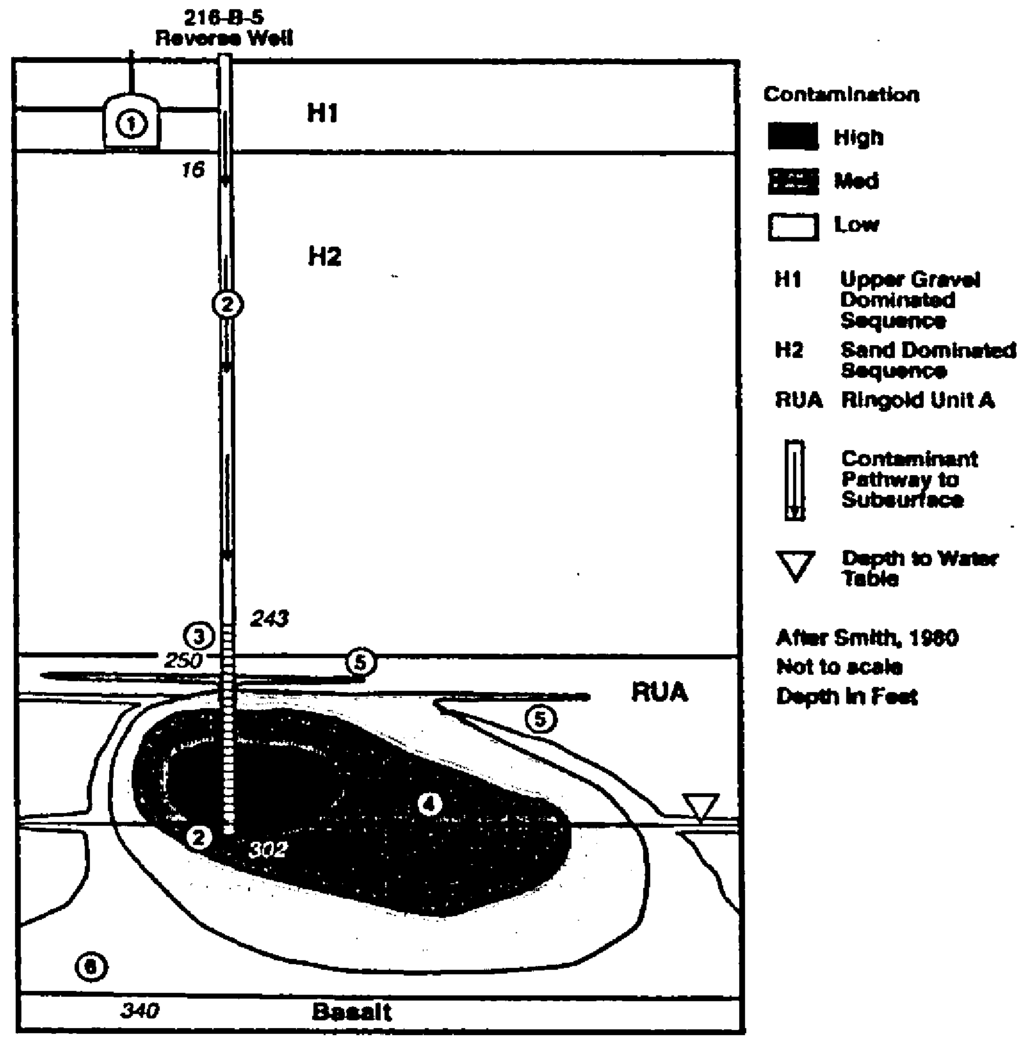


Figure 2-19. 216-B-26 Trench Contaminant Distribution Model of Contaminants of Potential Concern.

Figure 2-20. 216-B-5 Reverse Well Contaminant Distribution Model of Contaminants of Potential Concern.



1. High salt, neutral/basic/low organic liquid waste with high quantities of plutonium 239/240. Cesium-137, and strontium-90 were discharged to the 216-B-361 settling tank. Contaminants precipitated/settled out in the tank.
2. Wastewater overflowed from the 216-B-361 settling tank and into the 216-B-5 reverse well through a 5 cm (2-inch) diameter stainless steel inlet pipe about 3.6 m (12 ft) bgs. The reverse well received approximately 30,600,000 L (8.1 million gal) of liquid waste. In addition, studies indicate that the well receive 4.3 kg of Pu.
3. Waste was released to the vadose zone and the water table through a perforated section of the reverse well extending 74 m - 92 m (242 ft - 302 ft) bgs. When the well was actively receiving waste, it penetrated 3 m (10 ft) into the aquifer.
4. Contaminant detected in the subsurface include: cesium-137, strontium-90, plutonium-239/240, and americium-241. The highest activities were detected near the well perforations. Activities generally decrease away from the well.
5. Cesium-137 preferentially sorbs into silt lenses intersected by perforated casing.
6. Plutonium-239/240 may occur in phosphate based mineral phase.
7. The vadose zone and groundwater has been impacted by operation of the 216-B-5 reverse well.

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Figure 2-21. 216-B-7A Crib Contaminant Distribution Model of Contaminants of Potential Concern.

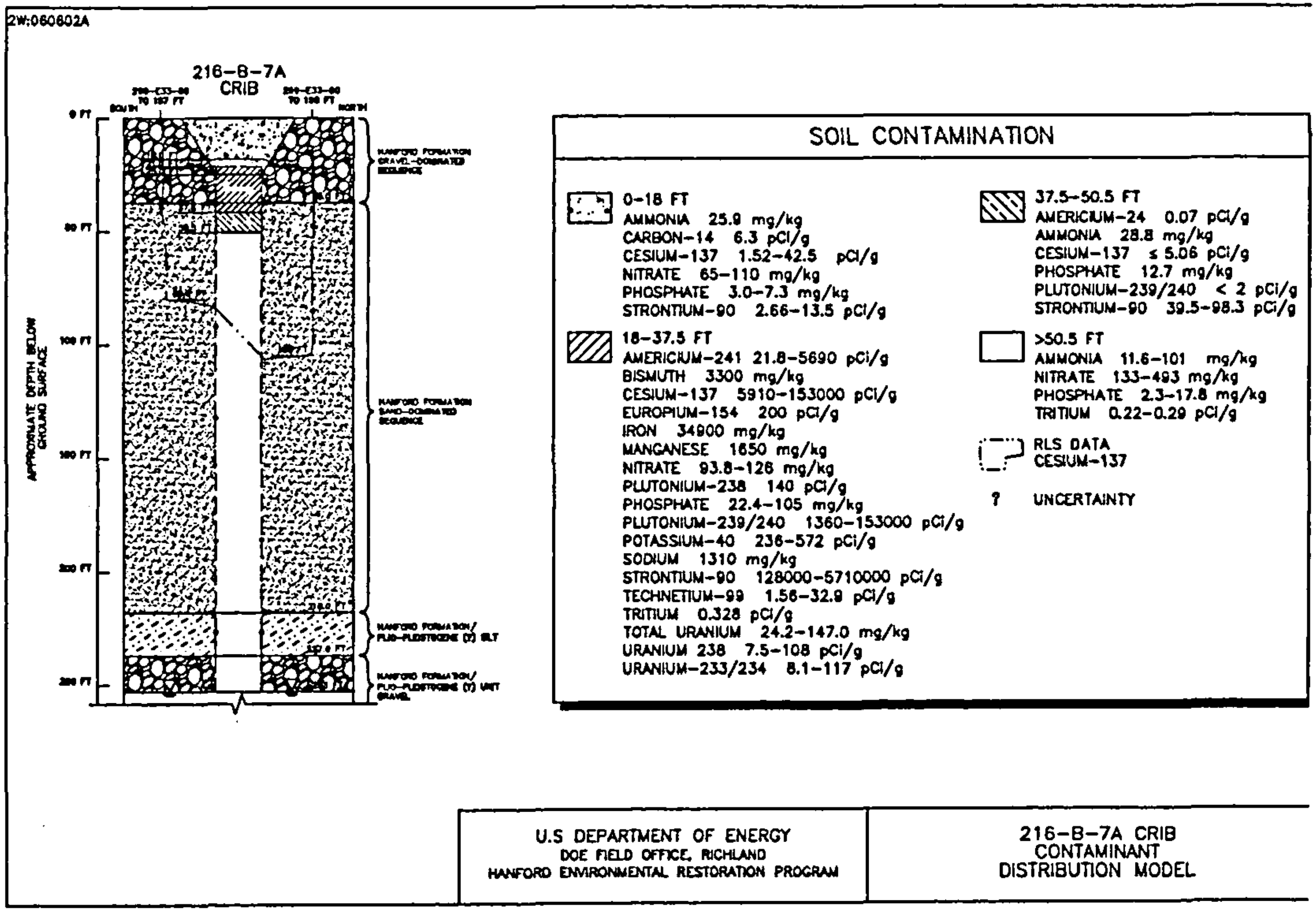


Figure 2-22. 216-B-38 Trench Contaminant Distribution Model of Contaminants of Potential Concern.

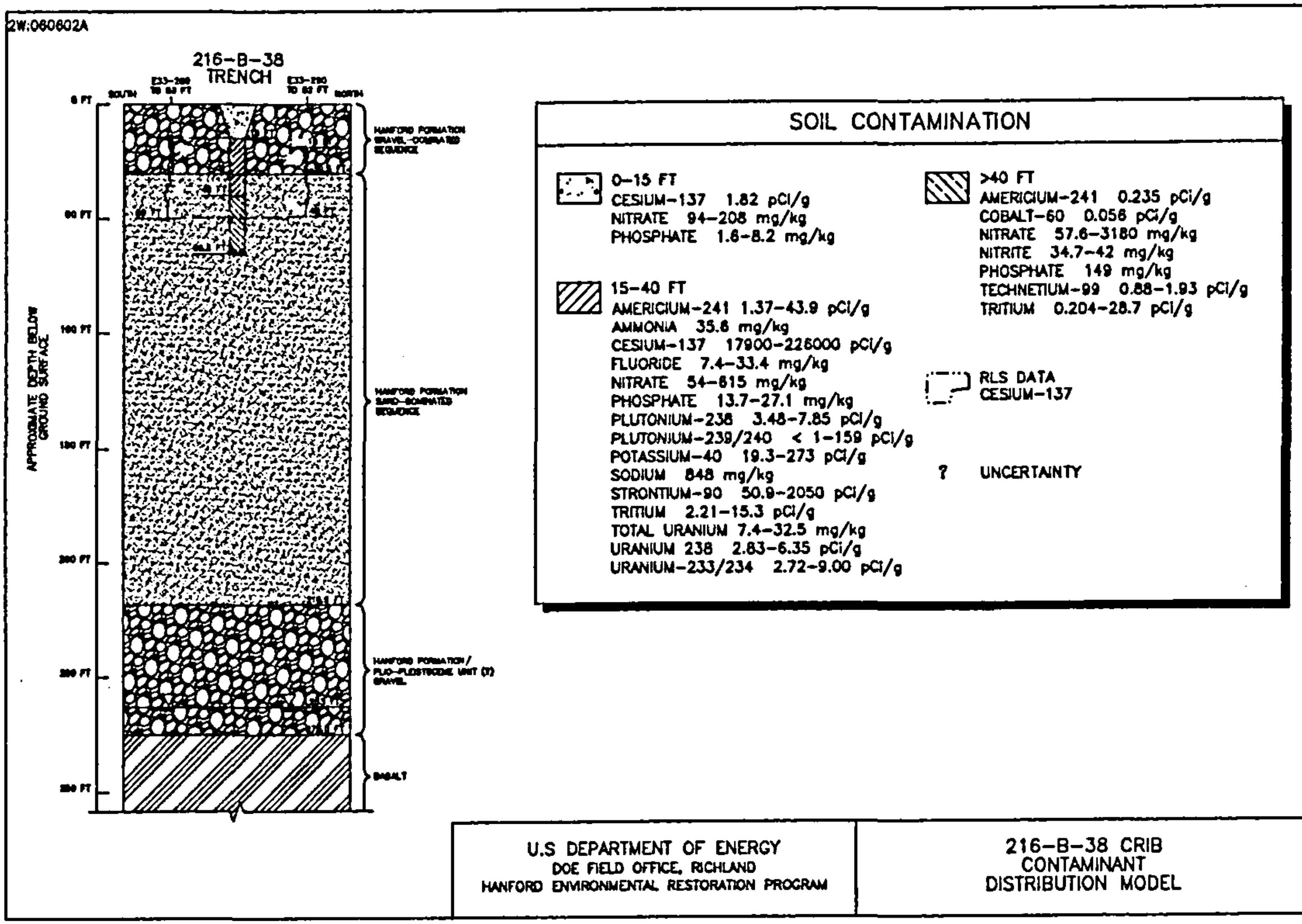
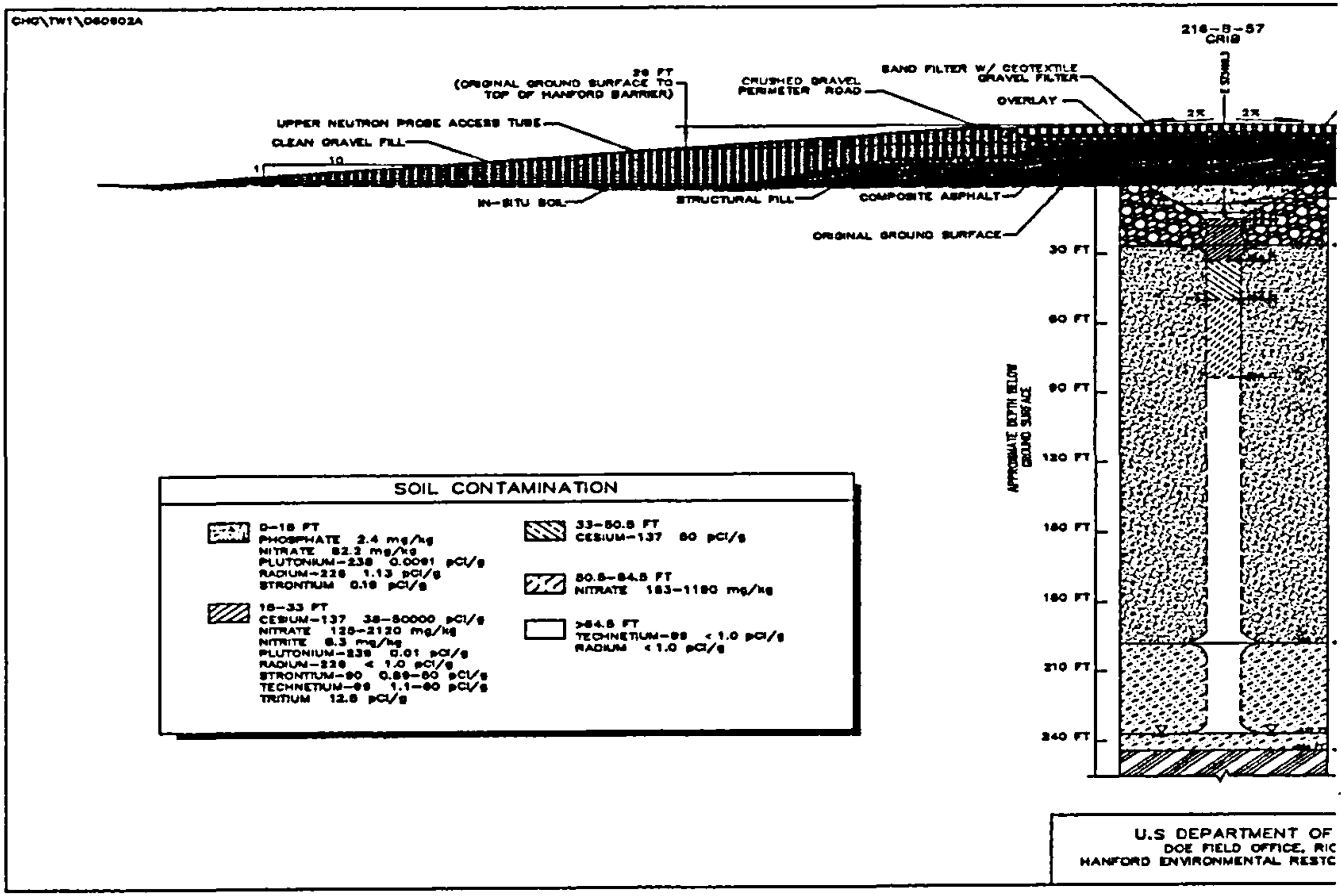


Figure 2-23. 216-B-57 Crib Contaminant Distribution Model of Contaminants of Potential Concern.



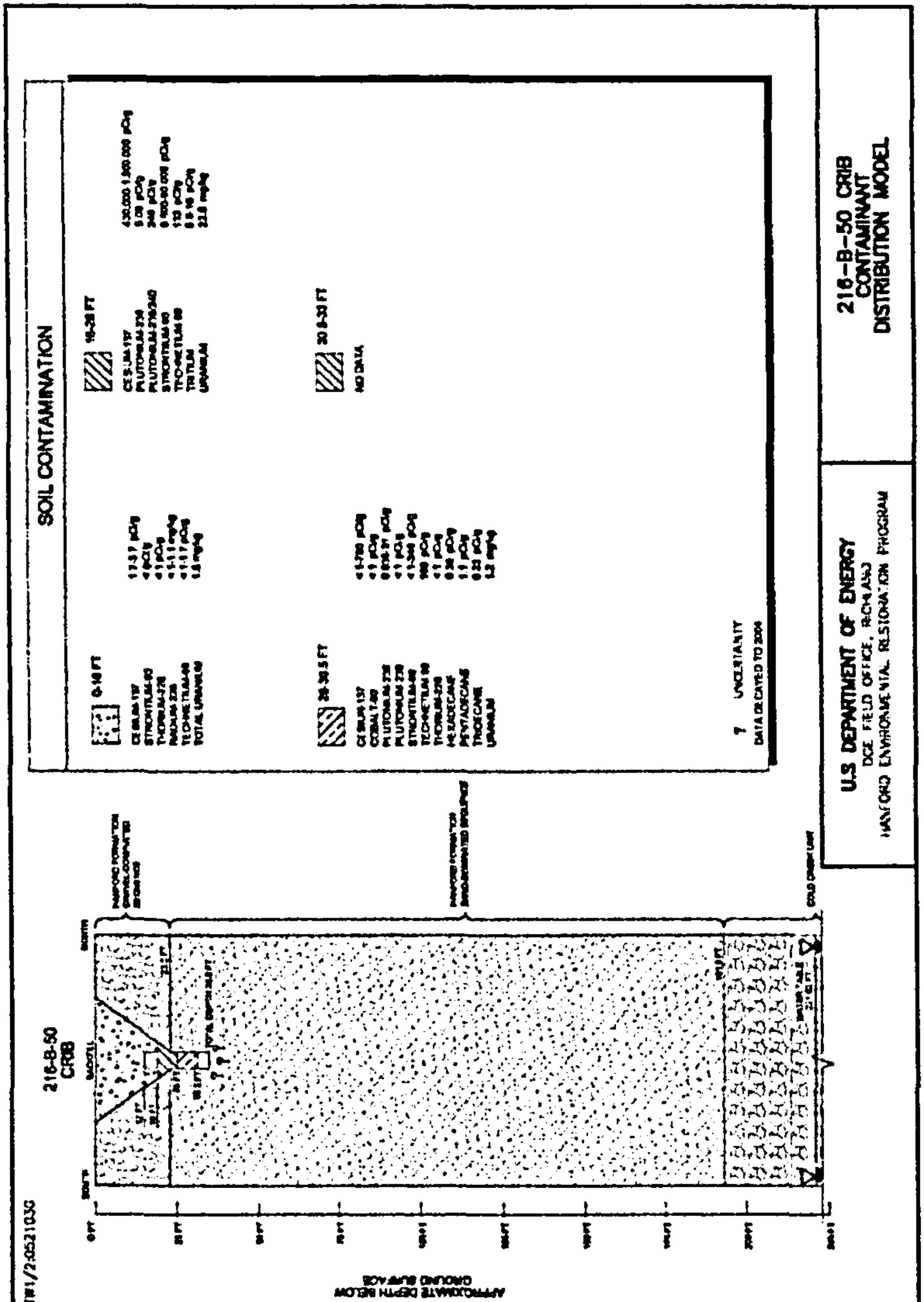


Figure 2-24. 216-B-50 Crib Contaminant Distribution Model of Contaminants of Potential Concern.

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Figure 2-25. Application of Analogous Site Approach.

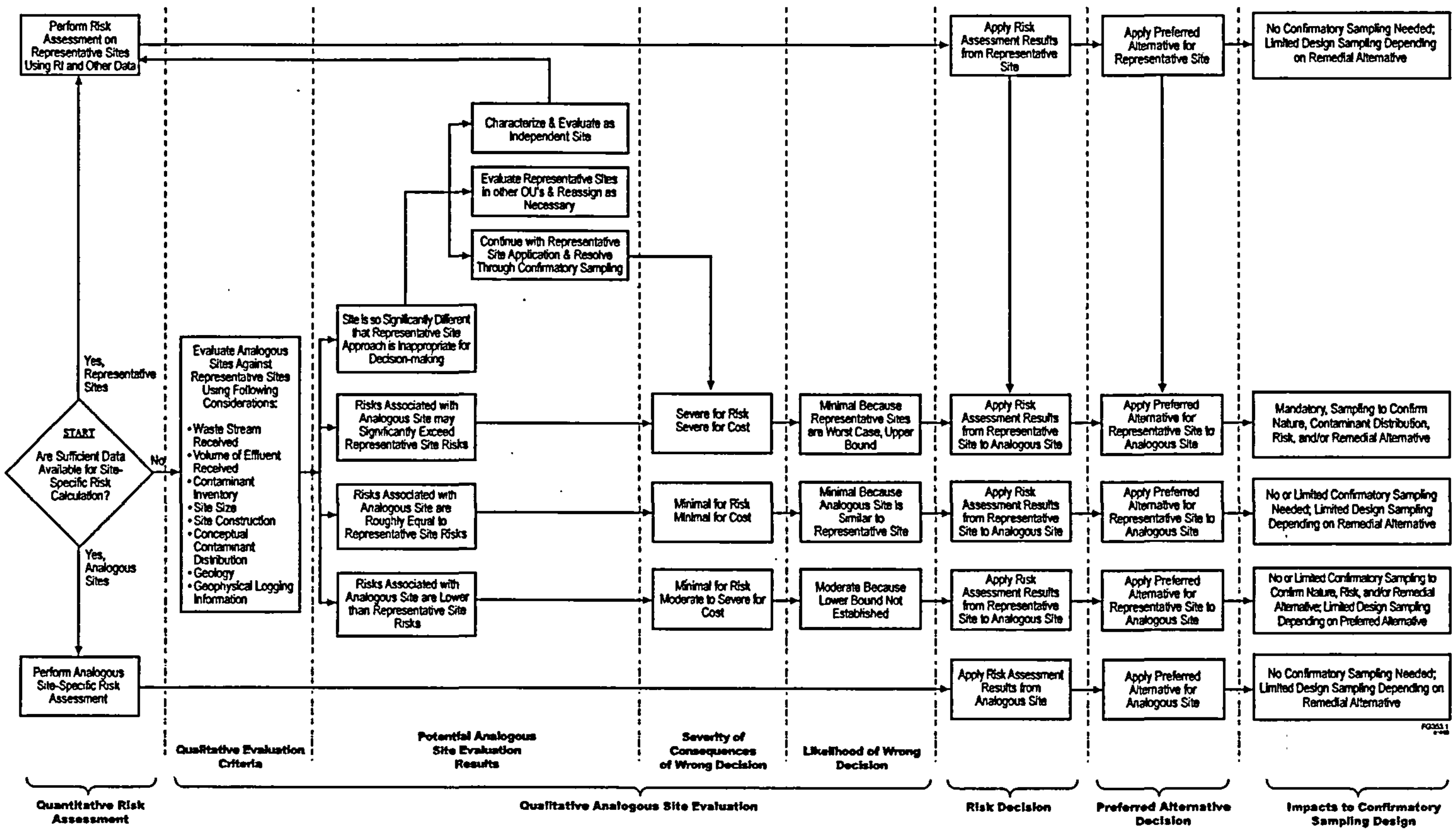

Table 2-1. Lithofacies of the Cold Creek Unit (Based on DOE/RL-2002-39).

Lithofacies	Environment of Deposition	Previous Site Nomenclature
Fine-grained, laminated to massive. Consists of a brown- to yellow very well sorted cohesive, compact, and massive- to laminated- and stratified-fine-grained sand and silt. It is moderately to strongly calcareous with relatively high natural background gamma activity.	Fluvial-overbank and eolian	Palouse soil, early Palouse" soil, Hanford formation/Plio-Pleistocene unit ? silt.
Fine- to coarse-grained, calcium carbonate cemented. Consists of basaltic to quartzite gravels, sands, silts, and clay that are cemented with one or more layers of secondary, pedogenic calcium carbonate.	Calcic paleosol	Highly weathered subunit of the Plio-Pleistocene unit/ caliche, calcrete.
Coarse-grained, multilithic. Consists of rounded, quartzose to gneissic clast-supported pebble- to cobble-size gravel with a quartzo-feldspathic sand matrix	Mainstream alluvium	Distantly derived subunit of the Plio-Pleistocene Unit/ pre-Missoula flood gravel.
Coarse-grained, angular, basaltic. Consists of angular, clast- to matrix-supported basaltic gravel in a poorly sorted mixture and sand and silt with no stratification. Calcic paleosols may be present.	Colluvium	New facies designation for the Pasco Basin.
Coarse-grained, round basaltic lithofacies.	Sidestream alluvium	Locally derived subunit of the Plio-Pleistocene unit

DOE/RL-2002-39, Standardized Stratigraphic Nomenclature for Post-Ringold Formation Sediments Within the Central Pasco Basin.

Figure 2-26. Central Plateau Risk Framework Anticipated Future Land Use - Core Zone, Industrial (Exclusive).

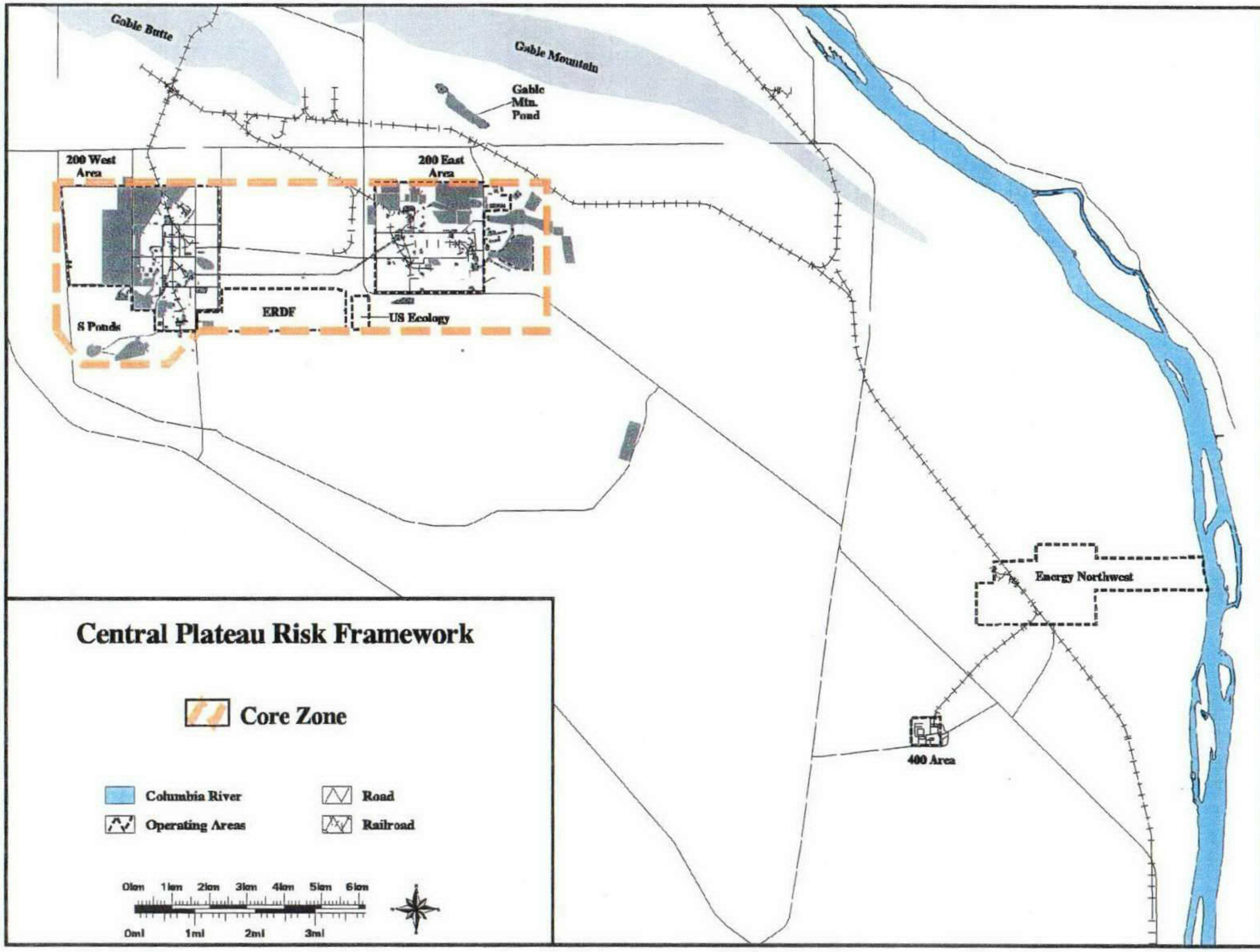

Table 2-2. 200-TW-1 Operable Unit Representative Sites and Associated Analogous Waste Sites. (21 Pages)

Waste Site	Waste Site Configuration, Construction, and Purpose	Site Discharge History (WIDS)	Contaminant Inventory (DOE/RL-96-81)							Effluent Volume (m^3)	Soil Pore Volume (m^3)	Eff Vol ÷ Pore Vol	Rationale
			Total U (kg)	Total Pu (g)	Tc-99* (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	Ferro-cyanide (kg)	Nitrate (kg)				
Representative Site													
216-T-26	The 216-T-26 Crib consists of four 1.2 m (4-ft)-diameter x 1.2 m (4-ft) long concrete culverts, buried vertically with centers spaced 4.6 m (15 ft) apart in a 9.1 x 9.1 x 4.6 m deep (30- x 30- x 15-ft deep) excavation. The depth to the top of contamination is 5.5 m (18 ft). This crib was stabilized along with the 216-T-27 and 216-T-28 Cribs. Located approximately 99 m (325 ft) from the TY Tank Farm tanks and associated with the 216-T-26 through 216-T-28 Cribs. This crib is also approximately 46 m (150 ft) from the 216-T-18 Crib.	Scavenged TBP Waste Stream Tank Farm/T Plant (bismuth phosphate/lanthanum fluoride): 1955-1956 (~1 yr duration). The crib received first-cycle scavenged supernatant waste from 221-T via an underground pipeline and the 216-TY-201 Flush Tank after cascading through Tanks 241-TY-101, 241-TY-103, and 241-TY-104. It also received scavenged $BiPO_4$ solvent extraction waste from "In Plant" and "In Tank Farm" scavenging operations.	150	59	15.2	756	282	6,000	1,000,000	12,000	680	17.65	Investigated in 2001 under DOE/RL-2000-38; Characterization is described in the 200-TW-1 and 200-TW-2 RI Report (DOE/RL-2002-42). Contaminant Distribution Most of the contamination is located at the crib bottom in a zone from 18 ft to 36.5 ft (5.5 to 11 m) bgs. The predominant contaminant of is Cs-137. The lower portion of this zone is the approximate top of the Cold Creek Unit. Only Tc-99 and H-3 were detected greater than 28.8 m (94.5 ft) bgs, but concentrations were less than 4 pCi/g for these constituents in this zone. Maximum Cs-137 concentration occurred at the site bottom and generally decreased with depth to 11 m (36.5 ft); however, the maximum concentrations of most contaminants occurred in the lower portion of this contaminated zone 34 to 36.5 ft (10.4 to 11 m) bgs. Maximum Cs-137 concentration: 47,900 pCi/g; maximum Sr-90 Concentration: 49,100 pCi/g. Significant reduction in the levels of contamination is associated with top of the sand-dominated sequence of the Hanford formation and the Cold Creek Unit. RLS detected Cs-137 from near the surface to a depth of 128 ft (39 m) bgs. Log data indicate that most of the Cs-137 was detected from 18 to 91 ft (5.5 to 27.7 m) bgs and is distributed deeper in the vadose zone toward the south end of the site. The maximum concentration detected by RLS is estimated to be greater than 3,000 pCi/g. Because contamination starts below 4.6 m (15 ft) bgs, human health risks from direct exposure and ecological risks are not anticipated. However, significant contamination exists just below the bottom of the crib that could pose risk to intruders. In addition, contaminations located deeper in the vadose zone pose a potential threat to groundwater (i.e., these contaminants could migrate through the vadose under existing conditions and cause further or continued impacts to groundwater). Risks associated with this site imply that groundwater protection is required and that alternatives should consider protection against inadvertent intruders.
200-TW-1 OU analogous wastes sites to be evaluated by the (216-T-26 Crib) model													
216-T-18	The 216-T-18 Crib has the same construction as the 216-T-26 Crib, consisting of four 1.2 m (4-ft)-diameter x 1.2 m (4-ft) long concrete culverts, buried vertically with centers spaced 4.6 m (15 ft) apart in a 9.1 x 9.1 x 4.6 m deep (30- x 30- x 15-ft deep) excavation. The depth to the top of contamination is 3.7 m (12 ft). Located approximately 107 m (350 ft) from the TY Tank Farm tanks and approximately 46 m (150 ft) from the 216-T-26 Crib.	Scavenging Test Effluent T Plant: 1953. The site received first cycle scavenged test effluent from T Plant and scavenged bismuth phosphate solvent extraction waste from the URP process in the 221-U Building.	26.8 Less than Rep Site	1,800 More than Rep Site	1.26 Less than Rep Site	24.2 Less than Rep Site	2.8 Less than Rep Site	- Less than Rep Site	80,000 Less than Rep Site	1,000 Less than Rep Site	699 Similar to Rep Site	1.43 Less than Rep Site	The 216-T-18 Crib is analogous to the 216-T-26 Crib as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received the same waste stream as 216-T-26 Crib; the contaminant types are expected to be very similar 2. Site construction is identical to 216-T-26 Crib 3. Waste was received from the same source (221-U) 4. Both sites are located in 200 West; the geology of the two sites is similar 5. Based on geophysical logs for the borehole near the 216-T-18 Crib, the vertical extent of contamination is similar 6. Risks are expected to be similar to 216-T-26 Crib; because the top of the contamination is located at 3.7 m (12 ft) bgs, human health and ecological risks are expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at 216-T-26 Crib 7. The relative effluent volume discharged to this crib suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to 216-T-26 Crib. More volume of effluent was sent to the 216-T-26 Crib; however, modeling for the 216-T-26 Crib indicates that contaminants remaining in the vadose will likely impact groundwater. Because less volume was discharged to the 216-T-18 Crib, higher inventories could remain in the vadose (i.e., less contamination may have flushed to the water table), posing a more significant future threat to groundwater than from the 216-T-26 Crib. This implies that groundwater protection is needed at this waste site, as it is at the 216-T-26 Crib 8. Generally received less contaminant inventory than 216-T-26 Crib with the exception of plutonium; the amount of plutonium and the total volume discharged to a small site might have resulted in contaminant concentrations of transuranic constituents at levels of concern (i.e., greater than 100 nCi/g). In general, the 216-T-18 Crib is analogous to and bounded by the 216-T-26 Crib. Remedial actions are needed to address the same risks as those of the 216-T-26 Crib, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and plutonium).

Table 2-2. 200-TW-1 Operable Unit Representative Sites and Associated Analogous Waste Sites. (21 Pages)

Waste Site	Waste Site Configuration, Construction, and Purpose	Site Discharge History (WIDS)	Contaminant Inventory (DOE/RL-96-81)							Effluent Volume (m^3)	Soil Pore Volume (m^3)	Eff Vol ÷ Pore Vol	Rationale
			Total U (kg)	Total Pu (g)	Tc-99* (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	Ferro-cyanide (kg)	Nitrate (kg)				
Representative Site													
216-B-46	The 216-B-46 Crib consists of four 1.2 m (4-ft)-diameter x 1.2 m (4-ft) long concrete culverts, buried vertically with centers spaced 4.6 m (15 ft) apart in a 9.1 x 9.1 x 4.6 m deep (30- x 30- x 15-ft deep) excavation. The depth to the top of contamination is 5.5 m (18 ft). Located approximately 140 m (460 ft) from the BY Tank Farm tanks and within the assembly of 216-B-43 through 216-B-50 Cribs.	<u>Scavenged TBP Waste Stream</u> Tank Farm/U Plant: 1955. The site received scavenged URP supernatant waste from the 221-U Building over a four-month period in 1955. The waste cascaded through the BY Tank Farm tanks before being discharged to the crib. The waste was originally bismuth phosphate/lanthanum fluoride metal wastes from 221-B.	190	20.0	32.6	88.9	631	4,000	1,200,000	6,700	9,730	0.68	Investigated in 1991 as part of the 200-BP-1 OU under DOE/RL-88-32; characterization is described in the 200-BP-1 RI Report (DOE/RL-92-70). <u>Contaminant Distribution</u> Sample data confirm that the bottom of the waste site is about 5.5 m (18 ft) bgs. Maximum contaminant concentrations were detected near the bottom of the crib at a depth of 5.5 m (18 ft) and generally decreased with depth. Most of the contamination detected was within a zone extending from the bottom of the crib to 49 ft. Maximum Cs-137: 280,000 pCi/g; maximum Sr-90: 260,000 pCi/g (concentrations decayed to 01/01/2004). With exception of Tc-99 and nitrate, little contamination was detected greater than 14.9 m (49.0 ft). Technetium-99 concentration is 160 pCi/g at depths greater than 14.9 m (49 ft). Because contamination starts below 4.6 m (15 ft) bgs, human health risks from direct exposure and ecological risks are not anticipated. However, significant contamination exists just below the bottom of the crib that could pose risk to intruders. In addition, contamination located deeper in the vadose zone poses a potential threat to groundwater. Risks associated with this site imply that groundwater protection is required and that alternatives should consider protection against inadvertent intruders.
200-TW-1 OU analogous wastes sites to be evaluated by the (216-B-46 Crib) model													
216-B-14	The 216-B-14 Crib is constructed of wood, cinder block and steel on a bed of gravel. Bottom dimensions of the crib are 6.1 x 6.1 m (20 x 20 ft). The waste site dimensions are 24 x 24 x 4 m deep (80 x 80 x 13 ft deep). The depth to the top of contamination is 3 m (10 ft).	<u>Scavenged TBP Waste Stream</u> Tank Farm/B, BX, BY: 1956. The site received scavenged bismuth phosphate waste from URP process waste in the 221-U Building. The waste cascaded through the BY Tank Farm tanks before being discharged to the crib. The point of the contaminant release is about 5 to 8 ft above the release point at the 216-B-46 Crib.	220 Similar to rep site	25.0 Similar to rep site	42.4 More than rep site	114 More than rep site	172 Less than rep site	5,000 More than rep site	1,500,000 More than rep site	8,710 More than rep site	17,670	0.49 Similar to rep site	The 216-B-14 Crib is analogous to the 216-B-46 Crib as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received the same waste stream as 216-B-46 Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to 216-B-46 Crib; however, the 216-B-14 Crib is slightly larger than the 216-B-46 Crib 3. Waste was received from the same source (221-U) 4. Both sites are located in 200 East Area; the geology of the two sites is similar 5. The vertical extent of contamination is expected to be similar, based on evidence from similar sites investigated (e.g., 216-B-43 through 216-B-50 Cribs) 6. Risks are expected to be similar to 216-B-46 Crib; because the top of the contamination is about 3 m (10 ft) bgs, human health and ecological risks are expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site, as evidenced by similar risk at 216-B-46 Crib 7. The relative effluent volume discharged to this crib suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to 216-B-46 Crib. A slightly greater relative volume of effluent was sent to the 216-B-14 Crib; however, the larger size of the 216-B-14 Crib suggests that contaminants remaining in the vadose may exceed those found in 216-B-46 Crib, which was found to pose a threat to groundwater. Because less volume was discharged to the 216-B-14 Crib, higher inventories could remain in the vadose, posing a more significant threat to groundwater than from the 216-B-46 Crib. This implies that groundwater protection is needed at this waste site, as it is at 216-B-46 Crib 8. Generally received equivalent or slightly more contaminant inventory than 216-B-46 Crib with the exception of nitrate; this strengthens the need for groundwater protection at this waste site. In general, the 216-B-14 Crib is analogous and roughly equivalent to the 216-B-46 Crib. Remedial actions are needed to address the same risks as those of 216-B-46 Crib, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90). Because the contamination is shallower at the 216-B-14 Crib, remedial actions also are needed to address human health and ecological risk in the 0 to 4.6 m (0 to 15-ft) bgs zone.

Table 2-2. 200-TW-1 Operable Unit Representative Sites and Associated Analogous Waste Sites. (21 Pages)

Waste Site	Waste Site Configuration, Construction, and Purpose	Site Discharge History (WIDS)	Contaminant Inventory (DOE/RL-96-81) Total U (kg)	Total Pu (g)	Tc-99* (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	Ferro-cyanide (kg)	Nitrate (kg)	Effluent Volume (m³)	Soil Pore Volume (m³)	Eff Vol ÷ Pore Vol	Rationale
216-B-15	The 216-B-15 Crib is a 3.0 x 3.0 x 0.9 m high (10 x 10 x 3 ft) structure constructed of wood, cinder block, and steel on a bed of gravel. Bottom dimensions of the crib are 6.1 x 6.1 m (20 x 20 ft). The waste site dimensions are 24 x 24 x 4 m deep (80 x 80 x 13 ft deep). The depth to the top of contamination is 4 m (13 ft). Located in the BC Cribs and Trenches Area and within the assembly of 216-B-14 through 216-B-19 Cribs.	Scavenged TBP Waste Stream Tank Farm/B, BX, BY: 1956-1957. The site received scavenged bismuth phosphate waste from URP process waste in the 221-U Building. The waste cascaded through the BY Tank Farm tanks before being discharged to the crib.	100 Less than rep site	5.0 Less than rep site	30.8 Similar to rep site	92.4 Similar to rep site	87.3 Less than rep site	3,300 Less than rep site	900,000 Less than rep site	6,320 Similar to rep site	17,670	0.36 Less than rep site	The 216-B-15 Crib is analogous to the 216-B-46 Crib as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received the same waste stream as 216-B-46 Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to 216-B-46 Crib; however, the 216-B-15 Crib is slightly larger than the 216-B-46 Crib 3. Waste was received from the same source (221-U) 4. Both sites are located in 200 East Area; the geology of the two sites is similar 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated (e.g., 216-B-43 through 216-B-50 Cribs) 6. Risks are expected to be similar to 216-B-46 Crib; because the top of the contamination is about 4 m (13 ft) bgs, human health and ecological risks are expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at 216-B-46 Crib 7. The relative effluent volume discharged to this crib suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to 216-B-46 Crib. An equivalent volume of effluent was sent to the 216-B-15 Crib; however, the larger size of the 216-B-15 Crib suggests that contaminants remaining in the vadose may exceed those found in 216-B-46 Crib, which was found to pose a threat to groundwater. Because less volume was discharged to the 216-B-15 Crib, higher inventories could remain in the vadose, posing a more significant threat to groundwater than from the 216-B-46 Crib. This implies that groundwater protection is needed at this waste site, as it is at 216-B-46 Crib. 8. Generally received equivalent or less contaminant inventory than 216-B-46 Crib. In general, the 216-B-15 Crib is analogous and roughly equivalent to the 216-B-46 Crib. Remedial actions are needed to address the same risks as those of 216-B-46 Crib, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90). Because the contamination is shallower at the 216-B-15 Crib, remedial actions also are needed to address human health and ecological risk in the 0 to 4.6 m (0 to 15-ft) bgs zone.
216-B-16	The 216-B-16 Crib is a 3.0 x 3.0 x 0.9 m high (10 x 10 x 3 ft) structure constructed of wood, cinder block, and steel on a 1.5 m (5 ft) bed of gravel. Bottom dimensions of the crib are 6.1 x 6.1 m (20 x 20 ft).The waste site dimensions are 24 x 24 x 4 m deep (80 x 80 x 13 ft deep). The depth to the top of contamination is 3 m (10 ft). Located in the BC Cribs and Trenches Area and within the assembly of 216-B-14 through 216-B-19 Cribs.	Scavenged TBP Waste Stream Tank Farm/B, BX, BY: 1956. The site received scavenged bismuth phosphate waste from URP process waste in the 221-U Building. The waste cascaded through the BY Tank Farm tanks before being discharged to the crib. The 216-B-16 Crib received scavenged waste over a short period of time (5 months).	320 More than rep site	10.0 Less than rep site	27.3 Similar to rep site	296 More than rep site	302 Less than rep site	3,000 Less than rep site	1,100,000 Similar to rep site	5,600 Less than rep site	17,670	0.32 Less than rep site	The 216-B-16 Crib is analogous to the 216-B-46 Crib as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received the same waste stream as 216-B-46 Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to 216-B-46 Crib; however, the 216-B-16 Crib is slightly larger than the 216-B-46 Crib 3. Waste was received from the same source (221-U) 4. Both sites are located in 200 East Area; the geology of the two sites is similar 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated (e g., 216-B-43 through 216-B-50 Cribs) 6. Risks are expected to be similar to 216-B-46 Crib; because the top of the contamination is about 3 m (10 ft) bgs, human health and ecological risks are expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at 216-B-46 Crib 7. The relative effluent volume discharged to this crib suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to 216-B-46 Crib. A slightly lower volume of effluent was sent to the 216-B-16 Crib; this suggests that contaminants remaining in the vadose may not have been flushed through the crib and concentrations may exceed those found in 216-B-46 Crib, which was found to pose a threat to groundwater. Because less volume was discharged to the 216-B-16 Crib, higher inventories could remain in the vadose, posing a more significant threat to groundwater than from the 216-B-46 Crib. This implies that groundwater protection is needed at this waste site, as it is at 216-B-46 Crib. 8. Generally received equivalent or greater contaminant inventory than 216-B-46 Crib. The 216-B-16 Crib received higher inventories of uranium, and Cs-137, supporting the need for groundwater protection and the possibility of even higher shallow zone and intruder risks than the 216-B-46 Crib. In general, the 216-B-16 Crib is analogous to the 216-B-46 Crib, with potential for higher risk from the Cs-137 in the shallow zone and in the zone at the bottom of the crib structure. Remedial actions are needed to address the same risks as those of 216-B-46 Crib, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90). Because the contamination is shallower at the 216-B-16 Crib, remedial actions also are needed to address human health and ecological risk in the 0 to 4.6 m (0 to 15-ft) bgs zone.

Table 2-2. 200-TW-1 Operable Unit Representative Sites and Associated Analogous Waste Sites. (21 Pages)

Waste Site	Waste Site Configuration, Construction, and Purpose	Site Discharge History (WIDS)	Contaminant Inventory (DOE/RL-96-81)							Effluent Volume (m^3)	Soil Pore Volume (m^3)	Eff Vol + Pore Vol	Rationale
			Total U (kg)	Total Pu (g)	Tc-99* (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	Ferro-cyanide (kg)	Nitrate (kg)				
216-B-17	The 216-B-17 Crib is a 3.0 x 3.0 x 0.9 m high (10 x 10 x 3 ft) structure constructed of wood, cinder block, and steel on a 1.5 m (5 ft) bed of gravel. Bottom dimensions of the crib are 6.1 x 6.1 m (20 x 20 ft). The waste site dimensions are 24 x 24 x 4 m deep (80 x 80 x 13 ft deep). The depth to the top of contamination is 3.4 m (11 ft). Located in the BC Cribs and Trenches Area and within the assembly of 216-B-14 through 216-B-19 Cribs.	Scavenged TBP Waste Stream Tank Farm/B, BX, BY: 1956. The site received in-tank scavenged (first cycle) and scavenged bismuth phosphate waste from URP process waste in the 221-U Building. The waste cascaded through the BY Tank Farm tanks before being discharged to the crib. The 216-B-17 Crib received waste over a short period of time (one month)	350 More than rep site	10.0 Less than rep site	16.6 Less than rep site	100 Similar to rep site	68.9 Less than rep site	1,800 Less than rep site	1,100,000 Similar to rep site	3,410 Less than rep site	17,670	0.19 Less than rep site	The 216-B-17 Crib is analogous to the 216-B-46 Crib as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received the same waste stream as 216-B-46 Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to 216-B-46 Crib; however, the 216-B-17 Crib is slightly larger than the 216-B-46 Crib 3. Waste was received from the same source (221-U) 4. Both sites are located in 200 East Area; the geology of the two sites is similar 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated (e.g., 216-B-43 through 216-B-50 Cribs) 6. Risks are expected to be similar to 216-B-46 Crib; because the top of the contamination is about 3.4 m (11 ft) bgs, human health and ecological risks are expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at 216-B-46 Crib 7. The relative effluent volume discharged to this crib suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to 216-B-46 Crib. A lower volume of effluent was sent to the 216-B-17 Crib; this suggests that contaminants remaining in the vadose may not have been flushed through the crib and concentrations may exceed those found in 216-B-46 Crib, which was found to pose a threat to groundwater. Because less volume was discharged to the 216-B-17 Crib, higher inventories could remain in the vadose, posing a more significant threat to groundwater than from the 216-B-46 Crib. This implies that groundwater protection is needed at this waste site, as it is at 216-B-46 Crib 8. Generally received equivalent or greater contaminant inventory than 216-B-46 Crib. The 216-B-17 Crib received a higher inventory of uranium, supporting the need for groundwater protection. In general, the 216-B-17 Crib is analogous and roughly equivalent to the 216-B-46 Crib. Remedial actions are needed to address the same risks as those of 216-B-46 Crib, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90). Because the contamination is shallower at the 216-B-17 Crib, remedial actions also are needed to address human health and ecological risk in the 0 to 4.6 m (0 to 15-ft) bgs zone.
216-B-18	The 216-B-18 Crib is a 3.0 x 3.0 x 0.9 m high (10 x 10 x 3 ft) structure constructed of wood, cinder block, and steel on a 1.5 m (5 ft) bed of gravel. Bottom dimensions of the crib are 6.1 x 6.1 m (20 x 20 ft).The waste site dimensions are 24 x 24 x 4 m deep (80 x 80 x 13 ft deep). The depthto the top of contamination is 3.4 m (11 ft). Located in the BC Cribs and Trenches Area and within the assembly of 216-B-14 through 216-B-19 Cribs.	Scavenged TBP Waste Stream Tank Farm/B, BX, BY: over a short period of time (one month) in 1956. The site received scavenged bismuth phosphate waste from URP process waste in the 221-U Building. The waste cascaded through the BY Tank Farm tanks before being discharged to the crib.	240 More than rep site	10.0 Less than rep site	41.5 More than rep site	114 More than rep site	81.8 Less than rep site	5,000 More than rep site	1,000,000 Similar to rep site	8,520 More than rep site	17,670	0.48 Less than rep site	The 216-B-18 Crib is analogous to the 216-B-46 Crib as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received the same waste stream as 216-B-46 Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to 216-B-46 Crib; however, the 216-B-18 Crib is slightly larger than the 216-B-46 Crib 3. Waste was received from the same source (221-U) 4. Both sites are located in 200 East Area; the geology of the two sites is similar 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated (e g., 216-B-43 through 216-B-50 Cribs) 6. Risks are expected to be similar to 216-B-46 Crib; however, because the top of the contamination is about 3.4 m (11 ft) bgs, human health and ecological risks are expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at 216-B-46 Crib 7. The relative effluent volume discharged to this crib suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to 216-B-46 Crib. A slightly greater volume of effluent was sent to the 216-B-18 Crib; however, the larger size of the 216-B-18 Crib suggests that contaminants remaining in the vadose may exceed those found in 216-B-46 Crib, which was found to pose a threat to groundwater. Because less relative volume was discharged to the 216-B-18 Crib, higher inventories could remain in the vadose, posing a more significant threat to groundwater than from the 216-B-46 Crib. This implies that groundwater protection is needed at this waste site, as it is at 216-B-46 Crib. 8. Generally received equivalent or greater contaminant inventory than 216-B-46 Crib. The 216-B-18 Crib received higher inventories of uranium and ferrocyanide, supporting the need for groundwater protection. In general, the 216-B-18 Crib is analogous and roughly equivalent to the 216-B-46 Crib. Remedial actions are needed to address the same risks as those of 216-B-46 Crib, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90). Because the contamination is shallower at the 216-B-18 Crib, remedial actions also are needed to address human health and ecological risk in the 0 to 4.6 m (0 to 15-ft) bgs zone.

Table 2-2. 200-TW-1 Operable Unit Representative Sites and Associated Analogous Waste Sites. (21 Pages)

Waste Site	Waste Site Configuration, Construction, and Purpose	Site Discharge History (WIDS)	Contaminant Inventory (DOE/RL-96-81)							Effluent Volume (m^3)	Soil Pore Volume (m^3)	Eff Vol + Pore Vol	Rationale
			Total U (kg)	Total Pu (g)	Tc-99* (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	Ferro-cyanide (kg)	Nitrate (kg)				
216-B-19	The 216-B-19 Crib is a 3.0 x 3.0 x 0.9 m high (10 x 10 x 3 ft) structure constructed of wood, cinder block, and steel on a 1.5 m (5 ft) bed of gravel. Bottom dimensions of the crib are 6.1 x 6.1 m (20 x 20 ft).The waste site dimensions are 24 x 24 x 4 m deep (80 x 80 x 13 ft deep). The depth to the top of contamination is 4 m (13 ft). Located in the BC Cribs and Trenches Area and within the assembly of 216-B-14 through 216-B-19 Cribs.	Scavenged TBP Waste Stream Tank Farm/B, BX, BY: 1957. The site received in-tank scavenged (first cycle) and scavenged bismuth phosphate waste from URP process waste in the 221-U Building. The waste cascaded through the BY Tank Farm tanks before being discharged to the crib.	180 Similar to rep site	10.0 Less than rep site	31.1 Similar to rep site	186 More than rep site	88.3 Less than rep site	3,400 Similar to rep site	1,500,000 Similar to rep site	6,400 Similar to rep site	17,670	0.36 Less than rep site	The 216-B-19 Crib is analogous to the 216-B-46 Crib as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received the same waste stream as 216-B-46 Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to 216-B-46 Crib; however, the 216-B-19 Crib is slightly larger than the 216-B-46 Crib 3. Waste was received from the same source (221-U) 4. Both sites are located in 200 East Area; the geology of the two sites is similar 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated (e.g., 216-B-43 through 216-B-50 Cribs) 6. Risks are expected to be similar to 216-B-46 Crib; because the top of the contamination is about 4 m (13 ft) bgs, human health and ecological risks are expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at 216-B-46 Crib 7. The relative effluent volume discharged to this crib suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to 216-B-46 Crib. An equivalent volume of effluent was sent to the 216-B-19 Crib; this suggests that contaminants remaining in the vadose may not have been flushed through the crib and concentrations may exceed those found in 216-B-46 Crib, which was found to pose a threat to groundwater. This implies that groundwater protection is needed at this waste site, as it is at 216-B-46 Crib 8. Generally received equivalent contaminant inventory compared to 216-B-46 Crib. The 216-B-19 Crib received higher inventories of Cs-137 and a similar quantity of nitrate, supporting the need for groundwater protection and the possibility of even higher shallow zone and intruder risks than the 216-B-46 Crib. In general, the 216-B-19 Crib is analogous to the 216-B-46 Crib, with a potential for higher risk from the Cs-137 in the shallow zone and in the zone at the bottom of the crib structure. Remedial actions are needed to address the same risks as those of 216-B-46 Crib, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90). Because the contamination is shallower at the 216-B-19 Crib, remedial actions also are needed to address human health and ecological risk in the 0 to 4.6 m (0 to 15-ft) bgs zone.
216-B-20	The 216-B-20 Trench is a backfilled unlined ditch. Waste site dimensions are 153 x 3 x 4 m deep (500 x 10 x 13 ft deep). The depth to the top of contamination is 3.7 m (12 ft). Located in the BC Cribs and Trenches Area and within the assembly of 216-B-20 through 216-B-22 Trenches.	Scavenged TBP Waste Stream Tank Farm/B, BX, BY: 1956. The site received scavenged bismuth phosphate waste from URP process waste in the 221-U Building. The waste cascaded through the BY Tank Farm tanks before being discharged to the trench.	350 More than rep site	1.3 Less than rep site	22.8 Less than rep site	684 More than rep site	340 Less than rep site	2,500 Less than rep site	1,100,000 Similar to rep site	4,680 Less than rep site	13,670	0.34 Less than rep site	The 216-B-20 Trench is analogous to the 216-B-46 Crib as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received the same waste stream as 216-B-46 Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to 216-B-46 Crib despite 216-B-20 being a trench rather than a crib; both are unlined near-surface liquid disposal sites 3. Waste was received from the same source (221-U) 4. Both sites are located in 200 East Area; the geology of the two sites is similar 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated (e.g., 216-B-43 through 216-B-50 Cribs) 6. Risks are expected to be similar to 216-B-46 Crib; because the top of the contamination is about 3.7 m (12 ft) bgs, human health and ecological risks are expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at 216-B-46 Crib 7. The relative effluent volume discharged to this trench suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to 216-B-46 Crib. Roughly half the relative volume of effluent was sent to the 216-B-20 Trench; this suggests that contaminants remaining in the vadose may not have been flushed through the trench and concentrations may exceed those found in 216-B-46 Crib, which was found to pose a threat to groundwater. This implies that groundwater protection is needed at this waste site, as it is at 216-B-46 Crib 8. Generally received equivalent or greater contaminant inventory than 216-B-46. The 216-B-20 Trench received higher inventories of Cs-137, and Tc-99 and uranium, supporting the need for groundwater protection and higher shallow zone and intruder risks than the 216-B-46 Crib. In general, the 216-B-20 Trench is analogous to the 216-B-46 Crib, with a potential for higher risk from the Cs-137 in the shallow zone and in the zone at the bottom of the trench structure, and higher risk from Tc-99 and uranium in the deeper vadose soil. Remedial actions are needed to address the same risks as those of 216-B-46, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90). Because the contamination is shallower at the 216-B-20 Trench, remedial actions also are needed to address human health and ecological risk in the 0 to 4.6 m (0 to 15-ft) bgs zone.

Table 2-2. 200-TW-1 Operable Unit Representative Sites and Associated Analogous Waste Sites. (21 Pages)

Waste Site	Waste Site Configuration, Construction, and Purpose	Site Discharge History (WIDS)	Contaminant Inventory (DOE/RL-96-81)							Effluent Volume (m^3)	Soil Pore Volume (m^3)	Eff Vol + Pore Vol	Rationale
			Total U (kg)	Total Pu (g)	Tc-99* (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	Ferro-cyanide (kg)	Nitrate (kg)				
216-B-21	The 216-B-21 Trench is a backfilled unlined ditch. Waste site dimensions are 153 x 3 x 4 m deep (500 x 10 x 13 ft deep). The depth to the top of contamination is 3.7 m (12 ft). Located in the BC Cribs and Trenches Area and within the assembly of 216-B-20 through 216-B-22 Trenches.	Scavenged TBP Waste Stream Tank Farm/B, BX, BY: 1956. The site received scavenged bismuth phosphate waste from URP process waste in the 221-U Building. The waste cascaded through the BY Tank Farm tanks before being discharged to the trench.	680 More than rep site	10.3 Less than rep site	22.7 Less than rep site	169 More than rep site	318 Less than rep site	-	-	4,670 Less than rep site	13,950	0.34 Less than rep site	The 216-B-21 Trench is analogous to the 216-B-46 Crib as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received the same waste stream as 216-B-46 Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to 216-B-46 Crib despite 216-B-21 being a trench rather than a crib; both are unlined near-surface liquid disposal sites 3. Waste was received from the same source (221-U) 4. Both sites are located in 200 East Area; the geology of the two sites is similar 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated (e.g., 216-B-43 through 216-B-50 Cribs) 6. Risks are expected to be similar to 216-B-46 Crib; because the top of the contamination is about 3.7 m (12 ft) bgs, human health and ecological risks are expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at 216-B-46 Crib 7. The relative effluent volume discharged to this trench suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to 216-B-46 Crib. Roughly half the relative volume of effluent was sent to the 216-B-21 Trench; this suggests that contaminants remaining in the vadose may not have been flushed through the trench and concentrations may exceed those found in 216-B-46 Crib, which was found to pose a threat to groundwater. This implies that groundwater protection is needed at this waste site, as it is at 216-B-46 Crib 8. Generally received equivalent or greater contaminant inventory than 216-B-46 Crib. The 216-B-21 Trench received higher inventories of uranium and Cs-137, supporting the need for groundwater protection and higher shallow zone and intruder risks than the 216-B-46 Crib. In general, the 216-B-21 Trench is analogous to the 216-B-46 Crib, with a potential for higher risk from the Cs-137 in the shallow zone and in the zone at the bottom of the trench structure, and higher risk from uranium in the deeper vadose soil. Remedial actions are needed to address the same risks as those of 216-B-46 Crib, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90). Because the contamination is shallower at the 216-B-21 Trench, remedial actions also are needed to address human health and ecological risk in the 0 to 4 6 m (0 to 15-ft) bgs zone.
216-B-22	The 216-B-22 Trench is a backfilled unlined ditch. Waste site dimensions are 153 x 3 x 4 m deep (500 x 10 x 13 ft deep). The depth to the top of contamination is 3.7 m (12 ft). Located in the BC Cribs and Trenches Area and within the assembly of 216-B-20 through 216-B-22 Trenches.	Scavenged TBP Waste Stream Tank Farm/B, BX, BY: 1956. The site received scavenged bismuth phosphate waste from URP process waste in the 221-U Building. The waste cascaded through the BY Tank Farm tanks before being discharged to the trench.	320 More than rep site	2.6 Less than rep site	23.1 Less than rep site	20.5 Less than rep site	176 Less than rep site	2,500 Less than rep site	900,000 Less than rep site	4,740 Less than rep site	13,800	0.34 Less than rep site	The 216-B-22 Trench is analogous to the 216-B-46 Crib as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received the same waste stream as 216-B-46 Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to 216-B-46 Crib despite 216-B-22 being a trench rather than a crib; both are unlined near-surface liquid disposal sites 3. Waste was received from the same source (221-U) 4. Both sites are located in 200 East Area; the geology of the two sites is similar 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated (e.g., 216-B-43 through 216-B-50 Cribs) 6. Risks are expected to be similar to 216-B-46 Crib; because the top of the contamination is about 3.7 m (12 ft) bgs, human health and ecological risks are expected in the 0 to 4 6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at 216-B-46 Crib 7. The relative effluent volume discharged to this trench suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to 216-B-46 Crib. Roughly half the relative volume of effluent was sent to the 216-B-22 Trench; this suggests that contaminants remaining in the vadose may not have been flushed through the trench and concentrations may exceed those found in 216-B-46 Crib, which was found to pose a threat to groundwater. This implies that groundwater protection is needed at this waste site, as it is at 216-B-46 Crib 8. Generally received less contaminant inventory than 216-B-46. The 216-B-22 Trench received higher inventory of uranium, supporting the need for groundwater protection. In general, the 216-B-22 Trench is analogous to the 216-B-46 Crib, with a potential higher risk from uranium in the deeper vadose soil. Remedial actions are needed to address the same risks as those of 216-B-46 Crib, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90). Because the contamination is shallower at the 216-B-22 Trench, remedial actions also are needed to address human health and ecological risk in the 0 to 4.6 m (0 to 15-ft) bgs zone..

Table 2-2. 200-TW-1 Operable Unit Representative Sites and Associated Analogous Waste Sites. (21 Pages)

Waste Site	Waste Site Configuration, Construction, and Purpose	Site Discharge History (WIDS)	Contaminant Inventory (DOE/RL-96-81)							Effluent Volume (m^3)	Soil Pore Volume (m^3)	Eff Vol ÷ Pore Vol	Rationale
			Total U (kg)	Total Pu (g)	Tc-99* (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	Ferro-cyanide (kg)	Nitrate (kg)				
216-B-23	The 216-B-23 Trench is a backfilled unlined ditch. Waste site dimensions are 153 x 3 x 5.4 m deep (500 x 10 x 18 ft deep). Includes 2.4 m (8 ft) of overburden. The depth to the top of contamination is 5.8 m (19 ft). Located in the BC Cribs and Trenches Area and within the assembly of 216-B-23 through 216-B-28 and 216-B-52 Trenches.	Scavenged TBP Waste Stream Tank Farm/B, BX, BY: 1956. The site received scavenged bismuth phosphate waste from URP process waste in the 221-U Building. The waste cascaded through the BY Tank Farm tanks before being discharged to the trench.	160 Similar to rep site	1.8 Less than rep site	22.0 Less than rep site	50.9 Less than rep site	62.5 Less than rep site	2,400 Less than rep site	1,000,000 Similar to rep site	4,520 Less than rep site	13,390	0.34 Less than rep site	The 216-B-23 Trench is analogous to the 216-B-46 Crib as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received the same waste stream as 216-B-46 Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to 216-B-46 Crib despite 216-B-23 being a trench rather than a crib; both are unlined near-surface liquid disposal sites 3. Waste was received from the same source (221-U) 4. Both sites are located in 200 East Area; the geology of the two sites is similar 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated (e.g., 216-B-43 through 216-B-50 Cribs) 6. Risks are expected to be similar to 216-B-46 Crib; because the top of the contamination is about 5.8 m (19 ft) bgs, human health and ecological risks are not anticipated in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at 216-B-46 Crib 7. The relative effluent volume discharged to this trench suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to 216-B-46 Crib. Roughly half the relative volume of effluent was sent to the 216-B-23 Trench; this suggests that contaminants remaining in the vadose may not have been flushed through the trench and concentrations may exceed those found in 216-B-46 Crib, which was found to pose a threat to groundwater. This implies that groundwater protection is needed at this waste site, as it is at 216-B-46 Crib 8. Generally received equivalent or less contaminant inventory than 216-B-46 Crib. Even so, the need for groundwater protection and the possibility of shallow zone and intruder risks exists. In general, the 216-B-23 Trench is analogous to the 216-B-46 Crib, with a potential for reduced risk in the shallow zone and in the zone at the bottom of the trench structure, and reduced risk in the deeper vadose soil. Remedial actions are needed to address the same risks as those of 216-B-46 Crib, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90).
216-B-24	The 216-B-24 Trench is a backfilled unlined ditch. Waste site dimensions are 153 x 3 x 5.4 m deep (500 x 10 x 18 ft deep). Includes 2.4 m (8 ft) of overburden. The depth to the top of contamination is 5.8 m (19 ft). Located in the BC Cribs and Trenches Area and within the assembly of 216-B-23 through 216-B-28 and 216-B-52 Trenches.	Scavenged TBP Waste Stream Tank Farm/B, BX, BY: 1956. The site received scavenged bismuth phosphate waste from URP process waste in the 221-U Building. The waste cascaded through the BY Tank Farm tanks before being discharged to the trench.	250 More than rep site	77.0 More than rep site	22.9 Less than rep site	58.6 Less than rep site	78.1 Less than rep site	2,500 Less than rep site	600,000 Less than rep site	4,700 Less than rep site	13,670	0.34 Less than rep site	The 216-B-24 Trench is analogous to the 216-B-46 Crib as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received the same waste stream as 216-B-46 Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to 216-B-46 Crib despite 216-B-24 being a trench rather than a crib; both are unlined near-surface liquid disposal sites 3. Waste was received from the same source (221-U) 4. Both sites are located in 200 East Area; the geology of the two sites is similar 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated (e.g., 216-B-43 through 216-B-50 Cribs) 6. Risks are expected to be similar to 216-B-46 Crib; because the top of the contamination is about 5.8 m (19 ft) bgs, human health and ecological risks are not expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at 216-B-46 Crib 7. The relative effluent volume discharged to this trench suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to 216-B-46 Crib. Roughly half the relative volume of effluent was sent to the 216-B-24 Trench; this suggests that contaminants remaining in the vadose may not have been flushed through the trench and concentrations may exceed those found in 216-B-46 Crib, which was found to pose a threat to groundwater. This implies that groundwater protection is needed at this waste site, as it is at 216-B-46 Crib 8. Generally received equivalent or less contaminant inventory than 216-B-46 Crib, except for uranium and roughly four times the quantity of plutonium. The need for groundwater protection and the possibility of shallow zone and intruder risks exists. In general, the 216-B-24 Trench is analogous to the 216-B-46 Crib, with a potential for reduced risk in the shallow zone and in the zone at the bottom of the trench structure, and reduced risk in the deeper vadose soil. Remedial actions are needed to address the same risks as those of 216-B-46 Crib, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90).

Table 2-2. 200-TW-1 Operable Unit Representative Sites and Associated Analogous Waste Sites. (21 Pages)

Waste Site	Waste Site Configuration, Construction, and Purpose	Site Discharge History (WIDS)	Contaminant Inventory (DOE/RL-96-81)							Effluent Volume (m^3)	Soil Pore Volume (m^3)	Eff Vol + Pore Vol	Rationale
			Total U (kg)	Total Pu (g)	Tc-99* (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	Ferro-cyanide (kg)	Nitrate (kg)				
216-B-25	The 216-B-25 Trench is a backfilled unlined ditch. Waste site dimensions are 153 x 3 x 6.2 m deep (500 x 10 x 20 ft deep). Includes 3 m (10 ft) of overburden. The depth to the top of contamination is 5.8 m (19 ft). Located in the BC Cribs and Trenches Area and within the assembly of 216-B-23 through 216-B-28 and 216-B-52 Trenches.	Scavenged TBP Waste Stream Tank Farm/B, BX, BY: 1956. The site received scavenged bismuth phosphate waste from URP process waste in the 221-U Building. The waste cascaded through the BY Tank Farm tanks before being discharged to the trench.	150 Less than rep site	2.0 Less than rep site	18.3 Less than rep site	25.5 Less than rep site	88.3 Less than rep site	2,000 Less than rep site	500,000 Less than rep site	3,760 Less than rep site	13,260	0.28 Less than rep site	The 216-B-25 Trench is analogous to the 216-B-46 Crib as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received the same waste stream as 216-B-46 Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to 216-B-46 Crib despite 216-B-25 being a trench rather than a crib; both are unlined near-surface liquid disposal sites 3. Waste was received from the same source (221-U) 4. Both sites are located in 200 East Area; the geology of the two sites is similar 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated (e g., 216-B-43 through 216-B-50 Cribs) 6. Risks are expected to be similar to 216-B-46 Crib; because the top of the contamination is about 5.8 m (19 ft) bgs, human health and ecological risks are not expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at 216-B-46 Crib 7. The relative effluent volume discharged to this trench suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to 216-B-46 Crib. Roughly half the relative volume of effluent was sent to the 216-B-25 Trench; this suggests that contaminants remaining in the vadose may not have been flushed through the trench and concentrations may exceed those found in 216-B-46 Crib, which was found to pose a threat to groundwater. This implies that groundwater protection is needed at this waste site, as it is at 216-B-46 Crib 8. Generally received less contaminant inventory than 216-B-46 Crib. In general, the 216-B-25 Trench is analogous to the 216-B-46 Crib, with a potential for reduced risk in the shallow zone and in the zone at the bottom of the trench structure, and reduced risk in the deeper vadose soil. Remedial actions are needed to address the same risks as those of 216-B-46, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90).
216-B-26	The 216-B-26 Trench is a backfilled unlined ditch. Waste site dimensions are 153 x 3 x 5.4 m deep (500 x 10 x 18 ft deep). Includes 2.4 m (8 ft) of overburden. The depth to the top of contamination is 5.8 m (19 ft). However, RLS logging of the C4191 borehole through the trench indicated contamination at approximately 3.7 m (12 ft) bgs. Located in the BC Cribs and Trenches Area and within the assembly of 216-B-23 through 216-B-28 and 216-B-52 Trenches.	Scavenged TBP Waste Stream Tank Farm/B, BX, BY: 1956-1957. The site received scavenged bismuth phosphate waste from URP process waste in the 221-U Building. The waste cascaded through the BY Tank Farm tanks before being discharged to the trench.	590 More than rep site	2.5 Less than rep site	28.6 Similar to rep site	438 More than rep site	475 Less than rep site	3,100 Less than rep site	800,000 Less than rep site	5,880 Less than rep site	13,390	0.44 Less than rep site	The 216-B-26 Trench is analogous to the 216-B-46 Crib as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received the same waste stream as 216-B-46 Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to 216-B-46 Crib despite 216-B-26 being a trench rather than a crib; both are unlined near-surface liquid disposal sites 3. Waste was received from the same source (221-U) 4. Both sites are located in 200 East Area; the geology of the two sites is similar 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated (216-B-43 – 216-B-50 Cribs) 6. Risks are expected to be similar to 216-B-46 Crib; because the top of the contamination is about 3.7 m (12 ft) bgs, human health and ecological risks are expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at 216-B-46 Crib 7. The relative effluent volume discharged to this trench suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to 216-B-46 Crib. Slightly more than half the relative volume of effluent was sent to the 216-B-26 Trench; this suggests that contaminants remaining in the vadose may not have been flushed through the trench and concentrations may exceed those found in 216-B-46 Crib, which was found to pose a threat to groundwater. This implies that groundwater protection is needed at this waste site, as it is at 216-B-46 Crib 8. Generally received equivalent or greater contaminant inventory than 216-B-46 Crib. The 216-B-26 Trench received higher inventories of uranium and Cs-137 supporting the need for groundwater protection. The 216-B-26 Trench was sampled in 2003 and is reported in this document. Contaminant Distribution is as follows, Sample data revealed that the bottom of the waste site is near 4.5 m (13 ft) bgs. The bulk of the contamination was observed at this depth. Maximum Cs-137: 529,00 pCi/g at 4.0 – 4.7 m (13 – 15.5 ft) bgs. Maximum Sr-90: 974,000 pCi/g at the same depth. Maximum plutonium-239/240: 195 pCi/g at the same depth. Maximum total uranium: 56.9 mg/kg at the same depth. Technetium-99 and nitrate were observed deeper in the vadose zone. Maximum Tc-99: 92 pCi/g at about 30.5 m (100 ft) bgs. Maximum nitrate: 4,090 mg/kg at the same depth. Because contamination starts above 4.6 m (15 ft) bgs, human health risks from direct exposure risks are anticipated. Significant contamination exists just below the bottom of the trench that could pose risk to intruders. In addition, contamination located deeper in the vadose zone poses a potential threat to groundwater. Risks associated with this site imply that groundwater protection is required and that alternatives should consider protection against inadvertent intruders.

Table 2-2. 200-TW-1 Operable Unit Representative Sites and Associated Analogous Waste Sites. (21 Pages)

Waste Site	Waste Site Configuration, Construction, and Purpose	Site Discharge History (WIDS)	Contaminant Inventory (DOE/RL-96-81)							Effluent Volume (m^3)	Soil Pore Volume (m^3)	Eff Vol + Pore Vol	Rationale
			Total U (kg)	Total Pu (g)	Tc-99* (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	Ferro-cyanide (kg)	Nitrate (kg)				
216-B-27	The 216-B-27 Trench is a backfilled unlined ditch. Waste site dimensions are 153 3 x 5.4 m deep (500 x 10 x 18 ft deep). Includes 2.4 m (8 ft) of overburden. The depth to the top of contamination is 5.5 m (18 ft). Located in the BC Cribs and Trenches Area and within the assembly of 216-B-23 through 216-B-28 and 216-B-52 Trenches.	Scavenged TBP Waste Stream Tank Farm/B, BX, BY: 1957. The site received scavenged bismuth phosphate waste from URP process waste in the 221-U Building. The waste cascaded through the BY Tank Farm tanks before being discharged to the trench.	340 More than rep site	0.7 Less than rep site	21.5 Less than rep site	15.8 Less than rep site	263 Less than rep site	2,300 Less than rep site	600,000 Less than rep site	4,420 Less than rep site	13,390	0.33 Less than rep site	The 216-B-27 Trench is analogous to the 216-B-46 Crib as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received the same waste stream as 216-B-46 Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to 216-B-46 Crib despite 216-B-27 being a trench rather than a crib; both are unlined near-surface liquid disposal sites 3. Waste was received from the same source (221-U) 4. Both sites are located in 200 East Area; the geology of the two sites is similar 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated (e.g., 216-B-43 through 216-B-50 Cribs) 6. Risks are expected to be similar to 216-B-46 Crib; because the top of the contamination is about 5.5 m (18 ft) bgs, human health and ecological risks are not expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at 216-B-46 Crib 7. The relative effluent volume discharged to this trench suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to 216-B-46 Crib. About half the relative volume of effluent was sent to the 216-B-27 Trench; this suggests that contaminants remaining in the vadose may not have been flushed through the trench and concentrations may exceed those found in 216-B-46 Crib, which was found to pose a threat to groundwater. This implies that groundwater protection is needed at this waste site, as it is at 216-B-46 Crib 8. Generally received equivalent or lesser contaminant inventory than 216-B-46 Crib. The 216-B-27 Trench received a higher inventory of uranium, though, supporting the need for groundwater protection. In general, the 216-B-27 Trench is analogous to the 216-B-46 Crib, with a potential higher risk from uranium in the deeper vadose soil. Remedial actions are needed to address the same risks as those of 216-B-46 Crib, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90).
216-B-28	The 216-B-28 Trench is a backfilled unlined ditch. Waste site dimensions are 153 x 3 x 3 m deep (500 x 10 x 10 ft deep). The depth to the top of contamination is 3.7 m (12 ft). Located in the BC Cribs and Trenches Area and within the assembly of 216-B-23 through 216-B-28 and 216-B-52 Trenches.	Scavenged TBP Waste Stream Tank Farm/B, BX, BY: 1957. The site received scavenged bismuth phosphate waste from URP process waste in the 221-U Building. The waste cascaded through the BY Tank Farm tanks before being discharged to the trench.	300 More than rep site	5.6 Less than rep site	24.6 Less than rep site	10.7 Less than rep site	49.5 Less than rep site	2,700 Less than rep site	1,000,000 Similar to rep site	5,050 Less than rep site	13,530	0.37 Less than rep site	The 216-B-28 Trench is analogous to the 216-B-46 Crib as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received the same waste stream as 216-B-46 Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to 216-B-46 Crib despite 216-B-28 being a trench rather than a crib; both are unlined near-surface liquid disposal sites 3. Waste was received from the same source (221-U) 4. Both sites are located in 200 East Area; the geology of the two sites is similar 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated (e.g., 216-B-43 through 216-B-50 Cribs) 6. Risks are expected to be similar to 216-B-46 Crib; because the top of the contamination is about 3.7 m (12 ft) bgs, human health and ecological risks are expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at 216-B-46 Crib 7. The relative effluent volume discharged to this trench suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to 216-B-46 Crib. Slightly more than half the relative volume of effluent was sent to the 216-B-28 Trench; this suggests that contaminants remaining in the vadose may not have been flushed through the trench and concentrations may exceed those found in 216-B-46 Crib, which was found to pose a threat to groundwater. This implies that groundwater protection is needed at this waste site, as it is at 216-B-46 Crib 8. Generally received equivalent or lesser contaminant inventory than 216-B-46 Crib. Even so, the need for groundwater protection exists. In general, the 216-B-28 Trench is analogous to the 216-B-46 Crib. Remedial actions are needed to address the same risks as those of 216-B-46 Crib, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90). Because the contamination is shallower at the 216-B-28 Trench, remedial actions also are needed to address human health and ecological risk in the 0 to 4.6 m (0 to 15-ft) bgs zone.

Table 2-2. 200-TW-1 Operable Unit Representative Sites and Associated Analogous Waste Sites. (21 Pages)

Waste Site	Waste Site Configuration, Construction, and Purpose	Site Discharge History (WIDS)	Contaminant Inventory (DOE/RL-96-81)							Effluent Volume (m^3)	Soil Pore Volume (m^3)	Eff Vol + Pore Vol	Rationale
			Total U (kg)	Total Pu (g)	Tc-99* (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	Ferro-cyanide (kg)	Nitrate (kg)				
216-B-29	The 216-B-29 Trench is a backfilled unlined ditch. Waste site dimensions are 153 x 3 x 3 m deep (500 x 10 x 13 ft deep). The depth to the top of contamination is 3.7 m (12 ft). Located in the BC Cribs and Trenches Area and within the assembly of 216-B-28 through 216-B-34 Trenches.	Scavenged TBP Waste Stream Tank Farm/B, BX, BY: 1957. The site received scavenged bismuth phosphate waste from URP process waste in the 221-U Building. The waste cascaded through the BY Tank Farm tanks before being discharged to the trench.	340 More than rep site	1.1 Less than rep site	23.6 Less than rep site	27.4 Less than rep site	84.8 Less than rep site	2,600 Less than rep site	700,000 Less than rep site	4,840 Less than rep site	13,530	0.36 Less than rep site	The 216-B-29 Trench is analogous to the 216-B-46 Crib as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received the same waste stream as 216-B-46 Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to 216-B-46 Crib despite 216-B-29 being a trench rather than a crib; both are unlined near-surface liquid disposal sites 3. Waste was received from the same source (221-U) 4. Both sites are located in 200 East Area; the geology of the two sites is similar 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated (e.g., 216-B-43 through 216-B-50 Cribs) 6. Risks are expected to be similar to 216-B-46 Crib; because the top of the contamination is about 3.7 m (12 ft) bgs, human health and ecological risks are expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at 216-B-46 Crib 7. The relative effluent volume discharged to this trench suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to 216-B-46 Crib. Slightly more than half the relative volume of effluent was sent to the 216-B-29 Trench; this suggests that contaminants remaining in the vadose may not have been flushed through the trench and concentrations may exceed those found in 216-B-46 Crib, which was found to pose a threat to groundwater. This implies that groundwater protection is needed at this waste site, as it is at 216-B-46 Crib 8. Generally received equivalent or lesser contaminant inventory than 216-B-46 Crib. The 216-B-29 Trench received a higher inventory of uranium, supporting the need for groundwater protection. In general, the 216-B-29 Trench is analogous to the 216-B-46 Crib. Remedial actions are needed to address the same risks as those of 216-B-46 Crib, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90). Because the contamination is shallower at the 216-B-29 Trench, remedial actions also are needed to address human health and ecological risk in the 0 to 4.6 m (0 to 15-ft) bgs zone.
216-B-30	The 216-B-30 Trench is a backfilled unlined ditch. Waste site dimensions are 153 x 3 x 3 m deep (500 x 10 x 13 ft deep). The depth to the top of contamination is 3.7 m (12 ft). Located in the BC Cribs and Trenches Area and within the assembly of 216-B-28 through 216-B-34 Trenches.	Scavenged TBP Waste Stream Tank Farm/B, BX, BY: 1957. The site received scavenged bismuth phosphate waste from URP process waste in the 221-U Building. The waste cascaded through the BY Tank Farm tanks before being discharged to the trench.	88.0 Less than rep site	2.1 Less than rep site	23.3 Less than rep site	1,570 More than rep site	265 Less than rep site	2,500 Less than rep site	1,100,000 Similar to rep site	4,780 Less than rep site	13,530	0.35 Less than rep site	The 216-B-30 Trench is analogous to the 216-B-46 Crib as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received the same waste stream as 216-B-46 Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to 216-B-46 Crib despite 216-B-30 being a trench rather than a crib; both are unlined near-surface liquid disposal sites 3. Waste was received from the same source (221-U) 4. Both sites are located in 200 East Area; the geology of the two sites is similar 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated (e.g., 216-B-43 through 216-B-50 Cribs) 6. Risks are expected to be similar to 216-B-46 Crib; because the top of the contamination is about 3.7 m (12 ft) bgs, human health and ecological risks are expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at 216-B-46 Crib 7. The relative effluent volume discharged to this trench suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to 216-B-46 Crib. Slightly more than half the relative volume of effluent was sent to the 216-B-30 Trench; this suggests that contaminants remaining in the vadose may not have been flushed through the trench and concentrations may exceed those found in 216-B-46 Crib, which was found to pose a threat to groundwater. This implies that groundwater protection is needed at this waste site, as it is at 216-B-46 Crib 8. Generally received lesser contaminant inventory than 216-B-46 Crib. The 216-B-30 Trench received considerably higher inventories of Cs-137, supporting the need for intruder protection. In general, the 216-B-30 Trench is analogous to the 216-B-46 Crib. Remedial actions are needed to address the same risks as those of 216-B-46 Crib, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90). Because the contamination is shallower at the 216-B-30 Trench, remedial actions also are needed to address human health and ecological risk in the 0 to 4.6 m (0 to 15-ft) bgs zone.

Table 2-2. 200-TW-1 Operable Unit Representative Sites and Associated Analogous Waste Sites. (21 Pages)

Waste Site	Waste Site Configuration, Construction, and Purpose	Site Discharge History (WIDS)	Contaminant Inventory (DOE/RL-96-81)							Effluent Volume (m^3)	Soil Pore Volume (m^3)	Eff Vol + Pore Vol	Rationale
			Total U (kg)	Total Pu (g)	Tc-99* (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	Ferro-cyanide (kg)	Nitrate (kg)				
216-B-31	The 216-B-31 Trench is a backfilled unlined ditch. Waste site dimensions are 153 x 3 x 3 m deep (500 x 10 x 13 ft deep). The depth to the top of contamination is 4 m (13 ft). Located in the BC Cribs and Trenches Area and within the assembly of 216-B-28 through 216-B-34 Trenches.	Scavenged TBP Waste Stream Tank Farm/B, BX, BY: 1957. The site received scavenged bismuth phosphate waste from URP process waste in the 221-U Building. The waste cascaded through the BY Tank Farm tanks before being discharged to the trench.	120 Less than rep site	-	23.1 Less than rep site	10.6 (HNF-1744) Less than rep site	74.5 (HNF-1744) Less than rep site	2,500 Less than rep site	1,100,000 Similar to rep site	4,740 Less than rep site	13,530	0.35 Less than rep site	The 216-B-31 Trench is analogous to the 216-B-46 Crib as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received the same waste stream as 216-B-46 Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to 216-B-46 Crib despite 216-B-31 being a trench rather than a crib; both are unlined near-surface liquid disposal sites 3. Waste was received from the same source (221-U) 4. Both sites are located in 200 East Area; the geology of the two sites is similar 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated (e.g., 216-B-43 through 216-B-50 Cribs) 6. Risks are expected to be similar to 216-B-46 Crib; because the top of the contamination is about 4 m (13 ft) bgs, human health and ecological risks are expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at 216-B-46 Crib 7. The relative effluent volume discharged to this trench suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to 216-B-46 Crib. Slightly more than half the relative volume of effluent was sent to the 216-B-31 Trench; this suggests that contaminants remaining in the vadose may not have been flushed through the trench and concentrations may exceed those found in 216-B-46 Crib, which was found to pose a threat to groundwater. This implies that groundwater protection is needed at this waste site, as it is at 216-B-46 Crib 8. Generally received lesser contaminant inventory than 216-B-46 Crib. In general, the 216-B-31 Trench is analogous to the 216-B-46 Crib. Remedial actions are needed to address the same risks as those of 216-B-46, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (*i.e., Cs-137 and Sr-90*). *Because the contamination is shallower at* the 216-B-31 Trench, remedial actions also are needed to address human health and ecological risk in the 0 to 4.6 m (0 to 15-ft) bgs zone.
216-B-32	The 216-B-32 Trench is a backfilled unlined ditch. Waste site dimensions are 153 x 3 x 3 m deep (500 x 10 x 13 ft deep). The depth to the top of contamination is 4 m (13 ft). Located in the BC Cribs and Trenches Area and within the assembly of 216-B-28 through 216-B-34 Trenches.	Scavenged TBP Waste Stream Tank Farm/B, BX, BY: 1957. The site received scavenged bismuth phosphate waste from URP process waste in the 221-U Building. The waste cascaded through the BY Tank Farm tanks before being discharged to the trench.	11.0 Less than rep site	2.6 Less than rep site	23.2 Less than rep site	58.6 Less than rep site	113 Less than rep site	2,500 Less than rep site	1,000,000 Similar to rep site	4,770 Less than rep site	13,530	0.35 Less than rep site	The 216-B-32 Trench is analogous to the 216-B-46 Crib as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. *Received the same waste stream as 216-B-46 Crib; therefore,* the contaminant types are expected to be very similar 2. Site construction is similar to 216-B-46 Crib despite 216-B-32 being a trench rather than a crib; both are unlined near-surface liquid disposal sites 3. Waste was received from the same source (221-U) 4. Both sites are located in 200 East Area; the geology of the two sites is similar 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated (e.g., 216-B-43 through 216-B-50 Cribs) 6. Risks are expected to be similar to 216-B-46 Crib; because the top of the contamination is about 4.0 m (13 ft) bgs, human health and ecological risks are expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at 216-B-46 Crib 7. The relative effluent volume discharged to this trench suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to 216-B-46 Crib. Slightly more than half the relative volume of effluent was sent to the 216-B-32 Trench; this suggests that contaminants remaining in the vadose may not have been flushed through the trench and concentrations may exceed those found in 216-B-46 Crib, which was found to pose a threat to groundwater. This implies that groundwater protection is needed at this waste site, as it is at 216-B-46 Crib 8. Generally received lesser contaminant inventory than 216-B-46 Crib. *In general, the 216-B-32 Trench is* analogous to the 216-B-46 Crib. Remedial actions are needed to address the same risks as those of 216-B-46 Crib, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90). Because the contamination is shallower at the 216-B-32 Trench, remedial actions also are needed to address human health and ecological risk in the 0 to 4.6 m (0 to 15-ft) bgs zone.

Table 2-2. 200-TW-1 Operable Unit Representative Sites and Associated Analogous Waste Sites. (21 Pages)

Waste Site	Waste Site Configuration, Construction, and Purpose	Site Discharge History (WIDS)	Contaminant Inventory (DOE/RL-96-81) Total U (kg)	Total Pu (g)	Tc-99* (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	Ferro-cyanide (kg)	Nitrate (kg)	Effluent Volume (m^3)	Soil Pore Volume (m^3)	Eff Vol + Pore Vol	Rationale
216-B-33	The 216-B-33 Trench is a backfilled unlined ditch. Waste site dimensions are 153 x 3 x 3 m deep (500 x 10 x 13 ft deep). The depth to the top of contamination is 4 m (13 ft). Located in the BC Cribs and Trenches Area and within the assembly of 216-B-28 through 216-B-34 Trenches.	Scavenged TBP Waste Stream Tank Farm/B, BX, BY: 1957. The site received scavenged bismuth phosphate waste from URP process waste in the 221-U Building. The waste cascaded through the BY Tank Farm tanks before being discharged to the trench.	20 Less than rep site	11.8 Less than rep site	23.1 Less than rep site	127 More than rep site	18.1 Less than rep site	2,500 Less than rep site	1,700,000 More than rep site	4,740 Less than rep site	13,530	0.35 Less than rep site	The 216-B-33 Trench is analogous to the 216-B-46 Crib as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received the same waste stream as 216-B-46 Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to 216-B-46 Crib despite 216-B-33 being a trench rather than a crib; both are unlined near-surface liquid disposal sites 3. Waste was received from the same source (221-U) 4. Both sites are located in 200 East Area; the geology of the two sites is similar 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated (e.g., 216-B-43 through 216-B-50 Cribs) 6. Risks are expected to be similar to 216-B-46 Crib; because the top of the contamination is about 4.0 m (13 ft) bgs, human health and ecological risks are expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at 216-B-46 Crib 7. The relative effluent volume discharged to this trench suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to 216-B-46 Crib. About half the relative volume of effluent was sent to the 216-B-33 Trench; this suggests that contaminants remaining in the vadose may not have been flushed through the trench and concentrations may exceed those found in 216-B-46 Crib, which was found to pose a threat to groundwater. This implies that groundwater protection is needed at this waste site, as it is at 216-B-46 Crib 8. Generally received lesser contaminant inventory of mobile constituents than 216-B-46 Crib; also received a higher inventory of Cs-137, which would imply a greater risk to humans from direct exposure, to ecological receptors, and to intruders. In general, the 216-B-33 Trench is analogous to the 216-B-46 Crib. Remedial actions are needed to address the same risks as those of 216-B-46 Crib, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90). Because the contamination is shallower at the 216-B-33 Trench, remedial actions also are needed to address human health and ecological risk in the 0 to 4.6 m (0 to 15-ft) bgs zone.
216-B-34	The 216-B-34 Trench is a backfilled unlined ditch. Waste site dimensions are 153 x 3 x 3 m deep (500 x 10 x 13 ft deep). The depth to the top of contamination is 4 m (13 ft). Located in the BC Cribs and Trenches Area and within the assembly of 216-B-28 through 216-B-34 Trenches.	Scavenged TBP Waste Stream Tank Farm/B, BX, BY: 1957. The site received scavenged bismuth phosphate waste from URP process waste in the 221-U Building. The waste cascaded through the BY Tank Farm tanks before being discharged to the trench.	85.0 Less than rep site	5.7 Less than rep site	23.7 Less than rep site	7.9 Less than rep site	18.1 Less than rep site	2,600 Less than rep site	1,900,000 More than rep site	4,870 Less than rep site	13,530	0.36 Less than rep site	The 216-B-34 Trench is analogous to the 216-B-46 Crib as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received the same waste stream as 216-B-46 Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to 216-B-46 Crib despite 216-B-34 being a trench rather than a crib; both are unlined near-surface liquid disposal sites 3. Waste was received from the same source (221-U) 4. Both sites are located in 200 East Area; the geology of the two sites is similar 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated (e.g., 216-B-43 through 216-B-50 Cribs) 6. Risks are expected to be similar to 216-B-46 Crib; because the top of the contamination is about 4.0 m (13 ft) bgs, human health and ecological risks are expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at 216-B-46 Crib 7. The relative effluent volume discharged to this trench suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to 216-B-46 Crib. Slightly more than half the relative volume of effluent was sent to the 216-B-34 Trench; this suggests that contaminants remaining in the vadose may not have been flushed through the trench and concentrations may exceed those found in 216-B-46 Crib, which was found to pose a threat to groundwater. This implies that groundwater protection is needed at this waste site, as it is at 216-B-46 Crib 8. Generally received lesser contaminant inventory than 216-B-46 Crib. The 216-B-34 Trench received a higher inventory of nitrate, supporting the need for groundwater protection. In general, the 216-B-34 Trench is analogous to the 216-B-46 Crib. Remedial actions are needed to address the same risks as those of 216-B-46 Crib, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90). Because the contamination is shallower at the 216-B-34 Trench, remedial actions also are needed to address human health and ecological risk in the 0 to 4.6 m (0 to 15-ft) bgs zone.

Table 2-2. 200-TW-1 Operable Unit Representative Sites and Associated Analogous Waste Sites. (21 Pages)

Waste Site	Waste Site Configuration, Construction, and Purpose	Site Discharge History (WIDS)	Contaminant Inventory (DOE/RL-96-81)							Effluent Volume (m^3)	Soil Pore Volume (m^3)	Eff Vol + Pore Vol	Rationale
			Total U (kg)	Total Pu (g)	Tc-99* (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	Ferro-cyanide (kg)	Nitrate (kg)				
216-B-42	The 216-B-42 Trench is a backfilled unlined ditch. Waste site dimensions are 77 x 3 x 3 m deep (252 x 10 x 13 ft deep). The depth to the top of contamination is 3 m (10 ft). Located approximately 167 m (550 ft) from the BX Tank Farm tanks and associated with the assembly of 216-B-35 through 216-B-42 Cribs.	Scavenged TBP Waste Stream Tank Farm/B, BX, BY: 1955. The site received scavenged bismuth phosphate waste from URP process waste in the 221-U Building. The waste cascaded through the BY Tank Farm tanks before being discharged to the trench.	680 More than rep site	10.0 Less than rep site	7.30 Less than rep site	42.7 Less than rep site	463 Less than rep site	800 Less than rep site	210,000 Less than rep site	1,500 Less than rep site	5,265	0.30 Less than rep site	The 216-B-42 Trench is analogous to the 216-B-46 Crib as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received the same waste stream as 216-B-46 Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to 216-B-46 Crib despite 216-B-42 being a trench rather than a crib; both are unlined near-surface liquid disposal sites 3. Waste was received from the same source (221-U) 4. Both sites are located in 200 East Area in proximity to each other; the geology of the two sites is similar 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated (e g., 216-B-43 through 216-B-50 Cribs) 6. Risks are expected to be similar to 216-B-46 Crib; because the top of the contamination is about 3.0 m (10 ft) bgs, human health and ecological risks are expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at 216-B-46 Crib 7. The relative effluent volume discharged to this trench suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to 216-B-46 Crib. About half the relative volume of effluent was sent to the 216-B-42 Trench; this suggests that contaminants remaining in the vadose may not have been flushed through the trench and concentrations may exceed those found in 216-B-46 Crib, which was found to pose a threat to groundwater. This implies that groundwater protection is needed at this waste site, as it is at 216-B-46 Crib 8. Generally received a lesser contaminant inventory than 216-B-46 Crib. The 216-B-42 Trench received a higher inventory of uranium, supporting the need for groundwater protection. In general, the 216-B-42 Trench is analogous to the 216-B-46 Crib. Remedial actions are needed to address the same risks as those of 216-B-46 Crib, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90). Because the contamination is shallower at the 216-B-42 Trench, remedial actions also are needed to address human health and ecological risk in the 0 to 4.6 m (0 to 15-ft) bgs zone.
216-B-43	The 216-B-43 Crib consists of four 1.2 m (4 ft) diameter x 1.2 m (4 ft) long concrete culverts, buried vertically with centers spaced 4.6 m (15 ft) apart. Construction data indicate that the crib is in a 9.1 x 9.1 x 4.6 m deep (30- x 30- x 15-ft deep) excavation. Sample data collected in 1993 confirm that the bottom of the excavation after stabilization (i e., addition of 3 ft of clean soil) is about 5.4 m (18 ft). Located approximately 61 m (200 ft) from the BY Tank Farm tanks and associated with the assembly of 216-B-43 through 216-B-50 Cribs.	Scavenged TBP Waste Stream The 216-B-43 Crib received URP/ scavenged liquid extraction waste routed via BY Tank Farm. Cribs B-43 to B-50 were stabilized together in 1975 with 0.3 m (1 ft) clean soil. Contaminated soil from UPR-200-E-89 was consolidated onto the 216-B-43 to 216-B-50 Cribs and covered with 0.6 m (2 ft) of clean fill in 1991.	14.0 Less than rep site	0.5 Less than rep site	10.2 Less than rep site	114 More than rep site	172 Less than rep site	5,000 More than rep site	400,000 Less than rep site	2,120 Less than rep site	10,200	0.21 Less than rep site	The 216-B-43 Crib is analogous to the 216-B-46 Crib as indicated by process history, contaminant inventory, effluent volume received, and sampling data collected under DOE/RL-88-32 and reported in DOE/RL-92-70; a risk assessment is provided in Appendix C of this FS: 1. Received the same waste stream as 216-B-46 Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is the same as 216-B-46 Crib 3. Waste was received from the same source (221-U) 4. Both sites are located in 200 East Area in proximity to each other; the geology of the two sites is similar 5. The vertical extent of contamination is similar based on characterization evidence from this site; contaminants were found mainly in a zone from 5.6 to 9.8 m (18.5 to 32 ft) bgs (this was a shallow borehole; based on 216-B-49 Crib, which was drilled to the water table as representative of the deep zone for the other sites in the 216-B-43 through 216-B-50 Cribs series of cribs, this zone would be expected to be about 15 m (50 ft) bgs; Tc-99 and nitrate are expected to be found throughout the vadose zone 6. Risks are similar to 216-B-46 Crib; because the top of the contamination is about 5.4 m (18 ft) bgs, direct contact human health risk and ecological risk are not anticipated; intruder risk is a concern 7. The relative effluent volume discharged to this crib suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to 216-B-46 Crib. About one-third the relative volume of effluent was sent to the 216-B-43 Crib; this suggests that contaminants remaining in the vadose may not have been flushed through the crib and concentrations may exceed those found in 216-B-46 Crib, which was found to pose a threat to groundwater. This implies that groundwater protection is needed at this waste site, as it is at 216-B-46 Crib 8. Generally received equivalent or less contaminant inventory than 216-B-46 Crib, except for more Cs-137 and cyanide, supporting the need for intruder and groundwater protection. In general, the 216-B-43 Crib is analogous to the 216-B-46 Crib. Remedial actions are needed to address the same risks as those of 216-B-46 Crib, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90).

Table 2-2. 200-TW-1 Operable Unit Representative Sites and Associated Analogous Waste Sites. (21 Pages)

Waste Site	Waste Site Configuration, Construction, and Purpose	Site Discharge History (WIDS)	Contaminant Inventory (DOE/RL-96-81)							Effluent Volume (m^3)	Soil Pore Volume (m^3)	Eff Vol + Pore Vol	Rationale
			Total U (kg)	Total Pu (g)	Tc-99* (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	Ferro-cyanide (kg)	Nitrate (kg)				
216-B-44	The 216-B-44 Crib consists of four 1.2 m (4-ft)-diameter x 1.2 m (4-ft) long concrete culverts, buried vertically with centers spaced 4.6 m (15 ft) apart in a 9.1 x 9.1 x 4.6 m deep (30- x 30- x 15-ft deep) excavation. The depth to the top of contamination is 5.5 m (18 ft). Sample data collected in 1993 confirm that the bottom of the excavation after stabilization (i.e., addition of 3 ft of clean soil) is about 18 ft. Located approximately 91 m (300 ft) from the BY Tank Farm tanks and associated with the assembly of 216-B-43 through 216-B-50 Cribs.	Scavenged TBP Waste Stream The 216-B-44 Crib received URP/ scavenged liquid extraction waste routed via BY Tank Farm. The 216-B-43 to 216-B-50 Cribs were stabilized together in 1975 with 0.3 m (1 ft) clean soil. Contaminated soil from UPR-200-E-89 was consolidated onto the 216-B-43 to 216-B-50 Cribs and covered with 0.6 m (2 ft) of clean fill in 1991.	5.3 Less than rep site	15.0 Similar to rep site	27.3 Similar to rep site	309 More than rep site	1,200 More than rep site	3,000 Less than rep site	800,000 Less than rep site	5,600 Less than rep site	9,885	0.57 Similar to rep site	The 216-B-44 Crib is analogous to the 216-B-46 Crib as indicated by process history, contaminant inventory, effluent volume received, and sampling data collected under DOE/RL-88-32 and reported in DOE/RL-92-70; a risk assessment is provided in Appendix C of this FS: 1. Received the same waste stream as 216-B-46 Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is the same as 216-B-46 Crib 3. Waste was received from the same source (221-U) 4. Both sites are located in 200 East Area in proximity to each other; the geology of the two sites is similar 5. The vertical extent of contamination is similar based on characterization evidence from this site; contaminants were found mainly in a zone from 5.8 to 9.6 m (19 to 31.5 ft) bgs (this was a shallow borehole; based on 216-B-49 Crib, which was drilled to the water table as representative of the deep zone for the other sites in the 216-B-43 through 216-B-50 Cribs series of cribs, this zone would be expected to be about 15 m (50 ft) bgs; Tc-99 and nitrate are expected to be found throughout the vadose zone 6. Risks are similar to 216-B-46 Crib; because the top of the contamination is about 5.4 m (18 ft) bgs, direct contact human health risk and ecological risk are not anticipated; intruder risk is a concern 7. The relative effluent volume discharged to this crib suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to 216-B-46 Crib. Slightly less relative volume of effluent was sent to the 216-B-44 Crib; this suggests that contaminants remaining in the vadose may not have been flushed through the crib and concentrations may exceed those found in 216-B-46 Crib, which was found to pose a threat to groundwater. This implies that groundwater protection is needed at this waste site, as it is at 216-B-46 Crib 8. Generally received equivalent or greater contaminant inventory than 216-B-46 Crib. The 216-B-44 Crib received considerably higher inventories Cs-137 and Sr-90, supporting the need for intruder protection. In general, the 216-B-44 Crib is analogous to the 216-B-46 Crib. Remedial actions are needed to address the same risks as those of 216-B-46 Crib, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90).
216-B-45	The 216-B-45 Crib consists of four 1.2 m (4-ft)-diameter x 1.2 m (4-ft) long concrete culverts, buried vertically with centers spaced 4.6 m (15 ft) apart in a 9.1 x 9.1 x 4 6 m deep (30- x 30- x 15-ft deep) excavation. A light chain outlines the group of cribs. The estimated depth to the top of contamination is 5.2 m (17 ft). Located approximately 114 m (375 ft) from the BY Tank Farm tanks and associated with the assembly of 216-B-43 through 216-B-50 Cribs.	Scavenged TBP Waste Stream The 216-B-45 Crib received URP/ scavenged liquid extraction waste routed via BY Tank Farm. The 216-B-43 to 216-B-50 Cribs were stabilized together in 1975 with 0.3 m (1 ft) clean soil. Contaminated soil from UPR-200-E-89 was consolidated onto the 216-B-43 to 216-B-50 Cribs and covered with 0.6 m (2 ft) of clean fill in 1991.	6.0 Less than rep site	10.0 Less than rep site	23.8 Less than rep site	666 More than rep site	1,180 More than rep site	2,600 Less than rep site	90,000 Less than rep site	4,920 Less than rep site	9,885	0.50 Similar to rep site	The 216-B-45 Crib is analogous to the 216-B-46 Crib as indicated by process history, contaminant inventory, effluent volume received, and sampling data collected under DOE/RL-88-32 and reported in DOE/RL-92-70; a risk assessment is provided in Appendix C of this FS: 1. Received the same waste stream as 216-B-46 Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is the same as 216-B-46 Crib 3. Waste was received from the same source (221-U) 4. Both sites are located in 200 East Area in proximity to each other; the geology of the two sites is similar 5. The vertical extent of contamination is similar based on characterization evidence from this site; contaminants were found mainly in a zone from 5.2 to 9 m (17 to 29.5 ft) bgs (this was a shallow borehole; based on 216-B-49 Crib, which was drilled to the water table as representative of the deep zone for the other sites in the 216-B-43 through 216-B-50 Cribs series of cribs, this zone would be expected to be about 15 m (50 ft) bgs; Tc-99 and nitrate are expected to be found throughout the vadose zone 6. Risks are similar to 216-B-46 Crib; because the top of the contamination is about 5.2 m (17 ft) bgs, direct contact human health risk and ecological risk are not anticipated; intruder risk is a concern 7. The relative effluent volume discharged to this crib suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to 216-B-46 Crib. Slightly less relative volume of effluent was sent to the 216-B-45 Crib; this suggests that contaminants remaining in the vadose may not have been flushed through the crib and concentrations may exceed those found in 216-B-46 Crib, which was found to pose a threat to groundwater. This implies that groundwater protection is needed at this waste site, as it is at 216-B-46 Crib 8. Generally received less contaminant inventory than 216-B-46 Crib except for considerably higher inventories of Cs-137 and Sr-90, supporting the need for intruder protection. In general, the 216-B-45 Crib is analogous to the 216-B-46 Crib. Remedial actions are needed to address the same risks as those of 216-B-46 Crib, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90).

Table 2-2. 200-TW-1 Operable Unit Representative Sites and Associated Analogous Waste Sites. (21 Pages)

Waste Site	Waste Site Configuration, Construction, and Purpose	Site Discharge History (WIDS)	Contaminant Inventory (DOE/RL-96-81)							Effluent Volume (m^3)	Soil Pore Volume (m^3)	Eff Vol + Pore Vol	Rationale
			Total U (kg)	Total Pu (g)	Tc-99* (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	Ferro-cyanide (kg)	Nitrate (kg)				
216-B-47	The 216-B-47 Crib has four 1.2 m (4-ft)-diameter x 1.2 m (4-ft) long concrete culverts, buried vertically with centers spaced 4 6 m (15 ft) apart in a 9.1 x 9.1 x 4.6 m deep (30- x 30- x 15-ft deep) excavation. Estimated depthto the top of contamination is 6.4 m (21 ft). Located approximately 61 m (200 ft) from the BY Tank Farm tanks and associated with the assembly of 216-B-43 through 216-B-50 Cribs.	Scavenged TBP Waste Stream The 216-B-47 Crib received URP/ scavenged liquid extraction waste routed via BY Tank Farm. The 216-B-43 to 216-B-50 Cribs were stabilized together in 1975 with 0.3 m (1 ft) clean soil. Contaminated soil from UPR-200-E-89 was consolidated onto the 216-B-43 to 216-B-50 Cribs and covered with 0.6 m (2 ft) of clean fill in 1991. A light chain outlines the group of cribs.	6.8 Less than rep site	5.0 Less than rep site	18.0 Less than rep site	66.6 Less than rep site	261 Less than rep site	2,000 Less than rep site	700,000 Less than rep site	3,710 Less than rep site	10,355	0.36 Less than rep site)	The 216-B-47 Crib is analogous to the 216-B-46 Crib as indicated by process history, contaminant inventory, effluent volume received, and sampling data collected under DOE/RL-88-32 and reported in DOE/RL-92-70; a risk assessment is provided in Appendix C of this FS: 1. Received the same waste stream as 216-B-46 Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is the same as 216-B-46 Crib 3. Waste was received from the same source (221-U) 4. Both sites are located in 200 East Area in proximity to each other; the geology of the two sites is similar 5. The vertical extent of contamination is similar based on characterization evidence from this site; contaminants were found mainly in a zone from 6.4 to 10.7 m (21 to 35 ft) bgs (this was a shallow borehole; based on 216-B-49 Crib, which was drilled to the water table as representative of the deep zone for the other sites in the 216-B-43 through 216-B-50 Cribs series of cribs, this zone would be expected to be about 15 m (50 ft) bgs; Tc-99 and nitrate are expected to be found throughout the vadose zone 6. Risks are similar to 216-B-46 Crib; because the top of the contamination is about 6.4 m (21 ft) bgs, direct contact human health risk and ecological risk are not anticipated; intruder risk is a concern 7. The relative effluent volume discharged to this crib suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to 216-B-46 Crib. Slightly less relative volume of effluent was sent to the 216-B-47 Crib; this suggests that contaminants remaining in the vadose may not have been flushed through the trench and concentrations may exceed those found in 216-B-46 Crib, which was found to pose a threat to groundwater. This implies that groundwater protection is needed at this waste site, as it is at 216-B-46 Crib 8. Generally received less contaminant inventory than 216-B-46 Crib. In general, the 216-B-47 Crib is analogous to the 216-B-46 Crib. Remedial actions are needed to address the same risks as those of 216-B-46 Crib, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90).
216-B-48	The 216-B-48 Crib consists of four 1.2 m (4-ft)-diameter x 1.2 m (4-ft) long concrete culverts, buried vertically with centers spaced 4.6 m (15 ft) apart in a 9.1 x 9.1 x 4.6 m deep (30- x 30- x 15-ft deep) excavation. The depth to the top of contamination is 5.3 m (17.5 ft). Located approximately 91 m (300 ft) from the BY Tank Farm tanks and associated with the assembly of 216-B-43 through 216-B-50 Cribs.	Scavenged TBP Waste Stream The 216-B-48 Crib received URP/ scavenged liquid extraction waste routed via BY Tank Farm. The 216-B-43 to 216-B-50 Cribs were stabilized together in 1975 with 0.3 m (1 ft) clean soil. Contaminated soil from UPR-200-E-89 was consolidated onto the 216-B-43 to 216-B-50 Cribs and covered with 0.6 m (2 ft) of clean fill in 1991. A light chain outlines the group of cribs.	2.3 Less than rep site	5.0 Less than rep site	20.0 Less than rep site	200 More than rep site	547 Less than rep site	2,200 Less than rep site	1,000,000 Similar to rep site	4,090 Less than rep site	10,042	0.41 Less than rep site	The 216-B-48 Crib is analogous to the 216-B-46 Crib as indicated by process history, contaminant inventory, effluent volume received, and sampling data collected under DOE/RL-88-32 and reported in DOE/RL-92-70; a risk assessment is provided in Appendix C of this FS: 1. *Received the same waste stream as 216-B-46 Crib; therefore, the contaminant types are expected to be very similar* 2. Site construction is the same as 216-B-46 Crib 3. Waste was received from the same source (221-U) 4. Both sites are located in 200 East Area in proximity to each other; the geology of the two sites is similar 5. The vertical extent of contamination is similar based on characterization evidence from this site; contaminants were found mainly in a zone from 5.2 to 9.8 m (17 to 32 ft) bgs (this was a shallow borehole; based on 216-B-49 Crib, which was drilled to the water table as representative of the deep zone for the other sites in the 216-B-43 through 216-B-50 Cribs series of cribs, this zone would be expected to be about 15 m (50 ft) bgs; Tc-99 and nitrate are expected to be found throughout the vadose zone 6. Risks are similar to 216-B-46 Crib; because the top of the contamination is about 5.3 m (17.5 ft) bgs, direct contact human health risk and ecological risk are not anticipated; intruder risk is a concern 7. The relative effluent volume discharged to this crib suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to 216-B-46 Crib. Approximately half the relative volume of effluent was sent to the 216-B-48 Crib; this suggests that contaminants remaining in the vadose may not have been flushed through the crib and concentrations may exceed those found in 216-B-46 Crib, which was found to pose a threat to groundwater. This implies that groundwater protection is needed at this waste site, as it is at 216-B-46 Crib 8. Generally received less contaminant inventory than 216-B-46 Crib. The 216-B-48 Crib received higher inventories of Tc-99 and Cs-137, supporting the need for intruder protection. In general, the 216-B-48 Crib is analogous to the 216-B-46 Crib. Remedial actions are needed to address the same risks as those of 216-B-46 Crib, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90).

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Waste Site	Waste Site Configuration, Construction, and Purpose	Site Discharge History (WIDS)	Contaminant Inventory (DOE/RL-96-81)							Effluent Volume (m^3)	Soil Pore Volume (m^3)	Eff Vol + Pore Vol	Rationale
			Total U (kg)	Total Pu (g)	Tc-99* (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	Ferro-cyanide (kg)	Nitrate (kg)				
216-B-49	The 216-B-49 Crib consists of four 1.2 m (4-ft)-diameter x 1.2 m (4-ft) long concrete culverts, buried vertically with centers spaced 4.6 m (15 ft) apart in a 9.1 x 9.1 x 4.6 m deep (30- x 30- x 15-ft deep) excavation. The depth to the top of contamination is 5 m (16.5 ft). Located approximately 114 m (375 ft) from the BY Tank Farm tanks and associated with the assembly of 216-B-43 through 216-B-50 Cribs.	<u>Scavenged TBP Waste Stream</u> The 216-B-49 Crib received URP/ scavenged liquid extraction waste routed via BY Tank Farm. The 216-B-43 to 216-B-50 Cribs were stabilized together in 1975 with 0.3 m (1 ft) clean soil. Contaminated soil from UPR-200-E-89 was consolidated onto the 216-B-43 to 216-B-50 Cribs and covered with 0.6 m (2 ft) of clean fill in 1991. A light chain outlines the group of cribs.	320 More than rep site	15.0 Less than rep site	32.6 Similar to rep site	182 More than rep site	1,140 More than rep site	4,000 Similar to rep site	1,500,000 More than rep site	6,700 Similar to rep site	9,885	0.68 Similar to rep site	The 216-B-49 Crib is analogous to the 216-B-46 Crib as indicated by process history, contaminant inventory, effluent volume received, and sampling data collected under DOE/RL-88-32 and reported in DOE/RL-92-70; a risk assessment is provided in Appendix C of this FS: 1. Received the same waste stream as 216-B-46 Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to 216-B-46 Crib 3. Waste was received from the same source (221-U) 4. Both sites are located in 200 East Area in proximity to each other; the geology of the two sites is similar 5. The vertical extent of contamination is similar based on characterization evidence from this site; contaminants were found mainly in a zone from 5 to 14.9 m (16.5 to 49 ft) bgs (this was drilled to the water table; Tc-99 and nitrate were found throughout the vadose zone) 6. Risks are similar to 216-B-46 Crib; because the top of the contamination is about 5 m (16.5 ft) bgs, direct contact human health risk and ecological risk are not anticipated; intruder risk is a concern 7. Mobile contaminants, such as nitrate and Tc-99, were found throughout the vadose zone, suggesting the need for groundwater protection 8. Generally received equivalent or greater contaminant inventory than 216-B-46 Crib. The 216-B-49 Crib received higher inventories of uranium, Cs-137, Sr-90 and nitrate, supporting the need for intruder and groundwater protection. In general, the 216-B-49 Crib is analogous to the 216-B-46 Crib. Remedial actions are needed to address the same risks as those of 216-B-46 Crib, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90).
216-B-51	The 216-B-51 French Drain is a 1.5 m (5-ft) diameter concrete pipe extending 0.3 m (1 ft) above ground and 4.3 m (14 ft) below ground. The pipe is filled with 4 m (13 ft) of gravel. The depth to the top of contamination is 4.0 m (13 ft) (estimated). It is an isolated waste site that is more than 213 m (700 ft) from the BY Tank Farm tanks.	<u>Scavenged TBP Waste Stream</u> Tank Farm/BY: 1956-1958. The site received scavenged bismuth phosphate waste from URP process waste in the 221-U Building. The waste cascaded through the BY Tank Farm tanks before being discharged to the french drain. Very little data are available to evaluate this site.	-	-	-	-	-	-	190 Less than rep site	1 Less than rep site	135	0.01 Less than rep site	The 216-B-51 French Drain is analogous to the 216-B-46 Crib as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received the same waste stream as 216-B-46 Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to 216-B-46 Crib although it is a French drain rather than a crib 3. Waste was received from the same source (221-U) 4. Both sites are located in 200 East Area in proximity to each other; the geology of the two sites is similar 5. The vertical extent of contamination is expected to be similar (or less) based on evidence from similar sites investigated (e.g., 216-B-43 through 216-B-50 Cribs) 6. Risks are expected to be similar to but less than for the 216-B-46 Crib; because the top of the contamination is about 4.9 m (16 ft) bgs, human health and ecological risks are not expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at 216-B-46 Crib 7. The relative effluent volume discharged to this waste site suggests that contaminant inventory in the vadose zone does not pose a threat to groundwater. Much less relative volume of effluent was sent to the 216-B-51 French Drain. 8. Very little contaminant inventory data are available; however, it is believed that the 216-B-51 French Drain received substantially lesser contaminant inventory than 216-B-46 Crib. In general, the 216-B-51 French Drain is bounded by the 216-B-46 Crib. Remedial actions are expect to be less than those for the 216-B-46 Crib. It should not be necessary to provide groundwater protection and protection against intrusion. Contaminant concentrations are expected to be low and decay to PRG within 150 yr.

Table 2-2. 200-TW-1 Operable Unit Representative Sites and Associated Analogous Waste Sites. (21 Pages)

Waste Site	Waste Site Configuration, Construction, and Purpose	Site Discharge History (WIDS)	Contaminant Inventory (DOE/RL-96-81)							Effluent Volume (m^3)	Soil Pore Volume (m^3)	Eff Vol + Pore Vol	Rationale
			Total U (kg)	Total Pu (g)	Tc-99* (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	Ferro-cyanide (kg)	Nitrate (kg)				
216-B-52	The 216-B-52 Trench is a backfilled unlined ditch. Waste site dimensions are 177 x 3 x 3 m deep (580 x 10 x 10 ft deep). The depth to the top of contamination is 3.7 m (12 ft). Located in the BC Cribs and Trenches Area and within the assembly of 216-B-23 through 216-B-28 and 216-B-52 Trenches.	<u>In-Tank Scavenged Waste Stream</u> Tank Farm/B, BX, BY: 1957-1958. The site received scavenged bismuth phosphate waste from URP process waste in the 221-U Building. The waste cascaded through the BY Tank Farm tanks before being discharged to the trench.	30.0 Less than rep site	19.0 Similar to rep site	41.5 More than rep site	160 More than rep site	4.92 Less than rep site	5,000 More than rep site	2,100,000 More than rep site	8,530 More than rep site	15,710	0.54 Similar to rep site	The 216-B-52 Trench is analogous to the 216-B-46 Crib as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received the same waste stream as 216-B-46 Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to 216-B-46 Crib despite 216-B-52 being a trench rather than a crib; both are unlined near-surface liquid disposal sites 3. Waste was received from the same source (221-U) 4. Both sites are located in 200 East Area; the geology of the two sites is similar 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated (e.g., 216-B-43 through 216-B-50 Cribs) 6. Risks are expected to be similar to 216-B-46 Crib; however, because the top of the contamination is about 3.7 m (12 ft) bgs, human health and ecological risks are expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at 216-B-46 Crib 7. The relative effluent volume discharged to this trench suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to 216-B-46 Crib. Slightly less relative volume of effluent was sent to the 216-B-52 Trench; this suggests that contaminants remaining in the vadose may not have been flushed through the trench and concentrations may exceed those found in 216-B-46 Crib, which was found to pose a threat to groundwater. This implies that groundwater protection is needed at this waste site, as it is at 216-B-46 Crib 8. Generally received greater contaminant inventory than 216-B-46 Crib. The 216-B-52 Trench received higher inventories of Cs-137, Tc-99, nitrate and cyanide, supporting the need for groundwater protection and the possibility of even higher shallow zone and intruder risks than the 216-B-46 Crib. In general, the 216-B-52 Trench is analogous to the 216-B-46 Crib, with a potential for higher risk from the Cs-137 in the shallow zone and in the zone at the bottom of the trench structure, and higher risk from Tc-99, cyanide and nitrate in the deeper vadose soil. Remedial actions are needed to address the same risks as those of 216-B-46 Crib, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90). Because the contamination is shallower at the 216-B-52 Trench, remedial actions also are needed to address human health and ecological risk in the 0 to 4.6 m (0 to 15-ft) bgs zone.
216-BY-201	The 216-BY-201 Settling Tank is a rectangular, reinforced concrete tank. The tank dimensions are 12.5 x 1.9 x 4.3 m (41 x 6 x 14 ft). 1.5 m (5 ft) is overburden. The depth to the top of contamination over the top of the tank is 1.5 m (5 ft). Located approximately 46 m (150 ft) from the BY Tank Farm tanks and associated with the assembly of 216-B-43 through 216-B-50 Cribs.	<u>In-Tank Scavenged Waste Stream</u> Tank Farm/BY: 1954-1958. The tank received tank farm and scavenged bismuth phosphate solvent extraction waste from the URP process waste in the 221-U Building.	0.19 less than rep site	0.025 less than rep site	-	1.3 less than rep site	4.6 less than rep site	6.7 less than rep site	2,300 less than rep site	<31 Less than rep site	N/A	N/A	The 216-BY-201 Settling Tank is analogous to the 216-B-46 Crib as indicated by waste stream chemistry and the expected distribution of contamination. Radioactive waste from the BY Tank Farm overflowed to this tank enroute to the 216-B-43 to 216-B-50 Cribs. The tank was designed to scavenge the TBP waste. Relatively free of solids, a small amount of salt cake may have been deposited in the tank. The volume of material in the tank is unknown but is less than 2800 L (750 gal) of sludge based on the low-liquid level where flushing action of the tank would stop and 31,100 L (8,230 gal) of liquid based on the high-liquid level where tank flushing action would commence: 1. Received the same waste stream as 216-B-46 Crib; therefore, the contaminant types are expected to be the same 2. Site construction is not similar to 216-B-46 Crib in that it was not designed as an unlined near-surface liquid disposal site; instead it was intended to be a process vessel 3. Waste was received from the same source (221-U) 4. Both sites are located in 200 East Area in proximity to each other; the geology of the two sites is similar 5. The vertical extent of contamination is expected to be considerably less because there is no evidence that the tank has leaked 6. Risks are expected to be much less than for 216-B-46 Crib because less contamination is expected to be associated with the tank; sludge in the tank bottom is expected to be the main source of risk for the site; the contamination associated with the sludge is less than 5.8 m (19 ft) bgs, and human health and ecological risks may be associated with the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination in the tank sludge 7. Groundwater threat is not expected for this tank, particularly any leak from this tank, because the tank was designed to pass effluents to the cribs and not to allow infiltration to the soil column; a leak associated with UPR-200-E-9 was cleaned up at the time of release; historical evidence of other leaks has not been documented. In general, the 216-BY-201 Settling Tank is analogous to the 216-B-46 Crib. Remedial actions are needed to address some of the same risks the 216-B-46 Crib, specifically protection against intrusion to contaminants in the bottom of the tank which could pose a significant direct contact risk to a potential intruder. The tank is located in proximity to the 216-B-43 through 216-B-50 series of cribs.

Table 2-2. 200-TW-1 Operable Unit Representative Sites and Associated Analogous Waste Sites. (21 Pages)

Waste Site	Waste Site Configuration, Construction, and Purpose	Site Discharge History (WIDS)	Contaminant Inventory (DOE/RL-96-81)							Effluent Volume (m^3)	Soil Pore Volume (m^3)	Eff Vol + Pore Vol	Rationale
			Total U (kg)	Total Pu (g)	Tc-99* (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	Ferro-cyanide (kg)	Nitrate (kg)				
UPR-200-E-9	The exact size of the release has not been determined. The general area and size of the release is depicted in HW-60807. The depth to the top of contamination is 3 m (10 ft). Located in the assembly of 216-B-43 through 216-B-50 Cribs just south of the 216-B-43 Crib.	Scavenged TBP Waste Stream Tank Farm/BY: 1955. UPR-200-E-9 is associated with the 216-BY-201 Settling Tank. The release consisted of scavenged bismuth phosphate solvent extraction waste from the URP process waste from the 221-U Building.	-	-	-	-	-	-	-	41.8 Less than rep site	-	-	The UPR-200-E-9 unplanned release is analogous to the 216-B-46 Crib as indicated by the waste stream received. Approximately 41,800 L of scavenged waste overflowed from the 216-BY-201Settling Tank and was released to the ground; most of the waste was cleaned up and removed from the site: 1. Received the same waste stream as 216-B-46 Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is not similar to 216-B-46 Crib in that it was a spill rather than a near-surface liquid disposal site 3. Waste was received from the same source (221-U) 4. Both sites are located in 200 East Area in proximity to each other; the geology of the two sites is similar 5. The vertical extent of contamination is expected to be considerably less because the quantity of the spill was much less 6. Risks are expected to be much less than for 216-B-46 Crib; because the depthto the top of contamination is 3.0 m (10 ft) bgs, human health and ecological risks are expected in the 0 to 4.6 m (0 to 15-ft) zone; however, these are expected to be low because the majority of the contaminants have been removed 7. The effluent volume spilled and the clean up activities conducted after the spill suggest that contaminant inventory in the vadose zone probably does not pose a threat to groundwater 8. Generally received lesser contaminant inventory than 216-B-46 Crib. In general, the UPR-200-E-9 unplanned release is bounded by the 216-B-46 Crib, with a potential for low risk to human and ecological receptors from near-surface contamination.
200-E-114	The 216-E-114 Pipeline is a steel pipeline. The pipeline extends from the BY and C Tank Farms to the BC Cribs and Trench Area. The pipeline is approximately 4,600 m (15,100 ft) long with a diameter of 6 cm (2.4 in.). The depth to the pipe is assumed to be 2.1 to 3.0 m (7 to 10 ft).	Scavenged TBP Waste Stream Tank Farm/BY and C: 1952-1954. The pipeline transported scavenged bismuth phosphate solvent extraction waste from the URP process waste in the 221-U Building.	-	-	-	-	-	-	-	-	-	-	The 200-E-114 Pipeline is analogous to the 216-B-46 Crib: 1. Received the same waste stream as 216-B-46 Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is not similar to 216-B-46 Crib in that it was not designed as an unlined near-surface liquid disposal site; instead it was intended to be a transfer pipeline 3. Waste was received from the same source (221-U) 4. Both sites are located in 200 East Area; the geology of the two sites is similar 5. The vertical extent of contamination is expected to be considerably less, because there is evidence that only minor pipeline leakage has occurred. In 1997, contamination measuring 2,500 to 5,000 dpm beta/gamma was observed in a 6.1 x 30.5 m (20 x 100 ft) area straddling the pipeline northeast of the B Tank Farm near the point where it turns south. In 2001, another radiological survey found contamination measuring up to 19,000 dpm beta/gamma within a 15.2 m (50 ft) diameter area straddling the pipeline near its junction to the 216-B-51 French Drain 6. Risks are expected to be much less than for 216-B-46 Crib; because the pipeline depth varies from about 2.1 to 3.0 m (7 to 10 ft) bgs, human health and ecological risks may exist in the 0 to 4 6 m (0 to 15-ft) zone where leaks have occurred 7. Groundwater threat is not expected for this pipeline, because the pipeline was designed to pass effluents to the cribs and not to allow infiltration to the soil column; no historical evidence of leaks has been documented 8. Generally received lesser contaminant inventory than 216-B-46 Crib. In general, the 200-E-114 Pipeline is bounded by the 216-B-46 Crib, with a potential for low risk to human and ecological receptors from near-surface contamination.

Table 2-2. 200-TW-1 Operable Unit Representative Sites and Associated Analogous Waste Sites. (21 Pages)

Waste Site	Waste Site Configuration, Construction, and Purpose	Site Discharge History (WIDS)	Contaminant Inventory (DOE/RL-96-81)							Effluent Volume (m^3)	Soil Pore Volume (m^3)	Eff Vol ÷ Pore Vol	Rationale
			Total U (kg)	Total Pu (g)	Tc-99* (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	Ferro-cyanide (kg)	Nitrate (kg)				
216-E-14	The 216-E-14 Siphon Tank is an underground tank. Tank dimensions are 8.2 x 3.9 m (27 x 12.75 ft). The depth to the top of contamination is 2.1 m (7 ft) to the top of the tank; however, the tank vent is only 0.6 m (2 ft) below current ground level. Located in the BC Cribs and Trenches Area and within the assembly of 216-B-14 through 216-B-19 Cribs.	Scavenged TBP Waste Stream Tank Farm/BY: 1956-1958. The tank received tank farm and scavenged bismuth phosphate solvent extraction waste from the URP process waste in the 221-U Building. The tank discharged waste to the 216-B-14 through 216-B-19 Cribs	1.5 less than rep site	0.075 less than rep site	-	1.9 less than rep site	2.0 less than rep site	24 less than rep site	7,600 less than rep site	<42 Less than rep site	N/A	N/A	The 200-E-14 Siphon Tank is analogous to the 216-B-46 Crib waste site as indicated by waste stream chemistry and the expected distribution of contamination. Radioactive waste from the BY tank farm system was received by this tank for routing to the 216-B-14 to 216-B-19 Cribs. The volume of material in the tank is unknown but is less than 3,825 L (1,010 gal) of sludge based on the low-liquid level where flushing action of the tank would stop and 31,100 L (41,800 gal) of liquid based on the high-liquid level where tank flushing action would commence: 1. Received the same waste stream as 216-B-46 Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is not similar to 216-B-46 Crib in that it was not designed as an unlined near-surface liquid disposal site; instead it was intended to be an accumulation tank that discharged to specific cribs when full 3. Waste was received from the same source (221-U) 4. Both sites are located in 200 East Area; the geology of the two sites is similar 5. The vertical extent of contamination is expected to be considerably less, because there is no evidence that the tank has leaked 6. Risks are expected to be much less than for 216-B-46 Crib; because the top of potential sludge in the tank bottom is about 2.1 m (7 ft) bgs, human health and ecological risks are expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the tank 7. Groundwater threat is not expected for this tank because the tank was designed to pass effluents to the cribs and not to allow infiltration to the soil column; no historical evidence of leaks has been documented 8. Generally received lesser contaminant inventory than 216-B-46 Crib. In general, the 200-E-14 Siphon Tank, particularly any leak from this tank, is bounded by the 216-B-46 Crib, with a potential for lower risk from the Cs-137 in the bottom of the tank. Remedial actions are needed to address direct contact risk to humans and ecological receptors; groundwater protection is not generally considered to be needed. Because the contamination is shallower at the 200-E-14 Siphon Tank, remedial actions also are needed to address human health and ecological risk in the 0 to 4.6 m (0 to 15-ft) bgs zone.
Representative Site													
216-B-58	The 216-B-58 Trench is 60 m (200 ft) long x 3.0 m (10 ft) wide and 3.0 m (10 ft) deep. It was divided into eight 8 m (25 ft) sections by earthen dams that were 1.5 m (5 ft) high and 0.1 m (0.3 ft) wide at their top. A corrugated 1.22 m (4 ft) diameter perforated pipe runs the length of the trench except for the western 8 m (25 ft) section. The depth to the top of contamination is 3.6 m (12 ft). Located in the BC Cribs and Trenches Area and within the assembly of 216-B-53A through 216-B-58 Trenches.	300 Area Laboratory Waste Liquid wastes from the 300 Area laboratory facilities were trucked to this trench from 1965 to 1967.	9.1	6.7	~0	4.40	5.55	--	10	413	5,640	0.073	Investigated in 2003; characterization is described in this document. Contaminant Distribution Sampling confirms that the bottom of the waste site is about 4.1 m (13.5) bgs. The bulk of the contamination is in the 4.1 to 4.9 m (13.5 to 16 ft) bgs zone. The predominant contaminant is Cs-137. A maximum Cs-137 concentration of 14,600 pCi/g was detected at a depth of about 4.3 m (14 ft) bgs. At 8.1 m (26.5 ft) bgs, the concentration was 69.9 pCi/g. A maximum Pu-239/240 concentration of 310 pCi/g was detected at about 4.3 m (14 ft) bgs. Barium concentration peaks at about 7.3 m (24 ft) bgs (100 mg/kg). Selenium concentration peaks at about 5.8 m (19 ft) bgs (13 mg/kg). Because contamination begins at depths shallower than 4.6 m (15 ft) bgs, human health risks from direct exposure and ecological risks are anticipated. This contamination also presents a risk to potential intruders. Minor concentrations of mobile contaminants suggest that risk to groundwater may be minor.

Table 2-2. 200-TW-1 Operable Unit Representative Sites and Associated Analogous Waste Sites. (21 Pages)

Waste Site	Waste Site Configuration, Construction, and Purpose	Site Discharge History (WIDS)	Contaminant Inventory (DOE/RL-96-81)							Effluent Volume (m^3)	Soil Pore Volume (m^3)	Eff Vol ÷ Pore Vol	Rationale
			Total U (kg)	Total Pu (g)	Tc-99* (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	Ferro-cyanide (kg)	Nitrate (kg)				
200-TW-1 OU analogous wastes sites to be evaluated by the (216-B-58 Trench) model													
216-B-53A	The 216-B-53A Trench is 18.3 m (60 ft) long x 3.0 m (10 ft) wide and 3.0 m (10 ft) deep. It was divided into two sections by an earthen dam at the center that was 1.5 m (5 ft) high and 0.1 m (0.3 ft) wide at its top. The depth to the top of contamination is 3 m (10 ft). Located in the BC Cribs and Trenches Area and within the assembly of 216-B-53A through 216-B-58 Trenches.	PRTR Process Tube Failure Cleanup Waste Stream Trench received liquid waste associated with the PRTR reactor upset (process tube failure). Secondary cooling water became contaminated with plutonium and mixed fission products. Of all of the specific retention trenches in the BC Cribs and Trenches Area, only this trench has the potential to have concentrations of transuranic constituents above 100 nCi/g. Trench was active in October and November 1965.	23.0 More than rep site	100 More than rep site	~0 Similar to rep site	0.056 Less than rep site	0.054 Less than rep site	--	1 Less than rep site	549 More than rep site	16,301	0.43 More than rep site	The 216-B-53A Trench is analogous to the 216-B-58 Trench as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. It did not receive the same waste stream; rather, it received secondary cooling water from the PRTR reactor following a fuel cladding failure 2. Site construction is similar to the 216-B-58 Trench 3. Both sites are located in 200 East Area in proximity to each other; the geology of the two sites is similar 4. The vertical extent of contamination is expected to be similar based on effluent volume received 5. Risks are expected to be similar to 216-B-58 Trench; because the top of the contamination is about 3.0 m (10 ft) bgs, human health and ecological risks are expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at 216-B-58 Trench 6. Although the relative effluent volume discharged to this trench suggests that contaminant inventory in the vadose zone may be deeper than at 216-B-58 Trench; the quantity of contaminants having potential to impact groundwater is relatively small, suggesting that the risk to groundwater may be negligible 7. Generally received equivalent or greater contaminant inventory than 216-B-58 Trench. The 216-B-53A Trench received higher inventories of uranium and plutonium, supporting the possibility of even higher shallow zone and intruder risks than the 216-B-58 Trench. In general, the 216-B-53A Trench is analogous to the 216-B-58 Trench, with a potential for higher risk from the plutonium in the shallow zone and in the zone at the bottom of the trench structure. Remedial actions are needed to address the same risks as those of the 216-B-58 Trench, specifically protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (plutonium).
216-B-53B	The 216-B-53B Trench is 46 m (150 ft) long x 3.0 m (10 ft) wide and 3.0 m (10 ft) deep. It was divided into two sections by an earthen dam at the center that was 1.5 m (5 ft) high and 0.1 m (0.3 ft) wide at its top. The depth to the top of contamination is 3 m (10 ft). Located in the BC Cribs and Trenches Area and within the assembly of 216-B-53A through 216-B-58 Trenches.	300 Area Laboratory Waste Liquid wastes from the 300 Area laboratory facilities were trucked to this trench from 1962 to 1963.	9.1 Similar to rep site	5.0 Similar to rep site	~0 Similar to rep site	3.70 Similar to rep site	5.06 Similar to rep site	--	1 Less than rep site	15.1 Less than rep site	4,120	0.004 Similar to rep site	The 216-B-53B Trench is analogous to the 216-B-58 Trench as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received the same waste stream as 216-B-58 Trench; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to 216-B-58 Trench 3. Both sites are located in 200 East Area in proximity to each other; the geology of the two sites is similar 4. The vertical extent of contamination is expected to be similar based on effluent volume received 5. Risks are expected to be similar to 216-B-58 Trench; because the top of the contamination is about 3.1 m (10 ft) bgs, human health and ecological risks are expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at 216-B-58 Trench 6. The relative effluent volume discharged to this trench suggests that the contaminant inventory in the vadose zone should be very close to the bottom of the trench, similar to 216-B-58 Trench. Also, the quantity of contaminants having potential to impact groundwater is relatively small, suggesting that the risk to groundwater may be negligible 7. Generally received equivalent inventory compared to 216-B-58 Trench. In general, the 216-B-53B Trench is analogous to the 216-B-58 Trench, with a potential for risk from contamination in the shallow zone and in the zone at the bottom of the trench structure. Remedial actions are needed to address the same risks as those of 216-B-58 Trench, specifically protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants.

Table 2-2. 200-TW-1 Operable Unit Representative Sites and Associated Analogous Waste Sites. (21 Pages)

Waste Site	Waste Site Configuration, Construction, and Purpose	Site Discharge History (WIDS)	Contaminant Inventory (DOE/RL-96-81)							Effluent Volume (m^3)	Soil Pore Volume (m^3)	Eff Vol + Pore Vol	Rationale
			Total U (kg)	Total Pu (g)	Tc-99* (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	Ferro-cyanide (kg)	Nitrate (kg)				
216-B-54	The 216-B-54 Trench is 60 m (200 ft) long x 3.0 m (10 ft) wide and 3.0 m (10 ft) deep. It was divided into two sections by an earthen dam at the center that was 1.5 m (5 ft) high and 0.1 m (0.3 ft) wide at its top. The depth to the top of contamination is 2 m (7 ft). Located in the BC Cribs and Trenches Area and within the assembly of 216-B-53A through 216-B-58 Trenches.	300 Area Laboratory Waste Liquid wastes from the 300 Area laboratory facilities were trucked to this trench from March to October 1963.	9.1 Similar to rep site	5.0 Similar to rep site	~0 Similar to rep site	0.055 Less than rep site	0.052 Less than rep site	--	100 More than rep site	999 More than rep site	5,470	0.183 More than rep site	The 216-B-54 Trench is analogous to the 216-B-58 Trench as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received the same waste stream as 216-B-58 Trench; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to 216-B-58 Trench 3. Both sites are located in 200 East Area in proximity to each other; the geology of the two sites is similar 4. The vertical extent of contamination is expected to be similar based on effluent volume received 5. Risks are expected to be similar to 216-B-58 Trench; because the top of the contamination is about 2.0 m (7 ft) bgs, human health and ecological risks are expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at 216-B-58 Trench 6. Somewhat more relative volume of effluent was sent to the 216-B-54 Trench, suggesting that contaminants in the vadose soil may be somewhat deeper than at 216-B-58 Trench. However, the quantity of contaminants having potential to impact groundwater is relatively small, suggesting that the risk to groundwater may be negligible 7. Generally received less or equivalent or greater contaminant inventory than 216-B-58 Trench. In general, the 216-B-54 Trench is analogous to the 216-B-58 Trench, with a potential for risk from contamination in the shallow zone and in the zone at the bottom of the trench structure. Remedial actions are needed to address the same risks as those of 216-B-58 Trench, specifically protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants.

* BHI-01496, *Groundwater/Vadose Zone Integration Project Hanford Soil Inventory Model.*

DOE/RL-88-32, *Remedial Investigation/Feasibility Study Work Plan for the 200-BP-1 Operable Unit, Hanford Site, Richland, Washington*, Rev. 1.

DOE/RL-92-70, *Phase I Remedial Investigation Report for 200-BP-1 Operable Unit*, Vols. 1 and 2, Rev. 0.

DOE/RL-96-81, *Waste Site Grouping for 200 Areas Soil Investigations*, Rev. 0.

DOE/RL-2000-38, *200-TW-1 Scavenged Waste Group Operable Unit and 200-TW-2 Tank Waste Group Operable Unit RI/FS Work Plan*, Rev. 0.

HNF-1744, *Radionuclide Inventories of Liquid Waste Disposal Sites on the Hanford Site.*

HW-60807, *Unconfined Underground Radioactive Waste and Contamination in the 200 Areas - 1959.*

Waste Information Data System Report, Hanford Site database.

bgs = below ground surface.
OU = operable unit.
PRTR = Plutonium Recycle Test Reactor.
RI = remedial investigation.
RLS = radionuclide logging system.
TBP = tributyl phosphate.
TRU = contaminated with 100 nCi/g of transuranic materials with half-lives longer than 20 years.
UPR = unplanned release.
URP = Uranium Recovery Process.
WIDS = *Waste Information Data System Report.*

Table 2-3. 200-TW-2 Operable Unit Representative Sites and Associated Analogous Waste Sites. (15 Pages)

Waste Site	Waste Site Configuration, Construction, and Purpose	Site Discharge History (WIDS)	Contaminant Inventory (DOE/RL-96-81)						Effluent Volume (m^3)	Soil Pore Volume (m^3)	Eff Vol ÷ Pore Vol	Rationale
			Total U (kg)	Total Pu (g)	Tc-99* (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	Nitrate (kg)				
Representative Site												
216-B-5	The 216-B-5 Injection/Reverse Well extends to a depth of 92 m (302 ft). The 20 cm (8-in.) diameter borehole casing is perforated from 74 m to 92 m (243 to 302 ft). Contaminants were injected directly into the aquifer. The depth to the top of contamination is 74.1 m (243 ft). Isolated from significant structures except the 241-B-361 Settling Tank located approximately 18 m (60 ft) away.	2nd Cycle, Cell 5-6 Drainage, and Lanthanum Fluoride Waste Stream The site received the liquid waste from 221-B and 224-B via overflow of the 216-BY-201 Settling Tank. Liquid process effluent was received between 1945 and 1947 (2 years).	---	4270	0.138	29.2	25.5	40,000	30,600	---		The 216-B-5 Injection Well/Reverse Well was characterized in 1980 (RHO-ST-37). Contamination in the vadose zone is about 73 to 86.6 m (243 to 284 ft) bgs at the 216-B-5 Injection Well/Reverse Well. Cesium-137, Sr-90, Pu-239/240 and Am-241 were the only constituents analyzed and detected. The maximum concentrations of Cs-137, Sr-90, Pu-239/240, and Am-241 range from 1,800 to 75,000 pCi/g. The Injection Well/Reverse Well received the same waste stream as the 216-B-7A Crib and 216-B-7B Cribs; therefore, similar contaminants should be present. Within the aquifer, contaminant concentration generally increases with depth.
200-TW-2 OU analogous wastes sites to be evaluated by the (216-B-5Injection Well/Reverse Well) model												
216-T-3	The 216-T-3 Injection/Reverse Well is a 20 cm (8-in.) diameter Injection Well/Reverse Well drilled to 62.8 m (206 ft) and perforated from 32.0 m (105 ft) to 62.2 m (204.1 ft). It consisted of well casings with varying diameters. The depth to the top of contamination is about 32 m (105 ft). Isolated from significant structures except the adjacent 241-T-361 Settling Tank and the 216-T-6 Crib, which are approximately 61 m (200 ft) away.	2nd Cycle, Cell 5-6 Drainage, and Lanthanum Fluoride Waste Stream The site received low salt, neutral/basic liquid waste from cell drainage from tank 5-6 in the 221-T canyon building and 224-T via the 241-T-361 Settling Tank. Site received liquid waste between June 1945 and August 1946 (active for 1 year).	--	3350 Less than rep site	0.098 Similar to rep site	21.3 Less than rep site	18.6 Less than rep site	290,000 More than rep site	11,300 Less than rep site	--	--	The 216-T-3 Injection Well/Reverse Well is analogous to the 216-B-5 Injection Well/Reverse Well as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received a waste stream similar to the 216-B-5 Injection Well/Reverse Well; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to the 216-B-5 Injection Well/Reverse Well in that both are injection well/reverse wells 3. Waste was received from a similar source 4. The geology of the two sites is similar, although the vadose zone is thinner in the 200 West Area 5. The vertical extent of contamination is expected to be similar based on similar methods of operation 6. Risks are expected to be similar to the 216-B-5 Injection Well/Reverse Well; however, because the top of the contamination is about 32 m (105 ft) bgs, human health and ecological risks are not expected in the 0 to 4.6 m (0 to 15-ft) zone 7. The effluent volume discharged to this waste site suggests that residual contaminant inventory in the vadose zone may pose a threat to groundwater, similar to the 216-B-5 Injection Well/Reverse Well. Although groundwater is already believed to be impacted, further impact is not anticipated from residual contaminants deep in the vadose soil due to the relatively immobile nature of the contaminants. 8. Generally received equivalent or less contaminant inventory than the 216-B-5Injection Well/Reverse Well; even so, groundwater protection is expected to be required. In general, the 216-T-3 Injection Well/Reverse Well is analogous to and bounded by the 216-B-5 Injection Well/Reverse Well. Remedial actions are needed to address the same risks as those of the 216-B-5 Injection Well/Reverse Well, specifically protection of groundwater.

Table 2-3. 200-TW-2 Operable Unit Representative Sites and Associated Analogous Waste Sites. (15 Pages)

Waste Site	Waste Site Configuration, Construction, and Purpose	Site Discharge History (WIDS)	Contaminant Inventory (DOE/RL-96-81)						Effluent Volume (m^3)	Soil Pore Volume (m^3)	Eff Vol ÷ Pore Vol	Rationale
			Total U (kg)	Total Pu (g)	Tc-99* (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	Nitrate (kg)				
Representative Site												
216-B-7A and 216-B-7B Cribs	The 216-B-7A Crib is the representative site, and the 216-B-7B Crib is analogous to it. Each crib is a hollow (i.e., not gravel-filled) 3.7 x 3.7 x 1.2 m (12 x 12 x 4 ft) high wooden structure made of 15 x 15 cm (6 x 6 in.) timbers placed in a 4.2 x 4.2 x 4.2 m (14 x 14 x 14 ft) deep excavation. Associated with, and assumed to contain similar types and concentrations of contaminants to the 216-B-7A Crib is the 216-B-7B Crib, which is located to the northwest of the 216-B-7A Crib. The cribs are about 28 ft apart. The cribs are underneath a large area of contaminated soil from the UPR-200-E-144 stabilization. This soil was covered with clean backfill and posted with "Underground Radioactive Material" signs. The crib locations are marked with light posts and chain with "Cave-In" warning signs. The depth to the top of contamination is 5.5 m (18 ft).	2nd Cycle, Cell 5-6 Drainage, and Lanthanum Fluoride Waste Stream The site received liquid waste from 221-B and 224-B via overflow of the 216-BY-201 Settling Tank. Liquid process effluent was received at the cribs between 1946 and 1967 (active for 21 years).	180	4300	0.509	43.2	2,200	1,800,000	43,600	558	78.1	The 216-B-7A Crib was characterized in 2001 (DOE/RL-2000-38). The results are presented in DOE/RL-2002-42. The crib received waste from the 221-B and 224-B Buildings via overflow of the 241-B-201 Settling Tank. The crib received significant inventories of Cs-137, plutonium, uranium, Sr-90, and nitrate; the effluent volume received was sufficient to impact groundwater. Soil data indicate that contamination is associated with the point of release about 5.5 m (18 ft) bgs and extends to a depth of about 11.4 m (37.5 ft) bgs. Very little contamination is present beyond a depth of 11.4 m (37.5 ft). RLS data indicate that contamination extends to a depth of about 85 ft near the crib. Maximum contaminant concentrations detected: Pu-239/240: 153,000 pCi/g; Cs-137: 153,000 pCi/g; Sr-90: 5,710,000 pCi/g; Tc-99: 37.9 pCi/g; and uranium: 346 ppm. The 216-B-7B Crib is included in the description for 216-B-7A Crib (and is analogous) because of identical construction and receipt of the same waste stream from the same feed piping; 216-B-7B acted as the overflow for 216-B-7A Crib.
200-TW-2 OU analogous wastes sites to be evaluated by the (216-B-7A Crib) model												
216-B-8	The 216-B-8 Crib is a 3.7 x 3.7 x 2.1 m (12 x 12 x 7 ft) high wooden structure constructed from 6 x 6 in. wooden timbers that were placed in a 4.2 x 4.2 x 6.9 m (14 x 14 x 22.5 ft) deep excavation. The crib has an associated tile field measuring 91.4 x 30.5 m (300 x 100 ft). Tile depth is associated with the bottom of the crib excavation. The tile field is constructed in a chevron pattern having a 97.5 m (320 ft) long central feeder and eight 21.3 m (70 ft) long branches. The central feeder pipe is 0.3 m (12 in.) diameter vitrified clay pipeline (VCP); the branches are 0.25 m (10 in.) diameter VCP. The crib and tile field are identified with concrete AC-540 monuments and posted with	2nd Cycle, Cell 5-6 Drainage, and Lanthanum Fluoride Waste Stream The site received second-cycle waste supernatant from 221-B Building. Sludge from the 241-B-104 Tank was inadvertently released to the crib and the crib became plugged. The sludge contained roughly 1,000 times the amount of plutonium and 5,000 times the fission products that usually would be found in the supernatant discharged to cribs. Acid was added to the crib in an attempt to unplug the crib. The acid did not significantly improve the crib blockage so the tile field was added to receive crib overflow. The site also received the second-cycle waste plus cell drainage stored in Tank 5-6 and other liquid waste from the 221-B	45 Less than rep site	30 Less than rep site	0.321 Similar to rep site	19.8 Less than rep site	5.58 Less than rep site	1,400,000 Less than rep site	27,200 Less than rep site	52,730	0.52 Less than rep site	The 216-B-8 Crib is analogous to the 216-B-7A Crib as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received the same waste stream as 216-B-7A Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to 216-B-7A Crib 3. Waste was received from the same source (221-B) 4. Both sites are located in the 200 East Area in proximity to each other; the geology of the two sites is similar 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated (e.g., 216-B-43 through 216-B-50) 6. Risks are expected to be similar to 216-B-7A Crib; however, because the top of the contamination is about 3 m (10 ft) bgs, human health and ecological risks are expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at the 216-B-7A Crib 7. The relative effluent volume discharged to this crib suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to the 216-B-7A Crib. A much lower relative volume of effluent was sent to the 216-B-8 Crib. Because less volume was discharged to the 216-B-8 Crib, higher inventories could remain in the vadose, posing a more significant threat to groundwater than from the 216-B-7A Crib. This implies that groundwater protection is needed at this waste site, as it is at the 216-B-7A Crib 8. Generally received less contaminant inventory than the 216-B-7A Crib. In general, the 216-B-8 Crib is analogous to and bounded by the 216-B-7A Crib. Remedial actions are needed to address the same risks as the 216-B-7A Crib, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90). Because the contamination is shallower at the 216-B-8 Crib, remedial actions also are needed to address human health and ecological risk in the 0 to 4.6 m (0 to 15-ft) bgs zone.

Table 2-3. 200-TW-2 Operable Unit Representative Sites and Associated Analogous Waste Sites. (15 Pages)

Waste Site	Waste Site Configuration, Construction, and Purpose	Site Discharge History (WIDS)	Contaminant Inventory (DOE/RL-96-81)						Effluent Volume (m^3)	Soil Pore Volume (m^3)	Eff Vol + Pore Vol	Rationale
			Total U (kg)	Total Pu (g)	Tc-99* (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	Nitrate (kg)				
	Underground Radioactive Material signs. The crib is delineated with light posts and chain with "Cave-In Potential" signs. The surface is covered with gravel. *The depth to the* top of contamination is 3 m (10 ft). Located approximately 107 m (350 ft) from the BY Tank Farm tanks and approximately 122 m (400 ft) from the B Tank Farm tanks. Nearest significant structure is the 200-E-45 Shaft that borders the crib.	Building. The site also received decontamination and cleanup waste generated during the shutdown of 221-B and 224-B. The waste is high *in salt, is neutral to basic, and* contains transuranic (TRU) constituents and fission materials.										
200-E-45	The 200-E-45 Sampling Shaft is a concrete shaft, 16.6 m (55 ft) deep, constructed of prefabricated concrete sections, 2.4 m (8 ft) in diameter and 1.9 m (6 ft 2 in.) high. Steel pipes were installed laterally through holes in the side of the shaft at 3 m (10 ft) and 6 m (20 ft) from the surface toward the 216-B-8 Crib. The pipes were 15 cm (6 in.) in diameter, and 6.6 m (22 ft) long. The site currently is topped with a large circular cover with a smaller "manhole" entry marked with a "Confined Space" sign, a hatch, and a vent pipe. The shaft area is surrounded by light duty posts and chain and is posted as a Contamination Area. Nearest significant structure is the adjacent 216-B-8 Crib.	2[nd] Cycle, Cell 5-6 Drainage, and Lanthanum Fluoride Waste Stream The shaft was used to obtain samples from the 216-B-8 Crib. The bottom of the shaft occasionally collected a significant amount of crib seepage that was pumped out of the shaft and back to the crib. Later the shaft was intermittently filled with water and used as a contaminated pump-testing pit.	–	–	–	–	–	–	–	–	–	The 200-E-45 Sampling Shaft waste site is associated with the 216-B-8 Crib; the shaft was used to collected field readings and data from the 216-B-8 Crib. Therefore, the 200-E-45 Shaft is considered analogous to the 216-B-7A Crib as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received overflow from the same waste stream as 216-B-7A Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to 216-B-7A Crib; the 200-E-45 Sampling Shaft is a shaft constructed to monitor crib leakage from the nearby 216-B-8 Crib 3. Waste was received from the same source (221-B and 224-B) 4. Both sites are located in the 200 East Area in proximity to each other; the geology of the two sites is similar 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated (e g., 216-B-43 through 216-B-50 Cribs) 6. Risks are expected to be similar to the 216-B-7A Crib; however, because the top of the contamination could be shallow, human health and ecological risks may be expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders in the shaft may be associated with high contamination at the bottom of the waste site 7. Although the relative effluent volume discharged to this shaft is unknown, contaminant inventory in the vadose zone may pose a threat to groundwater, similar to 216-B-7A Crib, because effluent that had seeped into it from the nearby 216-B-8 Crib dropped directly to the 16.8 m (55-ft) level. Although less volume probably was discharged to the 200-E-45 Sampling Shaft, high inventories could remain in the vadose, posing a threat to groundwater, similar to the 216-B-7A Crib. This implies that groundwater protection is needed at this waste site, as it is at the 216-B-7A Crib 8. Assumed to have received less contaminant inventory than the 216-B-7A Crib because contaminants were not intentionally disposed to the shaft in the beginning; contaminants entered the shaft because of overflow from the 216-B-8 Crib. Later the shaft was used for the testing of equipment. In general, the 200-E-45 Sampling Shaft waste site is analogous to and bounded by the 216-B-7A Crib. Remedial actions are needed to address the same risks as those of the 216-B-7A Crib, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90). Because the contamination could be shallower at the 200-E-45 Sampling Shaft, remedial actions also may be needed to address human health and ecological risk in the 0 to 4.6 m (0 to 15-ft) bgs zone.
216-B-9	The 216-B-9 Crib is a 4.3 x 4.3 x 2.4 m (14 x 14 x 8-ft) high wooden structure at the bottom of a 4.7 m (15.5 ft) deep excavation. The tile field, 55.0 x 25.6 m (180 x 84 ft), contains 165 m (540 ft) of 15.2 cm (6 in.) clay tile pipe. Pipes are buried 3.7 m (12 ft) deep at the head and 1.8 m (6 ft) at the other end. Six 18.3 m (60 ft) long lines branch in a chevron pattern from a 54.9 m (180 ft) long	2[nd] Cycle, Cell 5-6 Drainage, and Lanthanum Fluoride Waste Stream The site received cell drainage and other liquid waste via Tank 5-6 in the 221-B Building. After the 216-B-361 Settling Tank filled up with sludge, the 216-B-9 Crib was tied directly to the waste lines from the 221-B building and began to serve as both a settling tank and a crib. Sludge accumulated rapidly	45 Less than rep site	174 Less than rep site	0.078 Similar to rep site	3.92 Less than rep site	5.52 Less than rep site	1,000 Less than rep site	36,000 Less than rep site	25,990	1.39 Less than rep site	The 216-B-9 Crib is analogous to the 216-B-7A Crib as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received the same waste stream as 216-B-7A Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to 216-B-7A Crib 3. Waste was received from the same source (221-B and 224-B) 4. Both sites are located in the 200 East Area in proximity to each other; the geology of the two sites is similar 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated (e.g., 216-B-43 through 216-B-50 Cribs) 6. Risks are expected to be similar to the 216-B-7A Crib; however, because the top of the contamination is about 3 m (10 ft) bgs, human health and ecological risks are expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at the 216-B-7A Crib 7. The relative effluent volume discharged to this crib suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to the 216-B-7A Crib. Because less relative volume of effluent was sent to the 216-B-9 Crib, higher inventories could remain in the vadose, posing a significant threat to groundwater, similar to the 216-B-7A Crib. This implies that groundwater protection is needed at this waste site, as it is at the 216-B-7A Crib

Table 2-3. 200-TW-2 Operable Unit Representative Sites and Associated Analogous Waste Sites. (15 Pages)

Waste Site	Waste Site Configuration, Construction, and Purpose	Site Discharge History (WIDS)	Contaminant Inventory (DOE/RL-96-81)						Effluent Volume (m^3)	Soil Pore Volume (m^3)	Eff Vol + Pore Vol	Rationale
			Total U (kg)	Total Pu (g)	Tc-99* (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	Nitrate (kg)				
	central feeder line. Above and below the pipes is 0.5 m (1.5 ft) of gravel. The crib and associated tile field have been surface stabilized and are marked with "Underground Radioactive Material" signs. The crib is located at the south end of the posted area. It has a separate posting as a Radioactive Contamination Area and has a "Cave-In Potential" sign. The depthto the top of contamination is 3 m (10 ft). This site is located about 480 m south of the 216-B-7A and 216-B-7Crib and is constructed partly of wooden timbers. Nearest significant structure is the 216-B-5Injection Well/Reverse Well located approximately 91m (300 ft) away.	and waste overflowed to the tile field. The sludge was significantly more concentrated than the tile filed effluent as evidenced by historical scintillation probe profiles of respective monitoring wells. The waste contains TRU and fission products. A soil sample in 1949 showed 1830 µCi/kg of fission products and 14,800,000-dpm alpha. The site received about 36,000,000 liters of liquid process effluent during a period of 3 years (1948-1951).										8. Generally received less contaminant inventory than the 216-B-7A Crib; even so, groundwater protection is expected to be required. Historical scintillation probe profiles of monitoring wells in the vicinity of the crib and the tile field indicate substantially more inventory in the crib than in the tile field. In general, the 216-B-9 Crib is analogous to and bounded by the 216-B-7A Crib. Remedial actions are needed to address the same risks as those of the 216-B-7A Crib, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90). Because the contamination is shallower at the 216-B-9 Crib, remedial actions also are needed to address human health and ecological risk in the 0 to 4 6 m (0 to 15-ft) bgs zone.
UPR-200-E-7	Unplanned Release (site not separately posted or marked, although 216-B-9 Crib is marked with AC-540 concrete posts). Located near the 241-B-361 Settling Tank. A cave-in was noted over the underground line near the 241-B-361 Settling Tank, although the exact location cannot be determined. In 1954, the area was covered and marked as an Underground Radioactive Material site, but postings no longer exist at the site. The depth to the top of contamination is unknown and estimated at 0 6 m (2 ft).	<u>2nd Cycle, Cell 5-6 Drainage, and Lanthanum Fluoride Waste Stream</u> The release consisted of B Plant cell wash water from the 5-9 Tank. A leak in the underground waste line between the 221-B Building and the 241-B-361 Settling Tank resulted in a maximum dose rate of 1.7 rad/h (1954) at the surface. Approximately 2.8 m^2 (30 ft^2) of soil was contaminated by this release. Top of concentration is near ground surface; it is unknown how deep contamination has reached since 1954 when release occurred.	—	—	—	—	—	—	19 Less than rep site	—		*The UPR-200-E-7 waste site is analogous to 216-B-7A Crib as indicated by location and source of contamination. Because this site was caused by an unplanned* release originating from the 216-B-9 Crib, it is also bounded by and analogous to the 216-B-7A Crib. Types of contaminants should be the same as those of the 216-B-9 Crib. Concentrations of contaminants should be less. Contaminant inventory is unknown and was not documented. In general, the UPR-200-E-7 unplanned release is analogous to and bounded by the 216-B-7A Crib. Remedial actions are needed to address direct contact risks to humans and ecological receptors from shallow contamination.

Table 2-3. 200-TW-2 Operable Unit Representative Sites and Associated Analogous Waste Sites. (15 Pages)

Waste Site	Waste Site Configuration, Construction, and Purpose	Site Discharge History (WIDS)	Contaminant Inventory (DOE/RL-96-81)						Effluent Volume (m^3)	Soil Pore Volume (m^3)	Eff Vol + Pore Vol	Rationale
			Total U (kg)	Total Pu (g)	Tc-99* (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	Nitrate (kg)				
241-B-361	The 241-B-361 Settling Tank site is a 5 8 m high x 6.1 m diameter (19 ft high x 20 ft diameter), (domed top) settling tank with a capacity of ~136,000 L, and constructed from 15 cm (6-in.) reinforced, pre-stressed concrete. The top of the unit is 1.8 m (6 ft) below grade. Eleven risers are visible above grade; some are blanked off. Delineated with light post and chain, posted with "Underground Radioactive Material" and "Inactive Miscellaneous Underground Storage Tank" signs. Surface is covered with coarse rock. Tank is associated with the 216-B-5 Injection Well/Reverse Well. The depth to the top of the tank is 1.8 m (6 ft).	<u>2nd Cycle, Cell 5-6 Drainage, and Lanthanum Fluoride Waste Stream</u> The unit received over 3,175,000 L of low-salt alkaline radioactive liquid wastes from cell washings collected in the 5-6W Cells in 221-B and low-level concentrator condensate from the 224-B facility between 1945 and 1947 (active for 2 years). The tank currently contains approximately 78,000 L of black sludge having the consistency of thick pudding with the potential to contain transuranic constituents above 100 nCi/g.	1.10 Less than rep site	340 Ci Less than rep site	---	140 More than rep site	2,300 Similar to rep site	---	78 Less than rep site	---	---	The 241-B-361 Settling Tank is analogous to the 216-B-7A Crib as indicated by waste stream chemistry and the expected distribution of contamination. Radioactive waste from the 221-B and 224-B facilities were accumulated in this tank: 1. Received a waste stream similar to the 216-B-7A Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is not similar to 216-B-7A Crib in that it was not designed as an unlined near-surface liquid disposal site; instead it was intended to be a process vessel 3. Waste was received from the same source (221-B and 224-B) 4. Both sites are located in the 200 East Area in proximity to each other; the geology of the two sites is similar 5. The vertical extent of contamination is expected to be considerably less, because there is no evidence that the tank has leaked 6. Risks are expected to be much less than for the 216-B-7A Crib; however, because the top of the tank is estimated to be less than 3.0 m (10 ft) bgs, human health and ecological risks may be expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination in the tank 7. Contaminant inventory in the vadose zone should not pose a threat to groundwater because there has been no record of leakage. Any contaminants that have leaked are expected to remain in the vadose. Recent spectral gamma logging of two boreholes near this tank did not detect any gamma-emitting radionuclides that would indicate that this tank had leaked (GJO-2002-358-TAC) 8. Generally received lesser contaminant inventory than the 216-B-7A Crib; current tank volume is 83,000 L. In general, the 241-B-361 Settling Tank, particularly any leak from this tank, is analogous to the 216-B-7A Crib. Remedial actions are needed to address the same risks as those of 216-B-7A Crib, specifically protection against intrusion to contaminants in the bottom of the tank which could pose a significant direct contact risk to a potential intruder. Groundwater protection should not be an issue unless tank contents are released to the soil. Because the contamination is shallower at the 241-B-361 Settling Tank, remedial actions also are needed to address human health and ecological risk in the 0 to 4.6 m (0 to 15-ft) bgs zone.
216-T-5	The 216-T-5 Trench site is a 15.2 x 3.0 x 3.7 m (50 x 10 x 12 ft) deep specific retention trench. The above ground piping was removed and the trench backfilled when the specific retention capacity was reached. Two feet (0.6 m) of clean soil was placed on the trench in 1992. The depth to the top of contamination is 3.7 m (12 ft). Located approximately 91 m (300 ft) from the T Tank Farm tanks and approximately 38 m (125 ft) from the 216-T-32 Crib.	<u>2nd Cycle, Cell 5-6 Drainage, and Lanthanum Fluoride Waste Stream</u> The site received high-salt neutral/basic liquid second-cycle supernatant waste from the 221-T Canyon Building via Tank 241-T-112. Site received liquid waste in May 1955. Contents have the potential to contain transuranic constituents above 100 nCi/g.	5.94 Less than rep site	180 Less than rep site	0.239 Less than rep site	31.1 Less than rep site	0.42 Less than rep site	140,000 Less than rep site	2,600 Less than rep site	953	2.7 Less than rep site	The 216-T-5 Trench is analogous to 216-B-7A Crib as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received a waste stream similar to the 216-B-7A Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to the 216-B-7A Crib 3. Waste was received from a similar source 4. The geology of the two sites is similar, although the vadose zone is thinner in the 200 West Area 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated (e.g., 216-B-43 through 216-B-50 Cribs) 6. Risks are expected to be similar to the 216-B-7A Crib; however, because the top of the contamination is about 3.7 m (12 ft) bgs, human health and ecological risks are expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at the 216-B-7A Crib 7. The relative effluent volume discharged to this crib suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to the 216-B-7A Crib. Although much less relative volume of effluent was sent to the 216-B-9 Crib, effluent substantially exceeded calculated soil porosity volume. Although less volume was discharged to the 216-T-5 Trench, high inventories could remain in the vadose, posing a significant threat to groundwater, similar to the 216-B-7A Crib. This implies that groundwater protection is needed at this waste site, as it is at the 216-B-7A Crib 8. Generally received equivalent or less contaminant inventory than the 216-B-7A Crib, except for plutonium; even so, groundwater protection is expected to be required. In general, the 216-T-5 Trench is analogous to and bounded by the 216-B-7A Crib. Remedial actions are needed to address the same risks as those at the 216-B-7A Crib, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90). Because the contamination is shallower at the 216-T-5 Trench, remedial actions also are needed to address human health and ecological risk in the 0 to 4.6 m (0 to 15-ft) bgs zone.

Table 2-3. 200-TW-2 Operable Unit Representative Sites and Associated Analogous Waste Sites. (15 Pages)

Waste Site	Waste Site Configuration, Construction, and Purpose	Site Discharge History (WIDS)	Contaminant Inventory (DOE/RL-96-81)						Effluent Volume (m^3)	Soil Pore Volume (m^3)	Eff Vol ÷ Pore Vol	Rationale
			Total U (kg)	Total Pu (g)	Tc-99* (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	Nitrate (kg)				
216-T-6	The 216-T-6 Crib consists of two 3.7 x 3.7 x 1.2 m (12 x 12 x 4 ft) deep wooden cribs within a 6.1 m (20 ft) deep excavation. One crib overflows into the other. The crib boxes are set 18.9 m (62 ft) apart and are connected in series by a pipe. Above ground piping was removed, all sink holes were filled, and the ground surface was decontaminated and leveled in 1975. The area was surface stabilized and posted as "Underground Radioactive Material" in 1993. The depth to the top of contamination is 7.6 m (25 ft). Isolated from significant structures except the 216-T-3Injection Well/Reverse Well approximately 61 m (200 ft) away.	<u>2nd Cycle, Cell 5-6 Drainage, and Lanthanum Fluoride Waste Stream</u> The site received low-salt neutral/basic liquid waste from cell drainage from the 221-T Canyon Building and 224-T via the 241-T-361 Settling Tank. Site received liquid waste between August 1946 and October 1947 (active for 1 year). Site has potential to contain transuranic constituents above 100 nCi/g.	22.6 Less than rep site	390 Less than rep site	0.138 Less than rep site	110 More than rep site	124 Less than rep site	180,000 Less than rep site	45,000 Similar to rep site	1,305	34.48 Less than rep site	The 216-T-6 Crib assembly (two cribs) is analogous to the 216-B-7A Crib as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received a waste stream similar to the 216-B-7A Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to the 216-B-7A Crib 3. Waste was received from a similar source 4. The geology of the two sites is similar, although the vadose zone is thinner in the 200 West Area 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated (e.g., 216-B-43 through 216-B-50 Cribs) 6. Risks are expected to be similar to those of the 216-B-7A Crib; however, because the top of the contamination is about 7.6 m (25 ft) bgs, human health and ecological risks are not expected in the 0 to 4.6 m (0 to 15-ft) zone 7. The relative effluent volume discharged to this crib suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to the 216-B-7A Crib. High inventories could remain in the vadose, posing a significant threat to groundwater, similar to the 216-B-7A Crib. This implies that groundwater protection is needed at this waste site, as it is at the 216-B-7A Crib 8. Generally received equivalent or less contaminant inventory than the 216-B-7A Crib (except for Cs-137) In general, the 216-T-6 Crib is analogous to and bounded by the 216-B-7A Crib. Remedial actions are needed to address the same risks as those of the 216-B-7A Crib, specifically protection of groundwater and from intruders.
216-T-7	The 216-T-7 Crib structure consists of a 3.7 x 3.7 x 2.1 m high (12 x 12 x 7 ft high) wooden crib within a 6.1 m (10 ft) deep excavation and associated tile field. The tile field is a chevron pattern consisting of eight 12.2 m (40 ft) long branches from a 93.0 m (305 ft) long central pipe. The piping is VCP or concrete. Nominal liquid release depth in the tile field was 6.1 m (20 ft). The area was covered with 0.6 m (2 ft) of clean dirt and posted with "Underground Radioactive Material" signs in 1992. The tile field is marked with concrete AC-540 markers. The depth to the top of contamination is 7.6 m (25 ft). Located approximately 36.6 m (120 ft) from the T Tank Farm tanks and adjacent to the 216-T-32 Crib. The crib is within the T Tank Farm fence line; most of the tile field is outside the fence.	<u>2nd Cycle, Cell 5-6 Drainage, and Lanthanum Fluoride Waste Stream</u> The site received high-salt neutral/basic liquid second-cycle supernatant waste from 221-T, 224-T, and tank 5-6 after it cascaded through Tanks 241-T-110, 241-T-111, and 241-T-112. The 216-T-7 Tile Field received overflow from the 216-T-7 Crib. Site received liquid waste from April 1948 to November 1955 (active for seven years).	8.92 Less than rep site	130 Less than rep site	2.03 More than rep site	21.2 Less than rep site	24.0 Less than rep site	2,300,000 More than rep site	110,000 More than rep site	8,906	12.35 Similar to rep site	The 216-T-7 Crib is analogous to the 216-B-7A Crib as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received a waste stream similar to the 216-B-7A Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to the 216-B-7A Crib 3. Waste was received from a similar source 4. The geology of the two sites is similar, although the vadose zone is thinner in the 200 West Area 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated (e g., 216-B-43 through 216-B-50 Cribs) 6. Risks are expected to be similar to the 216-B-7A Crib; however, because the top of the contamination is about 7.6 m (25 ft) bgs, human health and ecological risks are not expected in the 0 to 4.6 m (0 to 15-ft) zone 7. The relative effluent volume discharged to this crib suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to the 216-B-7A Crib. High inventories could remain in the vadose, posing a significant threat to groundwater , similar to the 216-B-7A Crib. This implies that groundwater protection is needed at this waste site, as it is at the 216-B-7A Crib 8. Generally received equivalent or less contaminant inventory than the 216-B-7A Crib, but did receive more nitrate, supporting the need for groundwater protection In general, the 216-T-7 Crib is analogous to and bounded by the 216-B-7A Crib. Remedial actions are needed to protect groundwater and prevent intrusion.

Table 2-3. 200-TW-2 Operable Unit Representative Sites and Associated Analogous Waste Sites. (15 Pages)

Waste Site	Waste Site Configuration, Construction, and Purpose	Site Discharge History (WIDS)	Contaminant Inventory (DOE/RL-96-81)						Effluent Volume (m^3)	Soil Pore Volume (m^3)	Eff Vol + Pore Vol	Rationale
			Total U (kg)	Total Pu (g)	Tc-99* (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	Nitrate (kg)				
216-T-32	The 216-T-32 Crib structure consists of two 3.7 x 3.7 x 1.2 m high (12 x 12 x 4 ft high) wooden crib boxes, each set into a square bottom pit with sloping sides measuring 20.1 x 4.3 x 7.9 m (66 x 14 x 26 ft). The crib boxes are separated by 12.2 m (40 ft). The crib boxes are connected in series by a pipe, with one crib overflowing into the other. The site was stabilized with gravel, along with the rest of T Tank Farm, in 1992. The depth to the top of contamination is 6.7 m (22 ft). Located approximately 27 m (90 ft) from the T Tank Farm and adjacent to the 216-T-7 Crib and tile field.	<u>2nd Cycle, Cell 5-6 Drainage, and Lanthanum Fluoride Waste Stream</u> The site received high-salt neutral/basic liquid waste from 224-T via Tank 241-T-201. The site received liquid waste from November 1946 to May 1952 (active 6 years). Site has the potential to contain transuranic constituents above 100 nCi/g.	23.8 Less than rep site	3,200 Less than rep site	0.376 Similar to rep site	9.71 Less than rep site	10.9 Less than rep site	1,200,000 Less than rep site	29,000 Less than rep site	2,644	10.97 Less than rep site	The 216-T-32 Crib assembly (two cribs) is analogous to 216-B-7A Crib as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received a waste stream similar to the 216-B-7A Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to the 216-B-7A Crib 3. Waste was received from a similar source 4. The geology of the two sites is similar, although the vadose zone is thinner in the 200 West Area 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated (e.g., 216-B-43 through 216-B-50 Cribs) 6. Risks are expected to be similar to the 216-B-7A Crib; however, because the top of the contamination is about 6.7 m (22 ft) bgs, human health and ecological risks are not expected in the 0 to 4.6 m (0 to 15-ft) zone 7. The relative effluent volume discharged to this crib suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to the 216-B-7A Crib. High inventories could remain in the vadose, posing a significant threat to groundwater, similar to the 216-B-7A Crib. This implies that groundwater protection is needed at this waste site, as it is at the 216-B-7A Crib 8. Generally received less contaminant inventory than the 216-B-7A Crib; even so, groundwater protection is expected to be required. In general, the 216-T-32 Cribs are analogous to and bounded by the 216-B-7A Crib. Remedial actions are needed to address the same risks as those of the 216-B-7A Crib, specifically protection of groundwater and from intrusion.
241-T-361	The 241-T-361 Settling Tank site is a 5.8 m high x 6.1 m diameter (*19 ft high x 20 ft* diameter), capacity ~136,000 L (domed top) settling tank that is constructed of 15 cm (6-in.) reinforced, prestressed concrete. The top of the unit is 1.8 m (6 ft) below grade. Posted with "Underground Radioactive Material" and "Inactive Miscellaneous Underground Storage Tank" signs. Surface covered with coarse rock. Tank is associated with the adjacent 216-T-3 Injection Well/Reverse Well. The depth to the top of the tank is 3.7 m (12 ft).	<u>2nd Cycle, Cell 5-6 Drainage, and Lanthanum Fluoride *Waste Stream*</u> The unit received low-salt alkaline radioactive liquid wastes from cells 5 and 6 in 224-T. Overflow was sent to the 216-T-6 Crib. Site received solid and liquid sludge between 1946 and 1947 (active for 1 year). No liquid is believed to exist in the tank; the sludge is black and has the consistency of axle grease. Tank contents have the potential to contain transuranic constituents above 100 nCi/g.	23 less than rep site	5,400 More than rep site	–	0.091 less than rep site	3819 More than rep site	–	93 less than rep site	N/A	N/A	The 241-T-361 Settling Tank is analogous to the 216-B-7A Crib as indicated by waste stream chemistry and the expected distribution of contamination. Radioactive waste from the 221-B and 224-B facilities were accumulated in this tank: 1. *Received a waste stream similar to the 216-B-7A Crib; therefore, the contaminant types are expected to be very similar* 2. Site construction is not similar to the216-B-7A Crib in that it was not designed as an unlined near-surface liquid disposal site; instead it was intended to be a process vessel 3. Waste was received from a similar source 4. The geology of the two sites is similar, although the vadose zone is thinner in the 200 West Area 5. The vertical extent of contamination is expected to be considerably less, because there is no evidence that the tank has leaked 6. Risks are expected to be much less than for the 216-B-7A Crib; however, because the top of the tank is estimated to be 1.8 m (6 ft) bgs, human health and ecological risks are expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders are associated with high contamination in the tank 7. Contaminant inventory in the vadose zone should not pose a threat to groundwater because there has been no record of leakage. Any contaminants that have leaked are expected to be remaining in the vadose soil. 8. Generally received lesser contaminant inventory than the 216-B-7A Crib. In general, the 241-T-361 Settling Tank, particularly any leak from this tank, is analogous to the 216-B-7A Crib. Remedial actions are needed to address the same risks as the 216-B-7A Crib, specifically protection against intrusion to contaminants in the bottom of the tank which could pose a significant direct contact risk to a potential intruder. Groundwater protection should not be an issue unless tank contents are released to the soil. Because the contamination is accessible, remedial actions also may be needed to address human health and ecological risk in the 0 to 4.6 m (0 to 15-ft) bgs zone.

Table 2-3. 200-TW-2 Operable Unit Representative Sites and Associated Analogous Waste Sites. (15 Pages)

Waste Site	Waste Site Configuration, Construction, and Purpose	Site Discharge History (WIDS)	Contaminant Inventory (DOE/RL-96-81)						Effluent Volume (m^3)	Soil Pore Volume (m^3)	Eff Vol ÷ Pore Vol	Rationale
			Total U (kg)	Total Pu (g)	Tc-99* (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	Nitrate (kg)				
Representative Site												
216-B-38	The 216-B-38 Trench is an open, unlined trench that is 77 m (250 ft) long, 3 m (10 ft) wide, and 3 m (10 ft) deep. It was used as a specific retention trench in July 1954. The site was backfilled and stabilized in 1982 with 0.6 m (2 ft) of clean fill. Remedial investigation data suggest that the bottom of the trench is at 4.3 m (14 ft). Located approximately 80 m (250 ft) from the BX Tank Farm tanks and within the assembly of 216-B-35 through 216-B-42 Trenches.	Dissolved Cladding and 1st Cycle Waste Stream Received high-salt neutral/basic first-cycle supernatant waste from 221-B Building	42	1.2	1.87	221	759	120,000	1,430	5,055	0.28	Investigated in 2001 under DOE/RL-2000-38; results, including risk assessment, reported in DOE-RL-2002-42 and summarized below: • Zone of higher contamination from 14.5 to 40 ft • Maximum concentrations generally from 14.5 to 15.5 ft sample • Maximum Am-241: 43.9 pCi/g at 14.5 to 15.5 ft • Maximum Cs-137: 226,000 pCi at 14.5 to 15.5 ft and 18 to 20.5 ft, decreases an order of magnitude in 22.5- to 25-ft sample and basically not detected at significant concentrations below 54.5 ft • Maximum Pu-238: 7.85 pCi/g at 20 to 31.5 ft • Maximum Pu-23/240: 159 pCi/g at 18 to 20.5 ft • Maximum Sr-90: 2050 pCi at 18 to 20.5 ft • Maximum total uranium: 32.5 mg/kg at 18 to 20.5, above background to 54.5 ft • Maximum U-233/234: 9 pCi/g at 18 to 20.5 ft • Maximum U-238: 6.35 mg/kg at 22.5 to 25 ft • With exceptions noted above, concentrations tend to drop significantly by 40 ft • Technetium-99 (1.9 pCi/g) and tritium (28.7 pCi/g) detected in 52 to 54.5 ft and at lower levels through rest of borehole. Significant human health and ecological risk is associated with Cs-137 and Sr-90 in the 0 to 4.6 m (0 to 15 ft) zone; no chemicals above risk-based standards for human or ecological receptors for direct exposure; groundwater protection concerns for fluoride, nitrate, nitrite, total uranium, U-233/234, and U-238. Geology described in BHI-01607.
200-TW-2 OU analogous wastes sites to be evaluated by the (216-B-38 Trench) model												
216-B-35	The 216-B-35 Trench is an open, unlined trench that is 25 x 3 x 3 m deep (77 x 10 x 10 ft deep). Used as a specific retention trench in July 1954. Site was backfilled and stabilized in 1982 with 0.6 m (2 ft) of clean fill. It was stabilized with top soil, treated with herbicides, and seeded with wheat-grasses. The depth to the top of contamination is 3.7 m (12 ft). Located approximately 80 m (250 ft) from the BX Tank Farm tanks and within the assembly of 216-B-35 through 216-B-42 Trenches.	Dissolved Cladding and 1st Cycle Waste Stream This site received 1st cycle waste from 221-B Building. The waste is high in salt and is neutral to basic. Site was active for one month in 1954.	17.0 Less than rep site	1.2 Similar to rep site	2.04 Similar to rep site	185 Less than rep site	96.4 Less than rep site	90,000 Less than rep site	1,060 Less than rep site	5,190	0.20 Similar to rep site	The 216-B-35 Trench is analogous to the 216-B-38 Trench as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received the same waste stream as the 216-B-38 Trench; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to the 216-B-38 Trench 3. Waste was received from the same source (221-B) 4. Both sites are located in the 200 East Area in proximity to each other; the geology of the two sites is similar 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated 6. Risks are expected to be similar to the 216-B-38 Trench; because the top of the contamination is about 3.7 m (12 ft) bgs, human health and ecological risks are expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at the 216-B-38 Trench 7. The relative effluent volume discharged to this trench suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to the 216-B-38 Trench. Because a similar relative volume of effluent was sent to the 216-B-35 Trench, high inventories could remain in the vadose, posing a significant threat to groundwater, similar to the 216-B-38 Trench. This implies that groundwater protection is needed at this waste site, as it is at the 216-B-38 Trench 8. Generally received equivalent or less contaminant inventory than the 216-B-38 Trench. In general, the 216-B-35 Trench is analogous to and bounded by the 216-B-38 Trench. Remedial actions are needed to address the same risks as the 216-B-38 Trench, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90). Because the contamination is shallower at the 216-B-35 Trench, remedial actions also are needed to address human health and ecological risk in the 0 to 4.6 m (0 to 15-ft) bgs zone.

Table 2-3. 200-TW-2 Operable Unit Representative Sites and Associated Analogous Waste Sites. (15 Pages)

Waste Site	Waste Site Configuration, Construction, and Purpose	Site Discharge History (WIDS)	Contaminant Inventory (DOE/RL-96-81)						Effluent Volume (m^3)	Soil Pore Volume (m^3)	Eff Vol + Pore Vol	Rationale
			Total U (kg)	Total Pu (g)	Tc-99* (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	Nitrate (kg)				
216-B-36	The 216-B-36 Trench is a 77 x 3 x 3 m (252 x 10 x 10 ft) deep trench that was stabilized in 1982 with 2 ft of topsoil and treated with herbicides and seeded with wheat-grasses. The depth to the top of contamination is 3.7 m (12 ft). Located approximately 80 m (250 ft) from the BX Tank Farm tanks and within the assembly of 216-B-35 through 216-B-42 Trenches.	Dissolved Cladding and 1st Cycle Waste Stream This site received 1st cycle supernatant waste from 221-B Building. The waste is high in salt and neutral to basic. It was active for one month.	16 Less than rep site	0.8 Similar to rep site	2.54 Less than rep site	336 More than rep site	199 Less than rep site	160,000 More than rep site	1,940 More than rep site	5,190	0.37 More than rep site	The 216-B-36 Trench is analogous to the 216-B-38 Trench as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received the same waste stream as the 216-B-38 Trench; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to the 216-B-38 Trench 3. Waste was received from the same source (221-B) 4. Both sites are located in the 200 East Area in proximity to each other; the geology of the two sites is similar 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated 6. Risks are expected to be similar to the 216-B-38 Trench; however, because the top of the contamination is about 3.7 m (12 ft) bgs, human health and ecological risks are expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at the 216-B-38 Trench 7. The relative effluent volume discharged to this trench suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to the 216-B-38 Trench. Because a larger relative volume of effluent was sent to the 216-B-36 Trench, high inventories could remain in the vadose, posing a more significant threat to groundwater than from the 216-B-38 Trench. This implies that groundwater protection is needed at this waste site, as it is at the 216-B-38 Trench 8. Generally received equivalent or more contaminant inventory than the 216-B-38 Trench, higher inventories of Cs-137 and nitrate exist at the 216-B-36 Trench; thus groundwater protection and intrusion protection are expected to be required. In general, the 216-B-36 Trench is analogous to and bounded by the 216-B-38 Trench. Remedial actions are needed to address the same risks as those of the 216-B-38 Trench, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90). Because the contamination is shallow at the 216-B-36 Trench, remedial actions also are needed to address human health and ecological risk in the 0 to 4.6 m (0 to 15-ft) bgs zone.
216-B-37	The 216-B-37 Trench is a 77 x 3 x 3 m (252 x 10 x 10 ft) deep trench that was stabilized in 1982 with 0.6 m (2 ft) of topsoil, treated with herbicides, and seeded with wheat-grasses. The depth to the top of contamination is 3.7 m (12 ft). Located approximately 80 m (250 ft) from the BX Tank Farm tanks and within the assembly of 216-B-35 through 216-B-42 Trenches.	Dissolved Cladding and 1st Cycle Waste Stream This site received evaporator bottom waste from the 242-B Waste Evaporator after it had processed B Plant 1st cycle waste. Active for less than one month.	3.60 Less than rep site	2.0 More than rep site	25.8 More than rep site	1,350 More than rep site	6.56 Less than rep site	1,700,000 More than rep site	4,320 More than rep site	5,130	0.84 More than rep site	The 216-B-37 Trench is analogous to the 216-B-38 Trench as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received the same waste stream as the 216-B-38 Trench; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to the 216-B-38 Trench 3. Waste was received from the same source (221-B) 4. Both sites are located in the 200 East Area in proximity to each other; the geology of the two sites is similar 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated 6. Risks are expected to be similar to the 216-B-38 Trench; because the top of the contamination is about 3.7 m (12 ft) bgs, human health and ecological risks are expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at the 216-B-38 Trench 7. The relative effluent volume discharged to this trench suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to the 216-B-38 Trench. Because a larger relative volume was discharged to the 216-B-37 Trench, high inventories could remain in the vadose, posing a more significant threat to groundwater than from the 216-B-38 Trench. This implies that groundwater protection is needed at this waste site, as it is at the 216-B-38 Trench 8. Generally received equivalent or more contaminant inventory than the 216-B-38 Trench; higher inventories of Tc-99, Cs-137, and nitrate exist at the 216-B-36 Trench; Thus, groundwater and intrusion protection are expected to be required. In general, the 216-B-37 Trench is analogous to and bounded by the 216-B-38 Trench. Remedial actions are needed to address the same risks as those of the 216-B-38 Trench, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90). Because the contamination is shallow at the 216-B-37 Trench, remedial actions also are needed to address human health and ecological risk in the 0 to 4.6 m (0 to 15-ft) bgs zone.

Table 2-3. 200-TW-2 Operable Unit Representative Sites and Associated Analogous Waste Sites. (15 Pages)

Waste Site	Waste Site Configuration, Construction, and Purpose	Site Discharge History (WIDS)	Contaminant Inventory (DOE/RL-96-81)						Effluent Volume (m^3)	Soil Pore Volume (m^3)	Eff Vol + Pore Vol	Rationale
			Total U (kg)	Total Pu (g)	Tc-99* (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	Nitrate (kg)				
216-B-39	The 216-B-39 Trench is a 77 x 3 x 3 m (252 x 10 x 10 ft) deep trench that was stabilized in 1982 with 0.6 m (2 ft) of topsoil, treated with herbicides, and seeded with wheat-grasses. The depth to the top of contamination is 4.6 m (15 ft). Located approximately 80 m (250 ft) from the BX Tank Farm tanks and within the assembly of 216-B-35 through 216-B-42 Trenches.	Dissolved Cladding and 1st Cycle Waste Stream This site received 1st cycle supernatant waste from 221-B Building. The waste is high in salt and neutral to basic. Active for one year.	5.80 Less than rep site	1.51 Similar to rep site	1.92 Similar to rep site	192 Similar to rep site	9.27 Less than rep site	120,000 Similar to rep site	1,540 Similar to rep site	5,055	0.30 Similar to rep site	The 216-B-39 Trench is analogous to the 216-B-38 Trench as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received the same waste stream as the 216-B-38 Trench; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to the 216-B-38 Trench 3. Waste was received from the same source (221-B) 4. Both sites are located in the 200 East Area in proximity to each other; the geology of the two sites is similar 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated 6. Risks are expected to be similar to the 216-B-38 Trench; because the top of the contamination is about 4.6 m (15 ft) bgs, human health and ecological risks are expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at the 216-B-38 Trench 7. The relative effluent volume discharged to this trench suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to the 216-B-38 Trench. Because a similar relative volume of effluent was sent to the 216-B-39 Trench, high inventories could remain in the vadose, posing a significant threat to groundwater, similar to the 216-B-38 Trench. This implies that groundwater protection is needed at this waste site, as it is at the 216-B-38 Trench 8. Generally received equivalent or less contaminant inventory than the 216-B-38 Trench. In general, the 216-B-39 Trench is analogous to and bounded by the 216-B-38 Trench. Remedial actions are needed to address the same risks as those of the 216-B-38 Trench, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90). Because the contamination is shallow at the 216-B-39 Trench, remedial actions also are needed to address human health and ecological risk in the 0 to 4.6 m (0 to 15-ft) bgs zone.
216-B-40	The 216-B-40 Trench is a 77 x 3 x 3 m (252 x 10 x 10 ft) deep trench that was stabilized in 1982 with 0.6 m (2 ft) of topsoil, treated with herbicides, and seeded with wheat-grasses. The depth to the top of contamination is 4.6 m (15 ft). Located approximately 80 m (250 ft) from the BX Tank Farm tanks and within the assembly of 216-B-35 through 216-B-42 Trenches.	Dissolved Cladding and 1st Cycle Waste Stream This site received 1st cycle supernatant waste from 221-B Building. The waste is high in salt and neutral to basic. Active for three months.	35 Less than rep site	1.0 Similar to rep site	2.14 Similar to rep site	153 Less than rep site	115 Less than rep site	130,000 Similar to rep site	1,640 Similar to rep site	4,920	0.33 Similar to rep site	The 216-B-40 Trench is analogous to the 216-B-38 Trench as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received the same waste stream as the 216-B-38 Trench; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to the 216-B-38 Trench 3. Waste was received from the same source (221-B) 4. Both sites are located in the 200 East Area in proximity to each other; the geology of the two sites is similar 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated 6. Risks are expected to be similar to the 216-B-38 Trench; however, because the top of the contamination is about 4.6 m (15 ft) bgs, human health and ecological risks are expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at the 216-B-38 Trench 7. The relative effluent volume discharged to this trench suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to the 216-B-38 Trench. Because a similar relative volume of effluent was sent to the 216-B-40 Trench, high inventories could remain in the vadose, posing a significant threat to groundwater, similar to the 216-B-38 Trench. This implies that groundwater protection is needed at this waste site, as it is at the 216-B-38 Trench 8. Generally received equivalent or less contaminant inventory than the 216-B-38 Trench . In general, the 216-B-40 Trench is analogous to and bounded by the 216-B-38 Trench. Remedial actions are needed to address the same risks as those of the 216-B-38 Trench, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90). Because the contamination is shallow at the 216-B-40 Trench, remedial actions also are needed to address human health and ecological risk in the 0 to 4 6 m (0 to 15-ft) bgs zone.

Table 2-3. 200-TW-2 Operable Unit Representative Sites and Associated Analogous Waste Sites. (15 Pages)

Waste Site	Waste Site Configuration, Construction, and Purpose	Site Discharge History (WIDS)	Contaminant Inventory (DOE/RL-96-81)						Effluent Volume (m^3)	Soil Pore Volume (m^3)	Eff Vol + Pore Vol	Rationale
			Total U (kg)	Total Pu (g)	Tc-99* (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	Nitrate (kg)				
216-B-41	The 216-B-41 Trench is a 77 x 3 x 3 m (252 x 10 x 10 ft) deep trench that was stabilized in 1982 with 0.6 m (2 ft) of topsoil, treated with herbicides, and seeded with wheat-grasses. The depth to the top of contamination is 4.6 m (15 ft). Located approximately 80 m (250 ft) from the BX Tank Farm tanks and within the assembly of 216-B-35 through 216-B-42 Trenches.	Dissolved Cladding and 1[st] Cycle Waste Stream This site received 1[st] cycle supernatant waste from 221-B Building. The waste is high in salt and neutral to basic. Active for less than one month.	7.5 Less than rep site	0.30 Less than rep site	1.88 Similar to rep site	386 More than rep site	19.3 Less than rep site	120,000 Similar to rep site	1,440 Similar to rep site	4,920	0.29 Similar to rep site	The 216-B-41 Trench is analogous to the 216-B-38 Trench as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received the same waste stream as the 216-B-38 Trench; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to the 216-B-38 Trench 3. Waste was received from the same source (221-B) 4. Both sites are located in the 200 East Area in proximity to each other; the geology of the two sites is similar 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated 6. Risks are expected to be similar to the 216-B-38 Trench; because the top of the contamination is about 4.6 m (15 ft) bgs, human health and ecological risks may be expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at the 216-B-38 Trench 7. The relative effluent volume discharged to this trench suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to the 216-B-38 Trench. Because a similar relative volume of effluent was sent to the 216-B-41 Trench, high inventories could remain in the vadose, posing a significant threat to groundwater, similar to the 216-B-38 Trench. This implies that groundwater protection is needed at this waste site, as it is at 216-B-38 8. Generally received equivalent contaminant inventory than the 216-B-38 Trench, a higher inventories of Cs-137 exists at the 216-B-36 Trench. In general, the 216-B-41 Trench is analogous to and bounded by the 216-B-38 Trench. Remedial actions are needed to address the same risks as those of the 216-B-38 Trench, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90). Because the contamination isrelatively shallow at the 216-B-41 Trench, remedial actions may be needed to address human health and ecological risk in the 0 to 4.6 m (0 to 15-ft) bgs zone.
216-T-14	The 216-T-14 Trench is a 83.8 x 3.0 x 3.7 m (275 x 10 x 12 ft) deep trench that was surface stabilized in 1992 with 0.15 to 0.3 m (0.5 to 1 ft) of clean soil. Contaminated soil from the adjacent UPR-200-W-166 was consolidated onto the west slope of the trench. Then the entire grouping of 216-T-14 through 216-T-17 Trenches was covered with another 0.4 to 0.6 m (1.5 to 2 ft) of clean soil. The above ground piping was removed and the unit was backfilled. The depth to the top of contamination is 4 m (13 ft). Located approximately 99 m (325 ft) from the T Tank Farm tanks and within the assembly of 216-T-14 through 216-T-17 Trenches.	Dissolved Cladding and 1[st] Cycle Waste Stream This site received 1[st] cycle supernatant waste from 221-T Building via Tanks 241-T-104, 241-T-105, and 241-T-106. The waste is high in salt and neutral to basic. Received liquid process effluent. Active for less than one month (January 1954).	30.3 Less than rep site	0.88 Similar to rep site	1.31 Less than rep site	204 Similar to rep site	2.46 Less than rep site	80,000 Less than rep site	1,000 Less than rep site	4,943	0.20 Similar to rep site	The 216-T-14 Trench is analogous to the 216-B-38 Trench as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received a waste stream similar to the 216-B-38 Trench; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to the 216-B-38 Trench 3. Waste was received from a similar source 4. The geology of the two sites is similar, although the vadose zone is thinner in the 200 West Area 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated 6. Risks are expected to be similar to the 216-B-38 Trench; because the top of the contamination is about 4.0 m (13 ft) bgs, human health and ecological risks are expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at the 216-B-38 Trench 7. The relative effluent volume discharged to this trench suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to the 216-B-38 Trench. Because a similar relative volume of effluent was sent to the 216-T-14 Trench, high inventories could remain in the vadose, posing a significant threat to groundwater, similar to the 216-B-38 Trench. This implies that groundwater protection is needed at this waste site, as it is at the 216-B-38 Trench 8. Generally received equivalent or less contaminant inventory than the 216-B-38 Trench; thus, groundwater protection is expected to be required. In general, the 216-T-14 Trench is analogous to and bounded by the 216-B-38 Trench. Remedial actions are needed to address the same risks as those of the 216-B-38 Trench, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90). Because the contamination is shallow at the 216-T-14 Trench, remedial actions also are needed to address human health and ecological risk in the 0 to 4.6 m (0 to 15-ft) bgs zone.

Table 2-3. 200-TW-2 Operable Unit Representative Sites and Associated Analogous Waste Sites. (15 Pages)

Waste Site	Waste Site Configuration, Construction, and Purpose	Site Discharge History (WIDS)	Contaminant Inventory (DOE/RL-96-81)						Effluent Volume (m^3)	Soil Pore Volume (m^3)	Eff Vol + Pore Vol	Rationale
			Total U (kg)	Total Pu (g)	Tc-99* (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	Nitrate (kg)				
216-T-15	The 216-T-15 Trench is a 83.8 x 3.0 x 3.7 m (275 x 10 x 12 ft) deep trench that was surface stabilized in 1992 with clean soil as described for the 216-T-14 Trench. The above ground piping was removed and the unit was backfilled. The depth to the top of contamination is 4 m (13 ft). Located approximately 121 m (400 ft) from the T Tank Farm tanks and within the assembly of 216-T-14 through 216-T-17 Trenches.	Dissolved Cladding and 1st Cycle Waste Stream This site received 1st cycle supernatant waste from 221-T Building via Tanks 241-T-104, 241-T-105, and 241-T-106. The waste is high in salt and neutral to basic. Received liquid process effluent. Active for two months (January and February 1954).	27.1 Less than rep site	0.94 Similar to rep site	1.31 Less than rep site	450 More than rep site	8.62 Less than rep site	80,000 Less than rep site	1,000 Less than rep site	4,943	0.20 Similar to rep site	The 216-T-15 Trench is analogous to the 216-B-38 Trench as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received a waste stream similar to the 216-B-38 Trench; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to the 216-B-38 Trench 3. Waste was received from a similar source 4. The geology of the two sites is similar, although the vadose zone is thinner in the 200 West Area 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated 6. Risks are expected to be similar to the 216-B-38 Trench; because the top of the contamination is about 4.0 m (13 ft) bgs, human health and ecological risks are expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at the 216-B-38 Trench 7. The relative effluent volume discharged to this trench suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to the 216-B-38 Trench. Because a similar relative volume of effluent was sent to the 216-T-15 Trench, high inventories could remain in the vadose, posing a significant threat to groundwater, similar to the 216-B-38 Trench. This implies that groundwater protection is needed at this waste site, as it is at the 216-B-38 Trench 8. Generally received contaminant inventory equivalent to the 216-B-38 Trench (Tc-99 and Cs-137 inventories are greater); thus, groundwater protection is expected to be required. In general, the 216-T-15 Trench is analogous to and bounded by the 216-B-38 Trench. Remedial actions are needed to address the same risks as those of the 216-B-38, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90). Because the contamination is shallow at the 216-T-15 Trench, remedial actions also are needed to address human health and ecological risk in the 0 to 4.6 m (0 to 15-ft) bgs zone.
216-T-16	The 216-T-16 Trench is a 83.8 x 3.0 x 3.7 m (275 x 10 x 12 ft) deep trench that was surface stabilized in 1992 with clean soil as described for the 216-T-14 Trench. The above ground piping was removed and the unit was backfilled. The depthto the top of contamination is 4 m (13 ft). Located approximately 145 m (475 ft) from the T Tank Farm tanks and within the assembly of 216-T-14 through 216-T-17 Trenches.	Dissolved Cladding and 1st Cycle Waste Stream This site received 1st cycle supernatant waste from 221-T Building via Tanks 241-T-104, 241-T-105, and 241-T-106. The waste is high in salt and neutral to basic. Received liquid process effluent. Active for less than one month (February 1954).	22.0 Less than rep site	0.65 Less than rep site	1.31 Similar to rep site	227 Similar to rep site	3.28 Less than rep site	80,000 Less than rep site	1,000 Less than rep site	4,943	0.20 Similar to rep site	The 216-T-16 Trench is analogous to the 216-B-38 Trench as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received a waste stream similar to the 216-B-38 Trench; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to the 216-B-38 Trench 3. Waste was received from a similar source (221-T [illegible] 221-B) 4. The geology of the two sites is similar, although the vadose zone is thinner in the 200 West Area 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated 6. Risks are expected to be similar to the 216-B-38 Trench; however, because the top of the contamination is about 4.0 m (13 ft) bgs, human health and ecological risks are expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at the 216-B-38 Trench 7. The relative effluent volume discharged to this trench suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to the 216-B-38 Trench. Because a similar relative volume of effluent was sent to the 216-T-16 Trench, high inventories could remain in the vadose, posing a significant threat to groundwater, similar to the 216-B-38 Trench. This implies that groundwater protection is needed at this waste site, as it is at the 216-B-38 Trench 8. Generally received equivalent or less contaminant inventory than the 216-B-38 Trench; thus, groundwater protection is expected to be required. In general, the 216-T-16 Trench is analogous to and bounded by the 216-B-38 Trench. Remedial actions are needed to address the same risks as those of the 216-B-38 Trench, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90). Because the contamination is shallow at the 216-T-16 Trench, remedial actions also are needed to address human health and ecological risk in the 0 to 4.6 m (0 to 15-ft) bgs zone.

Table 2-3. 200-TW-2 Operable Unit Representative Sites and Associated Analogous Waste Sites. (15 Pages)

Waste Site	Waste Site Configuration, Construction, and Purpose	Site Discharge History (WIDS)	Contaminant Inventory (DOE/RL-96-81)						Effluent Volume (m^3)	Soil Pore Volume (m^3)	Eff Vol + Pore Vol	Rationale
			Total U (kg)	Total Pu (g)	Tc-99* (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	Nitrate (kg)				
216-T-17	The 216-T-17 Trench is a 83.8 x 3.0 x 3.7 m (275 x 10 x 12 ft) deep trench that was surface stabilized in 1992 with clean soil as described for the 216-T-14 Trench. The above ground piping was removed and the unit was backfilled. The depth to the top of contamination is 4 m (13 ft). Located approximately 168 m (550 ft) from the T Tank Farm tanks and within the assembly of 216-T-14 through 216-T-17 Trenches.	Dissolved Cladding and 1st Cycle Waste Stream This site received 1st cycle supernatant waste from 221-T Building via Tanks 241-T-104, 241-T-105, and 241-T-106. The waste is high in salt and neutral to basic. Received liquid process effluent. Active for 5 months (February to June 1954).	20.2 Less than rep site	0.53 Less than rep site	1.31 Less than rep site	162 Less than rep site	1.23 Less than rep site	60,000 Less than rep site	1,000 Less than rep site	4,943	0.20 Similar to rep site	The 216-T-17 Trench is analogous to the 216-B-38 Trench as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received a waste stream similar to the 216-B-38 Trench; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to the 216-B-38 Trench 3. Waste was received from a similar source 4. The geology of the two sites is similar, although the vadose zone is thinner in the 200 West Area 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated 6. Risks are expected to be similar to the 216-B-38 Trench; because the top of the contamination is about 4.0 m (13 ft) bgs, human health and ecological risks are expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at the 216-B-38 Trench 7. The relative effluent volume discharged to this trench suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to the 216-B-38 Trench. Because a similar relative volume of effluent was sent to the 216-T-17 Trench, high inventories could remain in the vadose, posing a significant threat to groundwater, similar to the 216-B-38 Trench. This implies that groundwater protection is needed at this waste site, as it is at the 216-B-38 Trench 8. Generally received equivalent or less contaminant inventory than the 216-B-38 Trench. In general, the 216-T-17 Trench is analogous to and bounded by the 216-B-38 Trench. Remedial actions are needed to address the same risks as those of the 216-B-38 Trench, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90). Because the contamination is shallow at the 216-T-17 Trench, remedial actions also are needed to address human health and ecological risk in the 0 to 4 6 m (0 to 15-ft) bgs zone.
216-T-21	The 216-T-21 Trench is a 73.1 x 3.0 x 3.0 m (240 x 10 x 10 ft) deep trench that was interim stabilized in 1982. The above ground piping was removed and the unit was backfilled. The depth to the top of contamination is 3.7 m (12 ft). Located approximately 107 m (350 ft) from the TX Tank Farm tanks and within the assembly of 241-T-21 through 241-T-25 Trenches.	Dissolved Cladding and 1st Cycle Waste Stream This site received 1st cycle supernatant waste from 221-T Building via Tanks 241-T-109, 241-T-110, and 241-T-111. The waste is high in salt and neutral to basic. Received liquid process effluent. Active for 3 months (June to August 1954).	0.89 Less than rep site	1.0 Similar to rep site	0.608 Less than rep site	174 Less than rep site	3.38 Less than rep site	40,000 Less than rep site	460 Less than rep site	3,730	0.12 Less than rep site	The 216-T-21 Trench is analogous to the 216-B-38 Trench as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received a waste stream similar to the 216-B-38 Trench; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to the 216-B-38 Trench 3. Waste was received from a similar source 4. The geology of the two sites is similar, although the vadose zone is thinner in the 200 West Area 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated 6. Risks are expected to be similar to the 216-B-38 Trench; because the top of the contamination is about 3.7 m (12 ft) bgs, human health and ecological risks are expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at the 216-B-38 Trench 7. The relative effluent volume discharged to this trench suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to the 216-B-38 Trench. Although a lesser relative volume of effluent was sent to the 216-T-21 Trench, high inventories could remain in the vadose, posing a significant threat to groundwater, similar to the 216-B-38 Trench. This implies that groundwater protection is needed at this waste site, as it is at the 216-B-38 Trench 8. Generally received equivalent or less contaminant inventory than the 216-B-38 Trench. In general, the 216-T-21 Trench is analogous to and bounded by the 216-B-38 Trench. Remedial actions are needed to address the same risks as those of the 216-B-38 Trench, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90). Because the contamination is shallow at the 216-T-21 Trench, remedial actions also are needed to address human health and ecological risk in the 0 to 4.6 m (0 to 15-ft) bgs zone.

Table 2-3. 200-TW-2 Operable Unit Representative Sites and Associated Analogous Waste Sites. (15 Pages)

Waste Site	Waste Site Configuration, Construction, and Purpose	Site Discharge History (WIDS)	Contaminant Inventory (DOE/RL-96-81)						Effluent Volume (m^3)	Soil Pore Volume (m^3)	Eff Vol ÷ Pore Vol	Rationale
			Total U (kg)	Total Pu (g)	Tc-99* (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	Nitrate (kg)				
216-T-22	The 216-T-22 Trench is a 73.1 x 3.0 x 3.0 m (240 x 10 x 10 ft) deep trench that was interim stabilized in 1982. The above ground piping was removed and the unit was backfilled. The depth to the top of contamination is 3.7 m (12 ft). Located approximately 107 m (350 ft) from the TX Tank Farm tanks and within the assembly of 241-T-21 through 241-T-25 Trenches.	Dissolved Cladding and 1st Cycle Waste Stream This site received 1st cycle supernatant waste from 221-T Building via Tanks 241-T-109, 241-T-110, and 241-T-111. The waste is high in salt and neutral to basic. Received liquid process effluent. Active for 2 months (July to August 1954).	2.08 Less than rep site	2.0 Similar to rep site	2.00 Similar to rep site	803 More than rep site	20.9 Less than rep site	120,000 Similar to rep site	1,530 Similar to rep site	3,730	0.41 More than rep site	The 216-T-22 Trench is analogous to the 216-B-38 Trench as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received a waste stream similar to the 216-B-38 Trench; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to the 216-B-38 Trench 3. Waste was received from a similar source 4. The geology of the two sites is similar, although the vadose zone is thinner in the 200 West Area 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated 6. Risks are expected to be similar to the 216-B-38 Trench; however, because the top of the contamination is about 3.7 m (12 ft) bgs, human health and ecological risks are expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at the 216-B-38 Trench 7. The relative effluent volume discharged to this trench suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to the 216-B-38 Trench. 8. Generally received equivalent or greater contaminant inventory than the 216-B-38 Trench (higher inventory of Cs-137 exists). In general, the 216-T-22 Trench is analogous to and bounded by the 216-B-38 Trench. Remedial actions are needed to address the same risks as those of the 216-B-38 Trench, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90). Because the contamination is shallow at the 216-T-22 Trench, remedial actions also are needed to address human health and ecological risk in the 0 to 4.6 m (0 to 15-ft) bgs zone.
216-T-23	The 216-T-23 Trench is a 73.1 x 3.0 x 3.0 m (240 x 10 x 10 ft) deep trench that was interim stabilized in 1982. The above ground piping was removed and the unit was backfilled. The depth to the top of contamination is 3.7 m (12 ft). Located approximately 107 m (350 ft) from the TX Tank Farm tanks and within the assembly of 241-T-21 through 241-T-25 Trenches.	Dissolved Cladding and 1st Cycle Waste Stream This site received 1st cycle supernatant waste from 221-T Building via Tanks 241-T-109, 241-T-110, and 241-T-111. The waste is high in salt and neutral to basic. Received liquid process effluent. Active for 2 months (July to August 1954).	0.89 Less than rep site	1.0 Similar to rep site	1.94 Similar to rep site	577 More than rep site	16.8 Less than rep site	120,000 Similar to rep site	1,480 Similar to rep site	3,730	0.40 More than rep site	The 216-T-23 Trench is analogous to the 216-B-38 Trench as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received a waste stream similar to the 216-B-38 Trench; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to the 216-B-38 Trench 3. Waste was received from a similar source 4. The geology of the two sites is similar, although the vadose zone is thinner in the 200 West Area 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated 6. Risks are expected to be similar to the 216-B-38 Trench; however, because the top of the contamination is about 3.7 m (12 ft) bgs, human health and ecological risks are expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at the 216-B-38 Trench 7. The relative effluent volume discharged to this trench suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to the 216-B-38 Trench. This implies that groundwater protection is needed at this waste site, as it is at the 216-B-38 Trench 8. Generally received equivalent or greater contaminant inventory than the 216-B-38 Trench (greater inventories of Tc-99 and Cs-137 exist). In general, the 216-T-23 Trench is analogous to and bounded by the 216-B-38 Trench. Remedial actions are needed to address the same risks as those of the 216-B-38 Trench, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90). Because the contamination is shallow at the 216-T-23 Trench, remedial actions also are needed to address human health and ecological risk in the 0 to 4.6 m (0 to 15-ft) bgs zone.

Table 2-3. 200-TW-2 Operable Unit Representative Sites and Associated Analogous Waste Sites. (15 Pages)

Waste Site	Waste Site Configuration, Construction, and Purpose	Site Discharge History (WIDS)	Contaminant Inventory (DOE/RL-96-81)						Effluent Volume (m^3)	Soil Pore Volume (m^3)	Eff Vol ÷ Pore Vol	Rationale
			Total U (kg)	Total Pu (g)	Tc-99* (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	Nitrate (kg)				
216-T-24	The 216-T-24 Trench is a 73.1 x 3.0 x 3.0 m (240 x 10 x 10 ft) deep trench that was interim stabilized in 1982. The above ground piping was removed and the unit was backfilled. The depth to the top of contamination is 3.7 m (12 ft). Located approximately 107 m (350 ft) from the TX Tank Farm tanks and within the assembly of 241-T-21 through 241-T-25 Trenches.	<u>Dissolved Cladding and 1st Cycle Waste Stream</u> This site received 1st cycle supernatant waste from 221-T Building via Tanks 241-T-109, 241-T-110, and 241-T-111. The waste is high in salt and neutral to basic. Received liquid process effluent. Active for less than one month (August 1954).	8.92 Less than rep site	2.0 Similar to rep site	2.00 Similar to rep site	617 More than rep site	16.4 Less than rep site	120,000 Similar to rep site	1,530 Similar to rep site	3,730	0.41 More than rep site	The 216-T-24 Trench is analogous to the 216-B-38 Trench as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received a waste stream similar to the 216-B-38 Trench; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to the 216-B-38 Trench 3. Waste was received from a similar source 4. The geology of the two sites is similar, although the vadose zone is thinner in the 200 West Area 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated 6. Risks are expected to be similar to the 216-B-38 Trench; because the top of the contamination is about 3.7 m (12 ft) bgs, human health and ecological risks are expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at the 216-B-38 Trench 7. The relative effluent volume discharged to this trench suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to the 216-B-38 Trench. Because a slightly larger relative volume of effluent was sent to the 216-T-24 Trench, high inventories could remain in the vadose, posing a significant threat to groundwater, similar to the 216-B-38 Trench. This implies that groundwater protection is needed at this waste site, as it is at the 216-B-38 Trench 8. Generally received equivalent or greater contaminant inventory than the 216-B-38 Trench (greater inventory Cs-137 exists). In general, the 216-T-24 Trench is analogous to and bounded by the 216-B-38 Trench. Remedial actions are needed to address the same risks as those of the 216-B-38 Trench, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90). Because the contamination is shallow at the 216-T-24 Trench, remedial actions also are needed to address human health and ecological risk in the 0 to 4.6 m (0 to 15-ft) bgs zone.
216-T-25	The 216-T-25 Trench is a 54.9 x 3.0 x 3.0 m (180 x 10 x 10 ft) deep trench that was interim stabilized in 1982. The above ground piping was removed and the unit was backfilled. The depth to the top of contamination is 3.7 m (12 ft). Located approximately 122 m (400 ft) from the TX Tank Farm tanks and within the assembly of 241-T-21 through 241-T-25 Trenches.	<u>Dissolved Cladding and 1st Cycle Waste Stream</u> This site received evaporator bottoms consisting of sludge from the 242-T Evaporator condensed first-cycle waste. The waste is high in salt and neutral to basic. Received liquid process effluent. Active for less than one month (September 1954).	8.92 Less than rep site	1.0 Similar to rep site	17.9 More than rep site	3,860 More than rep site	1.64 Less than rep site	1,200,000 More than rep site	3,000 More than rep site	2,797	1.07 More than rep site	The 216-T-25 Trench is analogous to the 216-B-38 Trench as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received a waste stream similar to the 216-B-38 Trench; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to the 216-B-38 Trench 3. Waste was received from a similar source 4. The geology of the two sites is similar, although the vadose zone is thinner in the 200 West Area 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated 6. Risks are expected to be similar to the 216-B-38 Trench; because the top of the contamination is about 3.7 m (12 ft) bgs, human health and ecological risks are expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at the 216-B-38 Trench 7. The relative effluent volume discharged to this trench suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to the 216-B-38 Trench. This implies that groundwater protection is needed at this waste site, as it is at the 216-B-38 Trench 8. Generally received equivalent or greater contaminant inventory than the 216-B-38 Trench (greater inventories of Tc-99 and Cs-137 exist). In general, the 216-T-25 Trench is analogous to and bounded by the 216-B-38 Trench. Remedial actions are needed to address the same risks as those of the 216-B-38 Trench, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90). Because the contamination is shallow at the 216-T-25 Trench, remedial actions also are needed to address human health and ecological risk in the 0 to 4.6 m (0 to 15-ft) bgs zone.

* BHI-01496, *Groundwater/Vadose Zone Integration Project Hanford Soil Inventory Model.*

BHI-01607, *Borehole Summary Report for Boreholes C3103 and C3104, and Drive Casing C3340, C3341, C3342, C3343, and C3344, in the 216-B-38 Trench and 216-B-7A Crib, 200-TW-2 Tank Waste Group Operable Unit.*

DOE/RL-96-81, *Waste Site Grouping for 200 Areas Soil Investigations*, Rev. 0.

DOE/RL-2000-38, *200-TW-1 Scavenged Waste Group Operable Unit and 200-TW-2 Tank Waste Group Operable Unit RI/FS Work Plan*, Rev. 0.

DOE/RL-2002-42, *Remedial Investigation Report for the 200-TW-1 and 200-TW-2 Operable Units (Includes the 200-PW-5 Operable Unit)*, Rev. 0.

GJO-2002-358-TAC, *Hanford 200 Area Spectral Gamma Baseline Characterization Project, 216-B-5 Injection Well and 216-B-9 Crib and Tile Field Waste Site Summary Report.*

RHO-ST-37, *216-B-5Injection Well/Reverse Well Characterization Study.*

Waste Information Data System Report, Hanford Site database.

bgs = below ground surface.
OU = operable unit.
RLS = radionuclide logging system.
TRU = contaminated with 100 nCi/g of transuranic materials with half-lives longer than 20 years.
VCP = vitrified clay pipeline.

Table 2-4. 200-PW-5 Operable Unit Representative Sites and Associated Analogous Waste Sites. (5 Pages)

Waste Site	Waste Site Configuration, Construction, and Purpose	Site Discharge History (WIDS)	Contaminant Inventory (DOE/RL-96-81)						Effluent Volume (m^3)	Soil Pore Volume (m^3)	Eff Vol ÷ Pore Vol	Rationale
			Total U (kg)	Total Pu (g)	Tc-99* (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	Nitrate (kg)				
Representative Site												
216-B-57	The 216-B-57 Crib is a 61 x 4.6 x 3.0 m (200 x 15 x 10 ft) deep excavation that was filled to 1.2 m (4 ft) above the bottom with gravel (approximately 474 m^3 [620 yd^3]). A perforated, 30.5 cm (12-in.) corrugated pipe runs the length of the crib, 0.9 m (3 ft) above the bottom. The side slope of the original crib construction is 1.5:1. The depth to the top of contamination is 12.5 m (41 ft). The crib is covered by the Hanford Barrier, which is an engineered barrier measuring 105 m (320 ft) long, 64 m (210 ft) wide, and 4.6 m (15 ft) high (minimum height). The engineered barrier was constructed on top of the crib in 1994. Located approximately 46 m (150 ft) from the BY Tank Farm tanks.	<u>Process Condensate Waste Stream</u> The site received the waste storage tank condensate from the In Tank Solidification (ITS) #2 Unit in the BY Tank Farm. The site was active from 1968 to 1973 (total of 5 years).	0.890	0.187	0.040	226	1.83	---	84,400	5,775	14.61	The 216-B-57 Crib was characterized during the 200-BP-1 remedial investigation in 1991 (reported in DOE/RL-92-70). The engineered structure is a gravel crib that received condensate from the ITS #2 Unit in the BY Tank Farm. The contaminant inventory is relatively small. Soil data indicate that contamination is associated with the point of release about 4.6 m (15 ft) below original grade and extends to a depth of about 10.1 m (33 ft), with maximum concentrations of Cs-137 (67,000 pCi/g), Sr-90 (67 pCi/g), Pu-239 (0.01 pCi/g), and Tc-99 (60 pCi/g) detected. Very little contamination is present beyond a depth of 7 m (33 ft) from original grade. The plume geometry and soil characterization data indicate a low potential for groundwater impact from the 216-B-57 Crib. The Hanford Barrier is constructed over this site, which adds approximately 4.6 m (15 ft) to the depth described above.
200-PW-5 OU analogous wastes sites to be evaluated by the (216-B-57 Crib) model												
216-C-6	The 216-C-6 Crib structure is composed of 15 cm (6-in.) diameter galvanized, corrugated, perforated piping placed horizontally 0.3 m (1 ft) above the bottom of the crib (on gravel) to form an "H" structure. It was topped with 1.8 m (6 ft) of gravel and backfill material. The bottom of the crib measured 6.1 m (20 ft) x 3.0 m (10 ft) and was 4.9 m (16 ft) below grade. The depth to the top of contamination is 3 m (10 ft). Located approximately 6.1 m (20 ft) from the 241-CX-72 Building (vault containing a tank). Next nearest structure is the 216-C-4 Crib approximately 43 m (140 ft) away.	<u>Process Condensate Waste Stream</u> The site received the process condensate from the 201-C Process Building and the 241-CX Vault floor drainage in the 241-CX Area. The waste is acidic. Site received liquid process effluent during 1955 – 1964 (active for 9 years).	0.05 Less than rep site	0.1 Similar to rep site	~0 Similar to rep site	0.0465 Less than rep site	28.8 More than rep site	---	530 Less than rep site	484	1.10 Less than rep site	The 216-C-6 Crib is analogous to the 216-B-57 Crib as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received a waste stream similar to that of the 216-B-57 Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to the 216-B-57 Crib 3. Waste was received from a similar source 4. Both sites are located in the 200 East Area; the geology of the two sites is similar 5. The vertical extent of contamination is expected to be similar based on evidence from similar site conditions 6. Risks are expected to be similar to the 216-B-57 Crib; however, because the top of the contamination is about 3.0 m (10 ft) bgs, human health and ecological risks are expected in the 0 to 4.6 m (0 to 15-ft) zone 7. The relative effluent volume discharged to this crib suggests that contaminant inventory in the vadose zone may pose a threat to groundwater 8. Generally received equivalent or less contaminant inventory than the 216-B-57 Crib. In general, the 216-C-6 Crib is analogous to and roughly equivalent to the 216-B-57 Crib. Remedial actions are needed to address the same risks as those of the 216-B-57 Crib, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site. Because the contamination is shallower at the 216-C-6 Crib, remedial actions also are needed to address human health and ecological risk in the 0 to 4.6 m (0 to 15-ft) bgs zone.

Table 2-4. 200-PW-5 Operable Unit Representative Sites and Associated Analogous Waste Sites. (5 Pages)

Waste Site	Waste Site Configuration, Construction, and Purpose	Site Discharge History (WIDS)	Contaminant Inventory (DOE/RL-96-81)						Effluent Volume (m^3)	Soil Pore Volume (m^3)	Eff Vol + Pore Vol	Rationale
			Total U (kg)	Total Pu (g)	Tc-99* (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	Nitrate (kg)				
216-B-11A and 216-B-11B	The 216-B-11A and 216-B-11B French Drains are constructed of 9.1 m (30 ft) long, 2.4 m (8 ft) diameter corrugated culvert perforated with 2.5 cm (½ in.) diameter holes, buried vertically 3.0 m (10 ft) below grade, and filled with rocks. The sites have the potential for cave-in and are posted with metal chains and signs. The depth to the top of contamination is 7.6 m (25 ft). Located approximately 61 m (200 ft) from the B Tank Farm tanks and approximately 46 m (150 ft) from the 216-B-7A and 216-B-7B Cribs.	Process Condensate Waste Stream The site received process condensate from the 242-B Evaporator. The waste is low in salt and considered neutral to basic. Site was active from 1951 to 1954.	14 More than rep site	4 More than rep site	0.0038 Similar to rep site	21.3 Less than rep site	2.01 Similar to rep site	---	29,600 Less than rep site	169.2	175.0 More than rep site	The 216-B-11A and 216-B-11B French Drains are analogous to the 216-B-57 Crib as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received a waste stream similar to that of the 216-B-57 Crib; therefore, the contaminant types are expected to be very similar 2. Both are unlined liquid disposal waste sites 3. Waste was received from the same source (condensate from 242-B Evaporator) 4. Both sites are located in the 200 East Area in proximity to each other; the geology of the two sites is similar 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated (e.g., 216-B-43 through 216-B-50 Cribs) 6. Risks are expected to be similar to the 216-B-57 Crib; however, because the top of the contamination is about 7.6 m (25 ft) bgs, human health and ecological risks are not expected in the 0 to 4.6 m (0 to 15-ft) zone 7. The relative effluent volume discharged to this crib suggests that contaminant inventory in the vadose zone may pose a threat to groundwater. A greater relative volume of effluent was sent to the 216-B-11A and 216-B-11B French Drains, suggesting that contaminants remaining in the vadose may be deeper than those found in the 216-B-57 Crib, which was found to pose a threat to groundwater. 8. Generally received equivalent or less contaminant inventory than the 216-B-57 Crib, supporting the need for groundwater protection at this waste site. In general, the 216-B-11A and 216-B-11B French Drains are analogous to and roughly equivalent to the 216-B-57 Crib. Remedial actions are needed to address the same risks as those of the 216-B-57 Crib, specifically protection of groundwater.
216-B-62	The 216-B-62 Crib has 1.2 m (4 ft) of gravel fill underneath a perforated fiberglass reinforced epoxy pipe. Excavation dimensions are 152.4 m (500 ft) x 3.0 m (10 ft) x ~ 3.1 m (10 ft) deep. Site surrounded by AC-540 concrete markers and posted as an "Underground Radioactive Material" site. The depth to the top of contamination is 3.7 m (12 ft). Located more than 300 m (1,000 ft) from any significant structure.	Process Condensate Waste Stream The site has received process condensate from the 221-B Building Separations Facilities. Received liquid process effluent (radioactive) from 1973 – 1991 (active for 18 years).	2.75 Similar to rep site	0.755 Similar to rep site	0.024 Similar to rep site	135 Less than rep site	74.6 More than rep site	—	282,000 More than rep site	11,580	24.35 More than rep site	The 216-B-62 Crib is analogous to the 216-B-57 Crib as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received a waste stream similar to the 216-B-57 Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to the 216-B-57 Crib; both are unlined liquid disposal sites 3. Waste was received from a similar source 4. Both sites are located in the 200 East Area in proximity to each other; the geology of the two sites is similar 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated (e.g., 216-B-43 through 216-B-50 Cribs) 6. Risks are expected to be similar to those of the 216-B-57 Crib; however, because the top of the contamination is about 3.7 m (12 ft) bgs, human health and ecological risks are expected in the 0 to 4.6 m (0 to 15-ft) zone; risks to intruders may be associated with high contamination at the bottom of the waste site as evidenced by similar risk at the 216-B-57 Crib 7. The relative effluent volume discharged to this crib suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to the 216-B-57 Crib. A greater relative volume was discharged to the 216-B-62 Crib, suggesting that high inventories could be deeper in the vadose and pose a significant threat to groundwater, similar to the 216-B-57 Crib. This implies that groundwater protection is needed at this waste site, as it is at the 216-B-57 Crib 8. Generally received equivalent contaminant inventory to the 216-B-57 Crib, although the Sr-90 inventory is greater. In general, the 216-B-62 Crib is analogous to and roughly equivalent to the 216-B-57 Crib. Remedial actions are needed to address the same risks as those of the 216-B-57 Crib, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90). Because the contamination is shallower at the 216-C-6 Crib, remedial actions also are needed to address human health and ecological risk in the 0 to 4.6 m (0 to 15-ft) bgs zone.

Table 2-4. 200-PW-5 Operable Unit Representative Sites and Associated Analogous Waste Sites. (5 Pages)

Waste Site	Waste Site Configuration, Construction, and Purpose	Site Discharge History (WIDS)	Contaminant Inventory (DOE/RL-96-81) Total U (kg)	Total Pu (g)	Tc-99* (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	Nitrate (kg)	Effluent Volume (m^3)	Soil Pore Volume (m^3)	Eff Vol + Pore Vol	Rationale
216-S-21	The 216-S-21 Crib site consists of a wooden crib box with two vent risers and one well in the center of the box. The crib structure is 4.9 x 4.5 x 3 m (16 x 15 x 10 ft). Waste site dimensions are 15.2 x 15.4 x 6.4 m (50 x 50 x 21 ft). About 3.0 m (10 ft) of overburden covers the crib. The depth to the top of contamination is 7.3 m (24 ft). Located approximately 137 m (450 ft) from the S Tank Farm tanks and approximately 69 m (225 ft) from the 216-S-4 French Drain.	<u>Tank Condensate Waste Stream</u> The site received 241-SX Tank Farm condensate from the 241-SX-401 Condenser Shielding Building in the SX Tank Farm via Tank 241-SX-206 from 1954 to 1970.	4.16 Similar to rep site	—	0.0156 Similar to rep site	88 Less than rep site	—	—	87,100 Similar to rep site	3,500	24.89 More than rep site	The 216-S-21 Crib is analogous to the 216-B-57 Crib as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received a waste stream similar to the 216-B-57 Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to the 216-B-57 Crib 3. Waste was received from a similar source 4. Both sites are located in the 200 East Area in proximity to each other; the geology of the two sites is similar 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated (e.g., 216-B-43 through 216-B-50 Cribs) 6. Risks are expected to be similar to the 216-B-57 Crib; however, because the top of the contamination is about 7.3 m (24 ft) bgs, human health and ecological risks are not expected 7. The relative effluent volume discharged to this crib suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to the 216-B-57 Crib. A greater relative volume was discharged to the 216-S-21 Crib, suggesting that high inventories could remain in the vadose that pose a significant threat to groundwater, similar to the 216-B-57 Crib. 8. Generally received equivalent or less contaminant inventory than the 216-B-57 Crib. In general, the 216-S-21 Crib is analogous to and roughly equivalent to the 216-B-57 Crib. Remedial actions are needed to address the same risks as those of the 216-B-57 Crib, specifically protection of groundwater and from intrusion.
216-S-9	The 216-S-9 Crib site is a gravel crib measuring 91.5 x 9.1 m (300 x 30 ft) and 7.6 m (25 ft) deep. A U-shaped 15 cm (6-in.) diameter distribution pipe [15 cm (6 in.) diameter, vitrified clay pipe] extends the length of the crib at a depth of approximately 6.4 m (21 ft). Waste site dimensions are 15.2 x 15.4 x 6.4 m (50 x 50 x 21 ft). About 3.0 m (10 ft) of overburden covers the crib. The depth to the top of contamination is 7 m (23 ft). Located more than 300 m (1,000 ft) from the SY Tank Farm tanks and approximately 53 m (175 ft) from the 216-S-18 Trench.	<u>Process Condensate Waste Stream</u> The site has received D-2 tank process condensate from the 202-S Building. The crib received effluent from 1965 to 1969. The waste was composed mainly of nitric acid.	32.7 More than rep site	65.0 More than rep site	0.0515 Similar to rep site	290 Similar to rep site	96.3 More than rep site	0	50,300 Less than rep site	15,050	3.34 Less than rep site	The 216-S-9 Crib is analogous to the 216-B-57 Crib as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received a waste stream similar to the 216-B-57 Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is similar to the 216-B-57 Crib 3. Waste was received from a similar source 4. Both sites are located in the 200 East Area in proximity to each other; the geology of the two sites is similar 5. The vertical extent of contamination is expected to be similar based on evidence from similar sites investigated 6. Risks are expected to be similar to the 216-B-57 Crib; however, because the top of the contamination is about 7.0 m (23 ft) bgs, human health and ecological risks are not expected 7. The relative effluent volume discharged to this crib suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to the 216-B-57 Crib. Although a smaller relative volume was discharged to the 216-S-9 Crib, high inventories could remain in the vadose that pose a significant threat to groundwater, similar to the 216-B-57 Crib. This implies that groundwater protection is needed at this waste site, as it is at the 216-B-57 Crib. Since 1965, monitoring wells have detected radioactive contamination from the crib bottom to the water table. 8. Generally received equivalent or greater contaminant inventory than the 216-B-57 Crib (uranium, plutonium, and Sr-90 inventories are greater). In general, the 216-S-9 Crib is analogous to and roughly equivalent to the 216-B-57 Crib. Remedial actions are needed to address the same risks as those of the 216-B-57 Crib, specifically protection of groundwater and from intrusion.

Table 2-4. 200-PW-5 Operable Unit Representative Sites and Associated Analogous Waste Sites. (5 Pages)

Waste Site	Waste Site Configuration, Construction, and Purpose	Site Discharge History (WIDS)	Contaminant Inventory (DOE/RL-96-81)						Effluent Volume (m^3)	Soil Pore Volume (m^3)	Eff Vol + Pore Vol	Rationale
			Total U (kg)	Total Pu (g)	Tc-99* (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	Nitrate (kg)				
UPR-200-W-108	The UPR-200-W-108 unplanned release occurred during the tie-in of the 216-S-9 Crib to the 216-S-23 Crib. The release occurred in an excavation at a depth of 6.1 m (20 ft). The depthto the top of contamination is 0.6 m (2 ft). Located adjacent to the 216-S-9 Crib.	Process Condensate Waste Stream The release was documented on January 8, 1969. Approximately 114 L (30 gal) of D-2 tank process condensate from the 202-S Building was released.	-	-	-	-	-	-	-	-		The UPR-200-W-108 unplanned release is analogous to the 216-B-57 Crib based on the source of contamination (216-S-9 Crib). This unplanned release area resulted from a break in a line used to transfer waste liquid from the 216-S-9 Crib to the 216-S-23 Crib and a subsequent spill of approximately 114 L of liquid waste. It is analogous to the 216-B-57 Crib based on its relationship with the 216-S-9 Crib. The UPR-200-W-108 unplanned release is analogous to the 216-B-57 Crib as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received a waste stream similar to the 216-B-57 Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is not similar to the 216-B-57 Crib in that it was a spill rather than a liquid disposal site 3. Waste was received from a similar source 4. Both sites are located in the 200 East Area in proximity to each other; the geology of the two sites is similar 5. The vertical extent of contamination is expected to be considerably less based on the limited quantity of the spill 6. Risks are expected to be similar to those of the 216-B-57 Crib with respect to human health and ecological risks, because the contamination is near the surface - 0.6 m (2 ft) 7. The volume of effluent spilled suggests that groundwater should not be impacted 8. Generally received lesser contaminant inventory than the 216-B-57 Crib. In general, the UPR-200-W-108 unplanned release is analogous to and roughly equivalent to the 216-B-57 Crib. Remedial actions are needed to address some of the same risks as those of the 216-B-57 Crib, specifically protection for human and ecological receptors from shallow contamination.
UPR-200-W-109	The UPR-200-W-109 unplanned release occurred during the tie-in of the 216-S-9 Crib to the 216-S-23 Crib. The release occurred within an open excavation. The dimensions of the release were not documented. The depth to the top of contamination is 0.6 m (2 ft). Isolated release approximately 107 m (350 ft) from the UPR-200-W-108 unplanned release (and just inside the 218-W-9 Burial Ground boundary).	Process Condensate Waste Stream The release was documented on January 24, 1969. However, the quantity of the release was not documented. The effluent contained D-2 tank process condensate from the 202-S Building.	-	-	-	-	-	-	-	-		The UPR-200-W-109 unplanned release is analogous to the 216-B-57 Crib based on the source of contamination (216-S-9 Crib). This unplanned release area resulted from a break in a line used to transfer waste liquid from the 216-S-9 Crib to the 216-S-23 Crib subsequent to the UPR-200-W-108 unplanned release. The amount of liquid waste spilled is unknown. It is analogous to the 216-B-57 Crib based on its relationship with the 216-S-9 Crib. The UPR-200-W-108 unplanned release is analogous to the 216-B-57 Crib as indicated by process history, contaminant inventory, effluent volume received, and expected nature and vertical extent of contamination: 1. Received a waste stream similar to the 216-B-57 Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is not similar to the 216-B-57 Crib in that it was a spill rather than a liquid disposal site 3. Waste was received from a similar source 4. Both sites are located in the 200 East Area in proximity to each other; the geology of the two sites is similar 5. The vertical extent of contamination is expected to be considerably less based on the limited quantity of the spill 6. Risks are expected to be similar to those of the 216-B-57 Crib with respect to human health and ecological risks, because the contamination is near the surface - 0.6 m (2 ft) 7. The volume of effluent spilled suggests that groundwater should not be impacted 8. Generally received lesser contaminant inventory than the 216-B-57 Crib. In general, the UPR-200-W-109 unplanned release is analogous to and roughly equivalent to the 216-B-57 Crib. Remedial actions are needed to address the some of the same risks as those of the 216-B-57 Crib, specifically protection for human and ecological receptors from shallow contamination.

Table 2-4. 200-PW-5 Operable Unit Representative Sites and Associated Analogous Waste Sites. (5 Pages)

Waste Site	Waste Site Configuration, Construction, and Purpose	Site Discharge History (WIDS)	Contaminant Inventory (DOE/RL-96-81) Total U (kg)	Total Pu (g)	Tc-99* (Ci)	Cs-137 (Ci)	Sr-90 (Ci)	Nitrate (kg)	Effluent Volume (m^3)	Soil Pore Volume (m^3)	Eff Vol ÷ Pore Vol	Rationale
The following sites are within the 200-PW-5 OU and analogous to the 216-B-57 Crib; however, sufficient information is available for stand-alone characterization.												
216-B-50	The 216-B-50 Crib site is a gravel crib with a bottom surface measuring 9.1 x 9.1 m (30 x 30 ft) that is 4.3 m (14 ft) below grade. The crib has been stabilized with gravel, is surrounded with light chain, and is posted as an "Underground Radioactive Material" area. The depth to the top of contamination is 4.6 m (15 ft). Located approximately 137 m (450 ft) from the BY Tank Farm tanks and associated with the assembly of 216-B-43 through 216-B-50 Cribs.	Tank Condensate Waste Stream The site received waste storage tank intermediate-level process condensate from the ITS #1 Unit in the BY Tank Farm from 1965 – 1974 (active for nine years).	0.29 Less than rep site	0.24 Similar to rep site	0.0091 Similar to rep site	51.2 Less than rep site	3.39 Similar to rep site	1,500	54,800 Less than rep site	9,885	5.54 Less than rep site	The 216-B-50 Crib is analogous to the 216-B-57 Crib as indicated by process history, contaminant inventory, effluent volume received, and sampling data collected under DOE/RL-88-32 and reported in DOE/RL-92-70; a risk assessment is provided in Appendix C of this feasibility study: 1. Received the same waste stream as the 216-B-57 Crib; therefore, the contaminant types are expected to be very similar 2. Site construction is the same as the 216-B-57 Crib 3. Waste was received from the same source (221-U) 4. Both sites are located in the 200 East Area in proximity to each other; the geology of the two sites is similar 5. The vertical extent of contamination is similar based on characterization evidence from this site; contaminants were found mainly in a zone from 5.6 to 9.8 m (18.5 to 32 ft) bgs (this was a shallow borehole; based on the 216-B-49 Crib, which was drilled to the water table as representative of the deep zone for the other sites in the 216-B-43 through 216-B-50 series of cribs, this zone would be expected to be about 15 m (50 ft) bgs; Tc-99 and nitrate are expected to be found throughout the vadose zone 6. Risks are similar to those of the 216-B-57 Crib; because the top of the contamination is about 4.6 m (15 ft) bgs, direct contact human health risk and ecological risk are not anticipated; intruder risk is a concern 7. The relative effluent volume discharged to this crib suggests that contaminant inventory in the vadose zone may pose a threat to groundwater, similar to the 216-B-57 Crib. About one-third of the relative volume of effluent was sent to the 216-B-43 Crib; this suggests that contaminants remaining in the vadose may not have been flushed through the crib, and concentrations may exceed those found in the 216-B-57 Crib, which was found to pose a threat to groundwater. This implies that groundwater protection is needed at this waste site, as it is at the 216-B-57 Crib 8. Generally received equivalent contaminant inventory than the 216-B-57 Crib. In general, the 216-B-50 Crib is analogous to the 216-B-57 Crib. Remedial actions are needed to address the same risks as those for the 216-B-57 Crib, specifically protection of groundwater and protection against intrusion to contaminants at the bottom of the waste site, which could pose a significant direct contact risk to a potential intruder because of the nature of the contaminants (i.e., Cs-137 and Sr-90).

DOE/RL-88-32, *Remedial Investigation/Feasibility Study Work Plan for the 200-BP-1 Operable Unit, Hanford Site, Richland, Washington*, Rev. 1.
DOE/RL-92-70, *Phase I Remedial Investigation Report for 200-BP-1 Operable Unit*, Vols. 1 and 2, Rev. 0.
DOE/RL-96-81, *Waste Site Grouping for 200 Areas Soil Investigations*, Rev. 0.
* PNNL-11800, *Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site*.
Waste Information Data System Report, Hanford Site database.

bgs = below ground surface.
ITS = in-tank solidification.
OU = operable unit.
WIDS = *Waste Information Data System Report*.

Table 2-5. Representative Waste Site Risk Summary. (2 Pages)

Risk Element	216-B-38 Trench (200-TW-2 OU)	216-B-46 Crib (200-TW-1 OU)	216-T-26 Crib (200-TW-1 OU)	216-B-7* Crib (200-TW-2 OU)	216-B-5 Reverse Well (200-TW-2 OU)	216-B-57 Crib (200-PW-5 OU)	216-B-58 Trench (200-TW-1 OU)
Does the Site meet Human Health Preliminary Remediation Goals - Chemicals?							
Are concentrations less than WAC 173-340-745 risk-based standards?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Does the Site meet Human Health Preliminary Remediation Goals - Radionuclides? Assumes that No Credit is Taken for the Protectiveness of the Existing Cover							
Does the waste site meet human health PRGs for radionuclides?	No	Yes	Yes	Yes	Yes	No	No
Dose at 0 years (mrem/yr)	128,300	1.9	No contamination from 0 to 4.6 m (0 to 15 ft)	15.1	No contamination from 0 to 4.6 m (0 to 15 ft)	26.1	13,000
Primary radionuclides that contribute dose, 0 years	Cs-137	Ra-226	NA	Cs-137	NA	Cs-137	Cs-137
Dose at 150 years (mrem/yr)	4,009	1.7	NA	0.47	NA	2.73	280
Primary radionuclides that contribute dose, 150 years	Cs-137	Ra-226	NA	Cs-137	NA	Ra-226	Cs-137
Dose at 1,000 years (mrem/yr)	1.22	0.9	NA	0	NA	1.04	17
Primary radionuclides that contribute dose, 1,000 years	Cs-137	Ra-226	NA	NA	NA	Ra-226	Th-232
Does the Site meet Human Health Preliminary Remediation Goals -Radionuclides? Assumes that the Existing Cover Provides Some Protection							
Does the waste site meet human health PRGs for radionuclides?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Dose at 0 years (mrem/yr)	3.45 E-13	Not modeled. Dose without cover is below 15 mrem.	Not modeled. No contamination from 0 to 4.6 m (0 to 15 ft)	0.08	Not modeled. No contamination from 0 to 4.6 m (0 to 15 ft)	Not modeled because site has a cap	0
Primary radionuclides that contribute dose, 0 years	Cs-137	Not modeled	NA	Cs-137	NA	NA	NA
Dose at 150 years (mrem/yr)	7.91 E-14	Not modeled	NA	0.04	NA	NA	0
Primary radionuclides that contribute dose, 150 years	Cs-137	Not modeled	NA	Cs-137	NA	NA	NA
Dose at 1,000 years (mrem/yr)	6.27 E-17	Not modeled	NA	0	NA	NA	0
Primary radionuclides that contribute dose, 1,000 years	Pu-238	Not modeled	NA	NA	NA	NA	NA

Table 2-5. Representative Waste Site Risk Summary. (2 Pages)

Risk Element	216-B-38 Trench (200-TW-2 OU)	216-B-46 Crib (200-TW-1 OU)	216-T-26 Crib (200-TW-1 OU)	216-B-7* Crib (200-TW-2 OU)	216-B-5 Reverse Well (200-TW-2 OU)	216-B-57 Crib (200-PW-5 OU)	216-B-58 Trench (200-TW-1 OU)
Does the Site meet Groundwater Protection Preliminary Remediation Goals - Chemicals?							
Are groundwater protection standards met based on initial screening?	No	No	No	No	No	No	No
Chemicals predicted to reach groundwater above MCL	Nitrate Nitrite Total uranium	Antimony Cadmium Cyanide Nitrate Total uranium	Cyanide Nitrate Nitrite Total uranium	Cyanide Fluoride Nitrate	Not modeled (Contaminants injected at watertable)	Cadmium Nitrate	Selenium Nitrate
Does the Site meet Groundwater Protection Preliminary Remediation Goals - Radionuclides?							
Are groundwater protection standards met based on initial screening?	No	No	No	No	NA (Contaminants injected at water table)	No (Hanford Barrier in place)	Yes
Radionuclides predicted to reach groundwater above MCL	Tc-99 U-233/234/ 238	Tc-99 U-238 Co-60 Ra-226	U-233/234/ 238 Tc-99 Pu-239	U-233/234/ 238 Tc-99 Sr-90	Not modeled (Contaminants injected at water table)	Tc-99	None
Does the Site meet Ecological Preliminary Remediation Goals – Chemicals?							
Are concentrations less than ecological PRGs?	Yes	Yes	NA (no contamination from 0 to 4.6 m (0 to 15 ft)	Yes	NA (no contaminants from 0 to 4.6 m (0 to 15 ft)	Yes	No
Constituents that exceed PRGs	None	None	None	None	None	None	Selenium Aroclor-1254
Does the Site meet Ecological Preliminary Remediation Goals – Radionuclides?							
Are ecological PRGs met?	No	Yes	NA (no contamination from 0 to 4.6 m (0 to 15 ft)	No	NA (no contaminants from 0 to 4.6 m (0 to 15 ft)	No	No
Constituents that exceed PRGs	Cs-137 Sr-90	None	None	Cs-137 Sr-90	None	Cs-137 Sr-90	Co-60 Cs-137 Sr-90

Note - this table presents a summary of the constituents identified as primary risk contributors and the constituents identified as a potential groundwater protection concern as discussed in Section 4.6 of the RI Report (DOE/RL-2002-42, *Remedial Investigation Report for the 200-TW-1 and 200-TW-2 Operable Units (Includes the 200-PW-5 Operable Unit)*.

WAC 173-340-745, "Soil Cleanup Standards for Industrial Properties."

MCL = maximum contaminant level.
NA = not applicable.
OU = operable unit.
PRG = preliminary remediation goal.

Table 2-6. Analogous Waste Site Risk Summary. (2 Pages)

Risk Element	216-B-43 Crib (200-TW-1 OU)[a]	216-B-44 Crib (200-TW-1 OU)[a]	216-B-45 Crib (200-TW-1 OU)[a]	216-B-47 Crib (200-TW-1 OU)[a]	216-B-48 Crib (200-TW-1 OU)[a]	216-B-49 Crib (200-TW-1 OU)[a]	216-B-26 Trench (200-TW-1 OU)[a]	216-B-50 Crib (200-PW-5 OU)
Does the Site meet Human Health Preliminary Remediation Goals - Chemicals?								
Are concentrations less than WAC 173-340-745?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Does the Site meet Human Health Preliminary Remediation Goals - Radionuclides? Assumes that No Credit is Taken for the Protectiveness of the Existing Cover.								
Does the waste site meet human health PRGs for radionuclides?	Yes	Yes	Yes	No	Yes	Yes	No	Yes
Dose at 0 years (mrem/yr)	3.85	4.85	3.11	51.2	4.68	0.91	310,000	4.37
Primary radionuclides that contribute dose, 0 years	Cs-137 Ra-226	Cs-137 Ra-226	Cs-137 Ra-226	Cs-137 Ra-226	Cs-137	Cs-137	Cs-137	Cs-137
Dose at 150 years (mrem/yr)	2.04	2.24	1.53	19.1	2.77	0.03	9,800	2.06
Primary radionuclides that contribute dose, 150 years	Ra-226	Ra-226	Ra-226	Ra-226	Ra-226	Cs-137	Cs-137	Ra-226
Dose at 1,000 years (mrem/yr)	1.07	1.17	0.8	9.73	1.46	8.3 E-11	3.5	1.07
Primary radionuclides that contribute dose, 1,000 years	Ra-226	Ra-226	Ra-226	Ra-226	Ra-226	Cs-137	Pu-239	Ra-226
Does the Site meet Groundwater Protection Preliminary Remediation Goals - Chemicals?								
Are groundwater protection standards met based on initial screening?	No	No	No	No	No	No	No	No
Chemicals predicted to reach groundwater above MCL	Nitrate Nitrite Uranium	Nitrate Nitrite Uranium	Aluminum Cadmium Nitrate Nitrite Uranium	Uranium	Nitrate Nitrite Uranium	Uranium	Manganese Nitrate Uranium Vanadium	Uranium
Does the Site meet Groundwater Protection Preliminary Remediation Goals - Radionuclides?[a]								
Are groundwater protection standards met based on initial screening?	No	No	No	No	No	NA (Contaminants injected at water table)	No	Yes
Radionuclides predicted to reach groundwater above MCL	Ra-226 Tc-99 U-233/234/238	Ra-226 Tc-99 U-233/234/238	Ra-226 Tc-99 U-233/234/238	Ra-226 Tc-99 U-233/234/238	Ra-226 Tc-99 U-233/234/238	Ra-226 Tc-99 U-233/234/238	Tc-99	Ra-226 Tc-99 U-233/234/238

Table 2-6. Analogous Waste Site Risk Summary. (2 Pages)

Risk Element	216-B-43 Crib (200-TW-1 OU)[a]	216-B-44 Crib (200-TW-1 OU)[a]	216-B-45 Crib (200-TW-1 OU)[a]	216-B-47 Crib (200-TW-1 OU)[a]	216-B-48 Crib (200-TW-1 OU)[a]	216-B-49 Crib (200-TW-1 OU)[a]	216-B-26 Trench (200-TW-1 OU)[a]	216-B-50 Crib (200-PW-5 OU)
Does the Site meet Ecological Preliminary Remediation Goals – Chemicals?								
Are ecological PRGs met?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constituents that exceed PRGs	None	None	None	None	None	None	None	None
Does the Site meet Ecological Preliminary Remediation Goals – Radionuclides?								
Are ecological PRGs met?	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Constituents that exceed PRGs	None	None	None	None	None	None	Cs-137 Sr-90	None

[a]Modeling not conducted for these sites; however, they are analogous to the 216-B-46 Crib.

Note - This table presents a summary of the constituents identified as primary risk contributors in Appendix C.

WAC 173-340-745, "Soil Cleanup Standards for Industrial Properties."

MCL = maximum contaminant level.
NA = not applicable.
OU = operable unit.
PRG = preliminary remediation goal.

Table 2-7. Depth to Top of Contamination at the Waste Sites.

200-TW-1 Operable Unit		200-TW-2 Operable Unit		200-PW-5 Operable Unit	
Waste Site	**Depth to Top of Contamination (ft)**	**Waste Site**	**Depth to Top of Contamination (ft)**	**Waste Site**	**Depth to Top of Contamination (ft)**
200-E-14	7 (top of tank)	200-E-45	10	216-B-11A&B	25 ft
200-E-114	10	216-B-5	243	216-B-50	15
216-B-14	10	216-B-7A&B	18	216-B-57	41
216-B-15	13	216-B-8	10	216-B-62	12
216-B-16	10	216-B-9	10	216-C-6	10
216-B-17	11	216-B-35	12	216-S-9	23
216-B-18	11	216-B-36	12	216-S-21	24
216-B-19	13	216-B-37	12	UPR-200-W-108	2
216-B-20	12	216-B-38	14	UPR-200-W-109	2
216-B-21	12	216-B-39	15		
216-B-22	12	216-B-40	15		
216-B-23	19	216-B-41	15		
216-B-24	19	216-T-3	15		
216-B-25	19	216-T-5	12?		
216-B-26	12*	216-T-6	25		
216-B-27	18	216-T-7	25		
216-B-28	12	216-T-14	13		
216-B-29	12	216-T-15	13		
216-B-30	12	216-T-16	13		
216-B-31	13	216-T-17	13		
216-B-32	13	216-T-21	12		
216-B-33	13	216-T-22	12		
216-B-34	13	216-T-23	12		
216-B-42	10	216-T-24	12		
216-B-43	18	216-T-25	12		
216-B-44	18	216-T-32	22		
216-B-45	17	241-B-361	6 (top of tank)		
216-B-46	18	241-T-361	6 (top of tank)		
216-B-47	21	UPR-200-E-7	17		
216-B-48	17.5				
216-B-49	16.5				
216-B-51	13				
216-B-52	12				
216-BY-201	5				
216-T-18	12				
216-T-26	18				
UPR-200-E-9	10				
216-B-58	8				
216-B-53A	10				
216-B-53B	10				
216-B-54	8				

*WIDS data indicate 19 ft but site sampling found contamination at 13 ft.

Table 2-8. Intruder Risk and Dose Summary

Waste Site	Intruder Dose (mrem/yr)	Intruder Risk (ELCR)
216-B-46 Crib	137	2.2E-03
216-T-26 Crib	26	3.8E-03
216-B-7A Crib	238	2.7E-03
216-B-38 Trench	109	1.8E-03
216-B-57 Crib	34.8	5.7E-04
216-B-58 Trench	7.7	1.3E-04
216-B-26 Crib	270	4.4E-03
216-B-43 Crib	1355	2.1E-02
216-B-44 Crib	1164	1.8E-02
216-B-45 Crib	2451	3.9E-02
216-B-47 Crib	4218	6.5E-02
216-B-48 Crib	4664	7.8E-02
216-B-49 Crib	625	4.2E-02
216-B-50 Crib	726	1.2E-02
216-B-26 Trench	270	4.4E-03

Table 2-9. Timeframes to Reach Human Health Preliminary Remediation Goals Through Natural Attenuation.

Waste Site	Contaminant and Maximum Concentration (pCi/g) in the 0 to 4.6 m (0 to 15-ft) Zone	Time to Reach Human Health PRGs[1] in the 0 to 4.6 m (0 to 15-ft) Zone (yr)	Maximum Concentration (pCi/g) and Depth (ft bgs) of Short-Lived Radionuclides	Time to Reach PRGs for Short-Lived Radionuclides[2] (yr)	Time to Reach PRGs for Long-Lived Radionuclides[3] (yr)
216-B-46 Crib (200-TW-1 OU)	Contaminant concentrations meet PRGs in this zone	NA	Cs-137: 280,000 Sr-90: 260,000 Depth: 18 to 49	410	>1000
216-T-26 Crib (200-TW-1 OU)	Contaminant concentrations meet PRGs in this zone	NA	Cs-137: 47,900 Sr-90: 49,100 Depth: 18 to 36.5	330	>1000
216-B-7A Crib (200-TW-2 OU)	Cs-137: 42.5	26	Cs-137: 153,000 Sr-90: 5,710,000 Depth: 18 to 37.5	380	>1000
216-B-38 Trench (200-TW-2 OU)	Cs-137: 226,000	400	Cs-137: 226,000 Sr-90: 2,050 Depth: 15 to 40	400	>1000
216-B-5 Reverse Well (200-TW-2 OU)[4]	No contaminants in this zone; contaminants were disposed of deep in the vadose	NA	NA	NA	>1000
216-B-57 Crib (200-PW-5 OU)	Cs-137: 50.5	33	Cs-137: 50,000 Sr-90: 50 Depth: 15 to 33	330	>1000
216-B-58 Trench (200-TW-1 OU; originally 200-LW-1 OU)	Cs-137: 14,600	279	Cs-137: 14,600 Sr-90: 18,400 Depth: 13.5 to 16 ft	280	NA[5]

NOTE: Soil frequently is clean in the top 15 ft. High contamination often is associated with soil just below the bottom of the waste site. Contaminants with the potential to affect groundwater may be distributed throughout deeper soil regions.

[1] –Timeframes to reach preliminary remediation goals are based on radioactive decay of short-lived radionuclides (i.e., Cs-137 and Sr-90).
[2] –The longest of Cs-137 or Sr-90 decay times based on radioactive decay alone, using Cs-137 PRG of 23.4 pCi/g and Sr-90 PRG of 2,410 pCi/g.
[3] –Long-lived radionuclides include, but are not limited to, U-238, Pu-239, and TC-99.
[4] –216-B-5 Reverse Well was not evaluated because of the depth of contaminants; no intrusion protection is assumed, and a removal, treatment, and dispose action is not appropriate for this site.
[5] –The 216-B-58 Trench has no long-lived radionuclides at concentrations greater than PRGs.

bgs = below ground surface.
NA = concentrations already are below preliminary remediation goals.
PRG = preliminary remediation goal.

Table 2-10. Timeframes to Reach Ecological Preliminary Remediation Goals Through Natural Attenuation.

Waste Site	Contaminant	Time to Reach Ecological PRGs (yr)
216-B-46 Crib (200-TW-1 OU)	No ecological contaminants of concern were identified	NA
216-T-26 Crib (200-TW-1 OU)	No ecological contaminants of concern were identified	NA
216-B-7A Crib (200-TW-2 OU)	Cs-137	33
216-B-38 Trench (200-TW-2 OU)	Cs-137	406
216-B-5 Reverse Well (200-TW-02 OU) [1]	No ecological contaminants of concern were identified	NA
216-B-57 Trench (200-PW-05 OU)	Cs-137	40
216-B-58 Trench (200-TW-1 OU; originally 200-LW-1 OU)	Cs-137 Sr-90	287

NOTES: Timeframes to reach preliminary remediation goals are based on RESRAD modeling (ANL 2002, *RESRAD for Windows*, Version 6.21) and the no-cover scenario.
[1] –216-B-5 Reverse Well was not modeled because of the depth of contaminants.
NA = concentrations already are below preliminary remediation goals.
PRG = preliminary remediation goal.

Table 2-11. Maximum Year Doses And Excess Lifetime Cancer Risk.

Site	Clean Cover			Without Clean Cover		
	Maximum Year Dose (mrem/yr)	**Excess Lifetime Cancer Risk**	**Year(s)**	**Maximum Year Dose (mrem/yr)**	**Maximum Excess Lifetime Cancer Risk**	**Year(s)**
Representative Sites						
216-T-26	not modeled*			not modeled*		
216-B-46	not modeled*			1.9	4.3×10^{-5}	0-30
216-B-7A	0.08	1.6×10^{-6}	0	15.1	2.5×10^{-4}	0
216-B-38	3.5×10^{-13}	6.7×10^{-18}	0	128,300	$>1 \times 10^{-2}$	0-150
216-B-57	not modeled*			26.1	4.4×10^{-4}	0
216-B-58	4.1×10^{-6}	8.6×10^{-11}	1,000	1.3×10^{4}	0.13	0
Analogous Sites						
216-B-43	not modeled*			3.85	7.7×10^{-5}	0
216-B-44	not modeled*			4.58	9.0×10^{-5}	0-1
216-B-45	not modeled*			3.11	6.1×10^{-5}	0
216-B-47	not modeled*			51.2	9.6×10^{-4}	0
216-B-48	not modeled*			4.68	9.5×10^{-5}	0
216-B-49	not modeled*			0.921	1.5×10^{-5}	0
216-B-50	not modeled*			4.37	8.5×10^{-5}	0
216-B-26	0	0	NA	3.1×10^{5}	4.3	0

* No radionuclides in the shallow zone exceed background.

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3.0 DEVELOPMENT OF REMEDIAL ACTION OBJECTIVES AND PRELIMINARY REMEDIATION GOALS

This chapter defines the land use for the 200-TW-1, 200-TW-2, and 200-PW-5 OUs and the region and defines the RAOs and PRGs. DOE/RL-98-28 (Implementation Plan), DOE/RL-2000-38 (Work Plan), DOE/RL-2002-42 (RI Report), DOE/RL-2001-66 (which contains information pertinent to the four 200-LW-1 waste sites included in this FS), and DOE/RL-88-32 provide initial information on these items for the waste sites. For this FS, the Implementation Plan information was compared to the data collected during the RI activities, and refinements were made as appropriate for the waste sites.

The RAOs are media-specific or OU-specific objectives for protecting human health and the environment. They are developed considering the land use, COPCs, potential ARARs, and exposure pathways (conceptual model). They also specify remediation goals so that an appropriate range of remedial options can be developed for evaluation. This chapter describes the elements used to develop the RAOs and presents the RAOs and remediation goals used to evaluate alternatives.

The RAO process begins by identifying potential future land use and the COPCs for the waste sites. This information ensures that the remedial alternatives being considered can adequately address the types of contaminants present, and it facilitates the refinement of potential ARARs. The RAOs also provide the basis for developing the GRAs that will satisfy the objectives of protecting human health and the environment. The RAOs are defined as specifically as possible without limiting the range of GRAs that can be applied.

3.1 LAND USE

To identify appropriate cleanup objectives, the future land use of a site must be considered. Current and future land uses of the 200 Areas and the Central Plateau are discussed in the following sections.

3.1.1 Current Land Use

All current land-use activities associated with the 200 Areas and the Central Plateau are industrial in nature. The facilities located in the Central Plateau were built to process irradiated fuel from the plutonium production reactors in the 100 Areas. Most of the facilities directly associated with fuel reprocessing are now inactive and awaiting final disposition. The Plutonium Finishing Plant continues to operate to process a residual backlog of plutonium. Several waste management facilities operate in the 200 Areas, including permanent waste disposal facilities such as the Environmental Restoration Disposal Facility (ERDF), low-level radioactive waste burial grounds, and a RCRA-permitted, mixed-waste trench. Construction of tank waste treatment facilities in the 200 Areas began in 2002, and the 200 Areas are the planned disposal location for the vitrified low-activity tank wastes. Past-practice disposal sites in the 200 Areas are being evaluated for remediation and are likely to include institutional controls (e.g., deed restrictions or covenants) as part of the selected remedy. Other Federal agencies, such as the

U.S. Department of the Navy, also use the Hanford Site 200 Areas nuclear waste treatment, storage, and disposal (TSD) facilities. A commercial low-level radioactive waste disposal facility, operated by US Ecology, Inc., currently operates on a portion of a tract in the 200 Areas that is leased to the State of Washington.

The DOE-selected land use for the 200 Areas, documented through the land-use record of decision (ROD) (64 FR 61615, "Record of Decision: Hanford Comprehensive Land-Use Plan Environmental Impact Statement (HCP-EIS)," is industrial (exclusive) for sites located within the exclusive-use boundary (core zone).

According to DOE/EIS-0222-F, *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement* (CLUP–EIS), industrial (exclusive) land use would preserve DOE control of the continuing remediation activities and would use the existing compatible infrastructure required to support activities such as dangerous waste, radioactive waste, and mixed-waste TSD facilities. The DOE and its contractors, and the U.S. Department of Defense and its contractors, could continue their Federal waste disposal missions; and the Northwest Low-Level Radioactive Waste Compact could continue using the US Ecology site for commercial radioactive waste. Research supporting the dangerous waste, radioactive waste, and mixed-waste TSD facilities also would be encouraged within this land-use designation. New uses of radioactive materials such as food irradiation could be developed, and the products could be packaged for commercial distribution under this land-use designation.

3.1.2 Anticipated Future Land Use

The reasonably anticipated future land use for the core zone is continued industrial (exclusive) activities for the foreseeable future. Eventually, portions of the core zone may be used for non-DOE-related industrial uses. The DOE worked for several years with cooperating agencies and stakeholders to define land-use goals for the Hanford Site and to develop future land-use plans (Drummond 1992, *The Future for Hanford: Uses and Cleanup, The Final Report of the Hanford Future Site Uses Working Group*). The cooperating agencies and stakeholders included the National Park Service, Tribal Nations, States of Washington and Oregon, local county and city governments, economic and business development interests, environmental groups, and agricultural interests. These efforts initially were reported by Drummond (1992) and culminated in the CLUP-EIS (DOE/EIS-0222-F) and associated ROD (64 FR 61615), which were issued in 1999.

The Future Site Uses Working Group was organized by Federal, Tribal, state, and local governments with jurisdictional interests in the Hanford Site. The Working Group was charged with three related tasks:

- Examine the Hanford Site and identify a range of potential future uses for the Site
- Select appropriate cleanup scenarios necessary to make these future uses possible in light of potential exposure to contamination, if any, after cleanup

- Look for convergences among the Working Group's cleanup scenarios for any priorities or criteria that could prove useful in focusing or conducting the cleanup of the Hanford Site.

The Working Group agreed to seven findings from their activities.

- **Hanford is important.** The Hanford Site has played a significant role in history and continues to be of major economic influence in the area; cleanup efforts at the Hanford Site, including technology research, may benefit other DOE sites and environmental restoration activities worldwide. Plausible future uses identified include agriculture, industrial and economic development, wildlife and habitat preserves, environmental restoration and waste management activities, public access and recreation, and Native American uses such as hunting, gathering, and religious practices.

- **Cleanup is now DOE's primary mission at Hanford.** As the mission at the Hanford Site transitions from nuclear materials production to supporting national defense to environmental restoration of the area, new challenges emerge for DOE in the conduct of business, involvement of the public, and accountability for its actions. The working group emphasized moving forward with the cleanup and maximizing the potential of the Hanford Site.

- **The Hanford Site will change as cleanup proceeds.** The Working Group envisioned that the area requiring DOE control will shrink in size as the cleanup proceeds, with portions of the site being turned over to other uses once they are no longer needed to support the DOE mission.

- **Both cleanup and future land uses face significant constraints.** Volumes and variety of contaminants and the associated risks pose constraints to the ultimate cleanup, as does the current state of technologies to address these problems. Funding also was identified as a constraint to the timeliness of the cleanup.

- **Native American treaty rights exist.** Treaties signed with the Yakama Indian Nation, the Nez Perce Tribe, and the Umatilla, Cayuse, and Walla Walla Tribes reserved specific rights to the tribes, including those related to hunting, fishing, gathering foods and medicines, and pasturing livestock on open and unclaimed portions of the ceded land, in common with citizens.

- **Uncertainty and risk surround the cleanup.** The current uncertainty about the extent of contamination and the ability of available technologies to address the contamination have produced resulting uncertainties in the future land use.

- **Time is a critical element in focusing the cleanup.** The Working Group expressed a desire that all of the Hanford Site could be used some day for activities other than waste management, but also recognized that technical constraints could affect the timing of the ultimate cleanup and potential future uses.

The Working Group identified nine major recommendations as a result of its efforts.

- **Protect the Columbia River.** Because of the significance of the Columbia River to the region and the Pacific Northwest, protection of the river and all of its uses is viewed as a high priority.

- **Deal realistically and forcefully with groundwater contamination.** Contaminated groundwater is seen as a threat to the Columbia River and to potential future land uses. The Working Group recommended restrictions on the use of groundwater if it would jeopardize public safety and health. Members also recommended restrictions on the use of groundwater or surface water, contaminated or not, if such use would adversely change hydraulic conditions, increase the spread of contaminated plumes, or increase the speed of contaminated groundwater flow to the river. The Working Group identified areas where restrictions should be applied, recommended removing sources before they reach groundwater, and recommended reducing or eliminating discharges to the soil and treating groundwater.

- **Use the Central Plateau wisely for waste management.** The Working Group recommended consolidation of Hanford Site wastes to the Central Plateau in as small an area as possible. Additionally, waste disposed of here should not necessarily be considered permanent disposal. Members recommended a buffer zone to reduce risks emanating from the waste management area.

- **Do no harm during cleanup or with new development.** The Working Group recognized that the primary cleanup goal is the protection of human health and public safety, but also noted that environmental values of the site are to be protected and restored. Decisions made in the course of the cleanup and future uses should support these goals and should result in decreased risks to public health and net benefits to the environment. Activities should be guided by the principle "do no harm." Cleanup and future development should be conducted to minimize impacts on plants and animals.

- **Cleanup of areas of high future-use value is important.** While the Working Group supports the cleanup priorities (i.e., current threats to public health or the environment, risk of catastrophic exposure, and technical feasibility) identified by DOE and the regulators, members also believe that areas of high future-use value should be considered priorities for cleanup. These areas include the Columbia River corridor, the southeast corner of the Hanford Site, areas north of the river, the Fitzner-Eberhardt Arid Lands Ecology Reserve, and the western and northwestern portions of the areas outside the river corridor and the 200 Areas.

- **Cleanup to the level necessary to ensure that the future-use option occurs.** The Working Group believed that "unrestricted" status would support all future-use options but felt that not all areas would need to be cleaned to unrestricted levels. In fact, the members thought that, in some cases, cleanup to unrestricted levels would cause more harm than good. They identified cleanup to levels that would be "clean enough for industry" in part of the southeast corner of the site and "clean enough for wildlife" in all other areas (those areas outside the river corridor and the 200 Areas).

- **Transport waste safely and be prepared.** The Working Group recognized that the management and cleanup of waste at the Hanford Site will require shipment of some wastes. Members believed that these shipments affect the public and that close cooperation between DOE and affected communities should be maintained. The Working Group endorsed preparedness through regulatory means and the use of the Hazardous Materials Management and Emergency Response (HAMMER) training facility.

- **Capture economic development opportunities locally.** The Working Group urged DOE and its contractors to help create the potential for meaningful economic development during cleanup, both onsite and offsite.

- **Involve the public in future decisions about Hanford** – Public involvement should be incorporated in future decision making at the Hanford Site.

Consistent with the Future Site Uses Working Group, the CLUP-EIS was developed (DOE/EIS-0222-F). The CLUP-EIS was written to address the growing need for a comprehensive, long-term approach to planning and development on the Hanford Site because of the DOE's separate missions of environmental restoration, waste management, and science and technology. The CLUP-EIS analyzes the potential environmental impacts of alternative land-use plans for the Hanford Site and considers the land-use implication of ongoing and proposed activities. In the CLUP-EIS, the land-use designation for sites inside the core zone, as shown in Figure 2-233-1, is industrial (exclusive) (i.e., those areas suitable and desirable for the TSD of hazardous, dangerous, radioactive, and nonradioactive wastes, and related activities.

Under the preferred land-use alternative selected in the ROD (64 FR 61615), the area inside the core zone of the Central Plateau was designated for industrial (exclusive) use. The current vision for all of the 200 Areas is that it will continue to be used for the TSD of hazardous, dangerous, radioactive, and nonradioactive wastes. The CLUP-EIS and ROD incorporate this vision in the selected alternative, describe the means by which new projects will be sited, and focus on using existing infrastructure and developed areas of the Hanford Site for new projects. To support the current vision, the 200 Areas projects will maintain current facilities for continuing missions, remediate soil waste sites and groundwater to support industrial land uses, lease facilities for waste disposal (e.g., US Ecology Inc.), and demolish facilities that have no further beneficial use. Based on the CLUP-EIS and associated ROD, and consistent with other Hanford Site waste management decisions, this FS report assumes an industrial land use for all the waste sites, because they are within the core zone. Risk assessments for the industrial land use are conducted considering a non-Hanford worker industrial receptor to bound the industrial land use exposure possibilities.

3.1.3 Regional Land Use

Communities in the region of the Hanford Site consist of the incorporated cities of Richland, West Richland, Kennewick, and Pasco, as well as surrounding communities within Benton and Franklin Counties. The estimated population of the region in 2000 was 186,600, with the population of Benton County being 140,700 and the population of Franklin County being 45,900. There are no residences on the Hanford Site. The inhabited residences nearest to the 200 Areas are farmhouses on land approximately 16 km (10 mi) north across the Columbia River. The City of Richland corporate boundary is approximately 27 km (17 mi) to the south (PNNL-6415).

3.1.4 Groundwater Use

The CLUP-EIS indicates that contamination in the groundwater would restrict use. Groundwater in the Central Plateau currently is contaminated and is not withdrawn for beneficial uses. This FS evaluates potential future impacts to groundwater from current vadose zone contaminants at the representative sites, but does not evaluate groundwater remediation or risks. These issues will be addressed through the evaluation of the groundwater OUs (e.g., 200-UP-1) and through other site-wide assessments.

3.2 CONTAMINANTS OF POTENTIAL CONCERN

Contaminants that have the potential to contribute significantly to site risk are referred to as COPCs. Identification of COPCs is an important process, because it determines the list of contaminants for which further risk evaluations will be developed. Development of COPCs in the data evaluation and risk assessment process is discussed in EPA/540/1-89/002, *Risk Assessment Guidance for Superfund (RAGS), Volume I -- Human Health Evaluation Manual (Part A) Interim Final.* Those contaminants that are COPCs are determined by comparing contaminant concentrations with background, developing a set of data for use in risk assessment, and (if appropriate) limiting the number of contaminants to be carried through a risk assessment by risk-based screening or other methods. The evaluation of COPCs is presented in the RI Report (DOE/RL-2002-42) for the representative sites. This evaluation is presented in Appendix C for the analogous sites with data as part of the risk assessment, with a summary of COPCs provided in Table C-30.

3.3 POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

The potential ARARs for the waste sites in this FS are identified in Appendix B.

3.4 REMEDIAL ACTION OBJECTIVES

The RAOs are general descriptions of what the remedial action is expected to accomplish (i.e., medium-specific or site-specific goals for protecting human health and the environment). They are defined as specifically as possible and usually address the following variables:

- Media of interest (e.g., contaminated soil, solid waste)
- Types of contaminants (e.g., radionuclides, inorganic, organic chemicals)
- Potential receptors (e.g., humans, animals, plants)

- Possible exposure pathways (e.g., external radiation, ingestion)
- Levels of residual contaminants that may remain following remediation (i.e., contaminant levels below cleanup standards or below a range of levels for different exposure routes).

The RAOs provide a basis for evaluating the capability of a specific remedial alternative to achieve compliance with potential ARARs and/or an intended level of risk protection for human health or the environment. The RAOs specific to the 200 Areas for soils, solid wastes, and groundwater were developed in the Implementation Plan (DOE/RL-98-28). Specific RAOs for this FS were defined based on the fate and transport of contaminants, projected land uses for the 200 Areas, and the 200-TW-1, TW-2, and PW-5 OU conceptual exposure model. The RAOs for this FS are as follows:

- RAO 1 - Prevent unacceptable risk to human health and ecological receptors from exposure to soils and/or debris contaminated with nonradiological constituents at concentrations above the industrial use criteria as defined in WAC 173-340-745(5) for human health, or the screening criteria in WAC 173-349-900, Table 749-3, for ecological receptors; prevent unacceptable risk to human health and ecological receptors from exposure to soils and/or debris contaminated with radiological constituents at concentrations above 15 mrem/yr[1] (OSWER Directive 9200.4-31P, EPA/540/R-99/006, *Radiation Risk Assessment at CERCLA Sites: Q&A*) under an industrial use scenario for humans or the screening criteria for ecological receptors based on an acceptable dose of 0.1 rad/d (DOE-STD-1153-2002, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terretrial Biota*).

- RAO 2 - Prevent migration of contaminants through the soil column to groundwater or reduce soil concentrations below WAC 173-340-747 groundwater protection values such that no further degradation of the groundwater occurs caused by leaching from soils or debris in the waste sites.

- RAO 3 - Minimize the general disruption of cultural resources and wildlife habitat and prevent adverse impacts to cultural resources and threatened or endangered species during remediation.

The RAOs will be finalized in the ROD for these waste sites. Achievement of the RAOs will be described in the remedial design report/remedial action work plan (RDR/RAWP) that is to be prepared after the ROD is approved. For the purposes of this FS (to determine preliminary remediation goals), RAO 1 is assumed to be achieved for radionuclides by prevention or reduction of risks from exposure to waste or contaminated soil that exceeds 500 mrem/yr above background for DOE site workers for a period of 50 years from the present, and 15 mrem/yr above background for a person who receives maximum exposure under an industrial exposure scenario for the period from 50 to 1,000 years after final remediation. For carcinogenic chemicals, the first RAO will be achieved by prevention or reduction of risks from waste or

[1] A dose limit of 15 mrem/year generally will achieve the U.S. Environmental Protection Agency excess lifetime cancer risk threshold, which ranges between 1×10^{-6} to 1×10^{-4}.

contaminated soil in an industrial scenario such that the CERCLA excess cancer-risk goal of 10^{-6} to 10^{-4} lifetime cancer risk for carcinogens is not exceeded. For noncarcinogenic chemicals, RAO 1 is defined as prevention or reduction of risks from direct contact with waste or contaminated soils that exceed a hazard quotient (HQ) or a hazard index (HI) of 1. For ecological receptors, exposure to wastes or soil contaminated with radionuclides will be prevented or reduced such that dose rates shall not exceed 0.1 rad/day for terrestrial organisms and 1.0 rad/day for aquatic organisms and terrestrial plants. Exposure of ecological receptors to wastes or soil contaminated with nonradiological constituents will be prevented or reduced so that the HQ and HI do not exceed 1.

The RAO 2 is assumed to be achieved by preventing or reducing migration of contaminants through the soil column to groundwater such that concentrations reaching groundwater do not exceed MCLs under 40 CFR 141 and the groundwater cleanup standards (WAC 173-340-720, "Ground Water Cleanup Standards"). Groundwater protection for the 200-TW-1, 200-TW-2, and 200-PW-5 OUs is assumed to be protective of the Columbia River. The pathway from the waste sites to the river will be evaluated through the groundwater OUs, with input from the source OUs concerning contributions to the groundwater.

RAO 3 will be achieved by meeting RAOs 1 and 2; by implementing existing Hanford Site standards for protection of cultural resources, wildlife habitat, and industrial workers; and by continuing to enforce existing institutional controls and monitoring requirements.

3.5 PRELIMINARY REMEDIATION GOALS

The PRGs are based on attainment of acceptable levels of human health and ecological risk. Typically, PRGs are identified for individual hazardous substances identified as contaminants of concern (COC) or COPCs. If multiple contaminants are present at a site, the suitability of using individual PRGs as the final cleanup values protective of human health and the environment is evaluated based on site-specific information and the potential for contaminant interaction.

Meeting these PRGs and the potential ARARs and, by extension, achieving RAOs, can be accomplished by reducing concentrations (or activities) of contaminants to remediation goal levels or by eliminating potential exposure pathways/routes. Contaminant-specific and numeric soil and particulate PRGs for direct exposure and protection of groundwater typically are presented as concentrations (milligrams per kilogram or milligrams per cubic meter) or activities (picocuries per gram), respectively. Final remedial action goals developed from the PRGs will be specified in a ROD that identifies the selected remedial alternative(s) for the 200-TW-1, 200-TW-2, and 200-PW-5 OUs.

Residual risks following completion of remediation of the waste sites must meet the 10^{-4} to 10^{-6} CERCLA risk range for radiological and nonradiological chemical constituents and must be below an HI of 1.0 for noncarcinogens. Actual soil contaminant concentrations achieving these cleanup objectives would be presented in a cleanup verification package for the facility. The cleanup verification package would demonstrate how and where specific criteria have been applied and how the remedy protects receptors from the COCs identified for the waste sites.

3.5.1 Direct Exposure Preliminary Remediation Goals for Nonradioactive Contaminants

Development of the PRGs for direct exposure to nonradioactive contamination for both human and ecological receptors is described in the following subsections.

3.5.1.1 Human Exposure

For human receptors, PRGs for direct exposure to nonradioactive contamination in soils are based on risk-based standards. Risk-based standards for individual hazardous substances are established using applicable Federal and state laws and the risk equations. Risk-based standards for individual carcinogens in an industrial exposure scenario are based on CERCLA guidelines of 10^{-4} to 10^{-6} ELCR. Risk-based standards for individual noncarcinogenic substances are set at concentrations that would result in no acute or chronic toxic effects on human health and the environment; this corresponds to an HQ of less than 1.0. Consistent with this approach, the methodology described for industrial properties under WAC 173-340-745(5), "Method C Industrial Soil Cleanup Levels," is used to calculate the risk-based standards.

Risk-based standards for some contaminants may be less than area background values or practical quantitation limits (PQL). Where risk-based standards are less than area background concentrations, PRGs may be set at concentrations that are equal to the agreed-upon site or area background concentrations. Area background values for select nonradioactive contaminants in soil have been characterized for the Hanford Site (DOE/RL-92-24). Similarly, where risk-based standards are less than PQLs, PRGs will default to the PQLs . Therefore, the PRGs for individual nonradioactive contaminants in solid waste and particulate reflect the value that is greatest among risk-based standards, area background values, or PQLs. Table 3-1 lists the nonradiological PRGs for direct human exposure for those COCs.

3.5.1.2 Ecological Exposure

Each of the 200-TW-1, 200-TW-2, and 200-PW-5 OUs is within the industrial area identified in the CLUP-EIS (DOE/EIS-0222-F) and within the area designated by the CLUP-EIS ROD as industrial (exclusive) (64 FR 61615). The industrial land-use designation allows for continued waste management operations within the 200 Areas consistent with past *National Environmental Policy Act of 1969* (NEPA), CERCLA, and RCRA commitments and, among other things, will allow for the development of new waste management facilities. Sites within the core zone currently have limited habitat that is suitable for the establishment of ecological communities and food webs to support a hierarchy of terrestrial receptors. Maintenance of the industrial-use designation will limit future inhabitation by biota. However, cleanup to industrial land-use standards may not continue to be protective of ecological receptors after loss of institutional controls. A SLERA has been used to develop soil PRGs for the protection of terrestrial wildlife.

Because the waste sites in the FS are all within the core zone, only terrestrial wildlife risks will be evaluated. Consistent with this approach, WAC 173-340-7490(3)(b), "Terrestrial Ecological Evaluation Procedures," "Goals," specifies that for industrial or commercial properties, current or potential exposure to soil contamination need only be evaluated for terrestrial wildlife protection. Plants and soil biota need not be considered unless the species is protected under the Federal *Endangered Species Act of 1973*. Currently, no federally listed threatened or endangered species are known to exist on the waste sites. Surveys conducted before the field activities begin will confirm the presence of any protected species. For sites with institutional controls to prevent excavation of deeper soil, a conditional point of compliance may be set at the biologically active soil zone, which is assumed to extend to a depth of 2.7 m (9 ft) (DOE/RL-98-28). Priority chemicals of ecological concern and their soil screening levels are listed in WAC 173-340-900, Table 749-3. These soil-screening levels were used in conjunction with the risk assessment to develop PRGs for the COCs that are protective of ecological receptors, as indicated in Table 3-1.

3.5.2 Direct Exposure Remediation Goals for Radionuclides

The PRGs for direct exposure to radioactive contamination for both human and ecological receptors are described in the following subsections.

3.5.2.1 Human Exposure

For locations within the core zone, DOE dose limit of 500 mrem/yr for radiological workers will be in effect for as long as waste management operations continue. After a period of 50 yr, all waste management facilities are assumed to be closed; however, access to the 200 Areas is assumed to be restricted for an additional 100 yr by the enforcement of effective institutional controls. After that time, although institutional controls would still exist, an intruder presumably could obtain access to the area and establish a residence.

After the cessation of waste management operations, remediation goals for radioactive wastes and radioactively contaminated soils for human receptors are considered to be based on the EPA radionuclide soil cleanup guidance. 40 CFR 300 establishes that CERCLA cleanup actions generally should achieve a level of risk within the 10^{-4} to 10^{-6} carcinogenic risk range, based on the reasonable maximum exposure for an individual. Furthermore, EPA policy has noted that the upper boundary of the risk range is not a discrete line at 10^{-4} and that a specific risk estimate around 10^{-4} may be considered acceptable, if justified based on site-specific conditions (EPA/540/R-99/006, *Radiation Risk Assessment At CERCLA Sites: Q & A* [OSWER Directive No. 9200.4-31P]). The goal of remediation is to achieve the 10^{-4} to 10^{-6} risk range, using a dose of 15 mrem/yr above background as an operational guideline to achieve this goal. Demonstration that the 10^{-4} to 10^{-6} residual risk-range goal has been achieved will be accomplished through final verification sampling during closeout of a site.

Numerical values of radionuclide PRGs corresponding to the 15 and 500 mrem/yr guidance limits depend on the specific exposure scenario selected for remedial design and site-specific parameters (e.g., the area extent of the waste site). Radionuclide PRGs corresponding to the 15 and 500 mrem/yr guidance limits for direct exposure to contaminated soil have been calculated for the industrial scenario as described in Appendix C. The individual PRGs for the identified contaminants of concern are calculated using the RESRAD dose assessment model (ANL 2002) and are provided in Table 3-2.

The soluble salts of uranium present noncarcinogenic toxic effects that are evaluated by an HQ, in addition to the incremental cancer risks presented by the radioactive isotopes of uranium. If the HQ exceeds 1, the possibility exists for systemic toxic effects. However, the dose from total uranium will exceed the 15 or 500 mrem/yr guidance limits at an activity or concentration less than that corresponding to an HQ of 1. Therefore, it would be expected that cleanup to meet the radioactivity hazard also would be adequate to address the hazard associated with chemical toxicity.

3.5.2.2 Ecological Exposure

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

ORNL/TM-13141, *Effects of Ionizing Radiation on Terrestrial Plants and Animals: A Workshop Report*, presents information from a DOE-sponsored workshop held in 1995. The workshop was attended by 12 experts in radioecology and ERA. The goal of the workshop was to evaluate the adequacy of current approaches to radiological protection, as exemplified by the IAEA report. The attendees reviewed DOE's perspective and responsibilities, rationales underlying the IAEA conclusions, and a summary of ecological data from the former Soviet Union. The consensus of the workshop participants was that the 0.1 rad/d limit for animals and the 1 rad/d limit for plants recommended by the IAEA are adequately supported by the available scientific information. However, they concluded that guidance is needed on implementing the limits and that the existing data support the application of the recommended limits for populations of terrestrial and aquatic organisms to representative, rather than maximally exposed, individuals.

In response to the workshop findings, DOE produced DOE/STD-1153-2002, which provides a graded approach to ERA for radionuclides and screening level BCGs. For radiological constituents, no promulgated screening or cleanup levels are available. The potential effects of surface residual contamination on terrestrial receptors are evaluated using the terrestrial radionuclide screening levels presented in DOE-STD-1153-2002, developed by the BDAC. The BDAC has been assisting DOE in developing this technical standard, which provides a graded approach for evaluating radiation doses to biota. The technical standard provides a cost-effective, easy-to-implement methodology that can be used to demonstrate compliance with DOE dose limits and with findings of the IAEA and the National Council on Radiation Protection and Measurements regarding doses below which deleterious effects on populations of aquatic and terrestrial organisms have not been observed. The technical standard also can be used to assess ecological effects of radiological exposure when conducting ERAs.

The DOE's graded approach for evaluating radiation doses to biota consists of a three-step process that is designed to guide a user from an initial, conservative general screening to a more rigorous analysis using site-specific information (if needed) and is consistent with the eight-step

EPA approach for conducting ERAs. The DOE recommends a three-step process that includes (1) assembling radionuclide concentration data and knowledge of sources, receptors, and routes of exposure for the area to be evaluated; (2) applying a general screening methodology that provides limiting radionuclide concentration values (i.e., BCGs) in soil, sediment, and water; and (3) if needed, conducting a risk evaluation through site-specific screening, site-specific analysis, or a site-specific biota dose assessment conducted within an ERA framework, similar to that recommended by EPA/630/R-95/002F, *Guidelines for Ecological Risk Assessment*. Any of the steps within the graded approach may be used at any time, but the general screening methodology usually is the simplest, most cost-effective, and least time-consuming process.

The BCGs contained in the technical standard guidance include conservative screening concentrations that are judged to be protective of the most sensitive terrestrial organisms, assuming a dose of 0.1 rad/day[2]. Each radionuclide-specific BCG represents the limiting radionuclide concentration in environmental media (i.e., soil, sediment, or water) that would not exceed DOE's established or recommended dose standards for biota protection. Therefore, soil concentrations that are less than the BCGs are not considered to pose a threat to terrestrial receptors.

3.5.3 Remediation Goals for the Protection of Groundwater

Remediation goals for the protection of groundwater must address both contamination reaching the groundwater and contamination remaining in the ground after remediation (i.e., residual contamination). The remediation goals must consider risk-based standards where contamination might have contacted groundwater and standards for residual contamination that might migrate through the vadose zone to groundwater. Residual vadose zone contamination must be below activities or concentrations that could cause groundwater to exceed protective levels, if contaminants migration occurs. The following subsections present remediation goals for groundwater and for residual contamination in the vadose zone and a discussion of achieving these remediation goals.

3.5.3.1 Nonradionuclide Preliminary Remediation Goals for the Protection of Groundwater

The PRGs for nonradionuclides in the vadose zone that are protective of groundwater are developed from potential ARARs (e.g., MCLs as defined in 40 CFR 141) and published risk-based standards. Consistent with this approach, soil concentrations protective of groundwater are established by evaluating the provisions of WAC 173-340-747, unless it can be demonstrated that a higher contaminant concentration is protective of groundwater (WAC 173-340-747[3][e], "Deriving Soil Concentrations for Ground Water Protection," "Overview of Methods," "Alternative Fate and Transport Models"). Values of soil concentrations protective of groundwater were calculated using formulas from WAC 173-340-747 and inputs from

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[2] Terrestrial plant species are assumed to be protected at sites containing a dose of up to 1 rad/day (DOE-STD-1153-2002).

Ecology 94-145. Table 3-1 provides the preliminary remediation goals for nonradionuclides identified as COCs.

3.5.3.2 Radionuclide Preliminary Remediation Goals for the Protection of Groundwater

Title 40 CFR 141 specifies MCLs for radionuclide contaminants in drinking water. Remediation goals for radionuclide contaminants in water, protective of both groundwater and surface water, are based on achieving these MCLs. Remediation goals for radionuclides in water, considered protective of human health, also are considered protective of potential ecological receptors at the groundwater/river interface.

The average annual activity of beta particle and photon radioactivity from manmade radionuclides in drinking water shall not produce an annual dose equivalent to the total body or any internal organ greater than 4 mrem/yr (40 CFR 141.66). The MCLs for Sr-90 and tritium are 8 pCi/L and 20,000 pCi/L, respectively (40 CFR 141.66). The MCLs for all other manmade radionuclides causing a 4-mrem/yr dose (except Ra-226 and Ra-228) are calculated based on a 2 L/d drinking water intake using the 168-h data listed in NBS Handbook 69, *Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air or Water for Occupational Exposure.* The EPA has calculated drinking water MCLs for radionuclides in 40 CFR 141, based on NBS Handbook 69. These values of radionuclide drinking water MCLs also are presented in EPA/540/R-00/007, *Soil Screening Guidance for Radionuclides: User's Guide* (OSWER Directive 9355.4-16A), Table D.2. If two or more radionuclides are present, the sum of their annual dose shall not exceed 4 mrem/yr (40 CFR 141.66).

The MCL for uranium in drinking water is 30 µg/L, as promulgated by the EPA (65 FR 76708, "National Primary Drinking Water Regulations; Radionuclides; Final Rule"). Based on the isotopic distribution of uranium on the Hanford Site, the 30 µg/L MCL corresponds to an activity of 21.2 pCi/L (BHI Calculation No. 0100X-CA-V0038, *Calculation of Total Uranium Activity Corresponding to a Maximum Contaminant level of Total Uranium of 30 Micrograms per Liter in Groundwater*).

For radionuclides in the vadose zone, concentrations of residual contaminants are considered protective of groundwater if the residual levels do not result (via migration through the vadose zone) in concentrations that exceed groundwater remediation goals.

Table 3-1. Summary of Nonradionuclide Soil Preliminary Remediation Goals for All Pathways.

Constituent	Hanford Site Background[a] (mg/kg)	Direct Contact[b] (mg/kg)	Groundwater and Columbia River Protection[c] (mg/kg)	Terrestrial Wildlife Protection[d] (mg/kg)	Overall PRG[e] (mg/kg)
Aroclor-1254	--	70	0.99	0.65	0.65
Aluminum	11,800	--	45	--	11,800
Antimony	--	1,400	5.4	17.7	5.4
Barium	132	245,000	923	102	132
Cadmium	1.0	3,500	0.69	14	1.0
Chromium	18.5	525,000	2,000	67	67
Copper	22	130,000	263	217	217
Cyanide	--	70,000	0.8	--	0.8
Fluoride	--	--	16	--	16
Lead	10.2	750	3,000	118	118
Manganese	512	490,000	50	1,500	512
Mercury	0.33	1,050	2.1	5.5	2.1
Nickel	19	70,000	130	980	130
Nitrate (as nitrogen)	11.7	350,000	40	--	40
Nitrite (as nitrogen)	--	350,000	4	--	4
Selenium	0.78	17,500	5.2	0.3	0.78
Silver	0.73	17,500	13.6	--	13.6
Sulfate	--	[g]	1,000	--	1,000
Thallium	--	280	38	--	38
Uranium	3.21	10,500	2.3	--	3.21
Vanadium	85.1	24,500	2,240	--	2,240
Zinc	68	Unlimited[f]	5,970	360	360
Benzoic acid	--	Unlimited[f]	257	--	257
Bis(2-ethylhexyl)phthalate	--	9,375	14	--	14
Butylbenzylphthalate	--	[g]	893	[g]	893
Diethylphthalate	--	Unlimited[f]	72	--	72
Di-n-butylphthalate	--	350,000	11	--	11
Di-n-octylphthalate	--	[g]	532,000	[g]	532,000
Dichlorodiphenyltryichloroethane	--	[g]	3.5	[g]	3.5
Isophorone	--	[g]	0.45	[g]	0.45
Pentachlorophenol	--	1,094	0.012	4.5	0.012
Phenol	--	350,000	44	--	44
2-Butanone	--	[g]	22	[g]	22
2-Hexanone	--	[g]	0.0048	[g]	0.0048

Table 3-1. Summary of Nonradionuclide Soil Preliminary Remediation Goals for All Pathways.

Constituent	Hanford Site Background[a] (mg/kg)	Direct Contact[b] (mg/kg)	Groundwater and Columbia River Protection[c] (mg/kg)	Terrestrial Wildlife Protection[d] (mg/kg)	Overall PRG[e] (mg/kg)
1,1,1-Trichloroethane	--	f	1.6	f	1.6
Acetone	--	350,000	3.2	--	3.2
Methylene chloride	--	17,500	0.025	--	0.025
Styrene	--	f	0.033	8	0.033
Toluene	--	700,000	7.3	--	7.3

NOTES: Shaded areas represent the pathway driver for the overall preliminary remediation goal (PRG).

[a] Background concentrations are 90th percentile values of the log normal distribution of sitewide soil background data from DOE/RL-92-24, *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes*. Where the applicable PRG for a constituent is less than background, the background value is used as the PRG per WAC 173-340-700(6)(d), "Overview of Cleanup Standards," "Requirements for Setting Cleanup Levels," "Natural Background and Analytical Considerations."

[b] Direct contact values represent vadose zone concentrations that are protective of human and ecological receptors from direct contact with contaminated solids. Listed standards for industrial soil are obtained from Ecology 94-145, *Cleanup Levels and Risk Calculations under the Model Toxics Control Act Cleanup Regulation; CLARC, Version 3.1*, (updated November 2001), and apply to the top 4.6 m (15 ft) (WAC 173-340-745, "Soil Cleanup Standards for Industrial Properties").

[c] Values represent vadose zone soil concentrations that will be protective of groundwater and the Columbia River. Values are calculated using the three-phase model for protection of drinking water (WAC 173-340-747[4], "Deriving Soil Concentrations for Ground Water Protection," "Overview of Methods," "Fixed Parameter Three-Phase Partitioning Model," amended February 12, 2001).

[d] Industrial soil levels protective of terrestrial wildlife are obtained from WAC 173-340-900, "Tables," Table 749-3.

[e] Listed values apply to the top 4.6 m (15 ft) and represent the most restrictive soil PRG derived from evaluation of direct contact, groundwater and river protection, and terrestrial wildlife protection. Below 4.6 m (15 ft), alternate cleanup levels may be required to meet remedial action objectives based on verification of protectiveness of groundwater and the Columbia River during remedial actions.

[f] Direct contact cleanup levels for contaminated solids calculated using WAC 173-340-745 result in values greater than pure material (e.g., >1 million parts per million).

[g] Constituent not detected in 0 to 4.6 m (0 to 15-ft) zone.

-- = No value established.

Table 3-2. Summary of Radionuclide Preliminary Remediation Goals for All Pathways.

Constituent	Direct Exposure[a] (pCi/g)		Terrestrial Wildlife BCG[c] (pCi/g)	Groundwater and River Protection (pCi/g)	Overall PRG[d] (pCi/g)
	15 mrem/yr Dose	500 mrem/yr Dose[b]			
Americium-241	335	112,000	4,000	NA[e]	335
Cesium-137	23.4	780	20	NA[e]	20
Cobalt-60	4.90	164	700	NA[e]	4.90
Neptunium-237	59.2	1,980	1,900	NA[e]	59.2
Nickel-63	3,070,000	102,000,000	22,000,000	NA[e]	3,070,000
Plutonium-238	47	15,700	5,400	NA[e]	47
Plutonium-239/240	425	14,200	6,000	NA[e]	425
Potassium-40	76.4	2,540	2,200	NA[e]	76.4
Radium-226	7.03	234	50	NA[e]	7.03
Radium-228	8.15	272	40	NA[e]	8.15
Strontium-90	2,410	80,300	20	NA[e]	20
Technetium-99	412,000	13,700,000	5,400	[f]	[f]
Thorium-228	7.73	258	2,200	NA[e]	7.73
Thorium-232	4.8	160	2,000	NA[e]	4.8
Tritium	66,900	2,230,000	5,400	[f]	[f]
Uranium-233/234	2,660	88,800	5,000	[f]	[f]
Uranium-235	101	3,370	3,000	[f]	[f]
Uranium-238	504	20,800	2,000	[f]	[f]

NOTE: Shaded areas represent the pathway driver for the overall preliminary remediation goal (PRG).

[a]Direct exposure values represent activities for individual radionuclides corresponding to a 15 or 500 mrem/yr dose rate in an industrial scenario. Values will be lower for multiple radionuclides to achieve the same dose rate. Listed values apply to the top 4.6 m (15 ft) of the soil column.

[b]500 mrem/yr is the DOE dose limit for radiological workers, not for the general public.

[c]Biota Concentration Guide (BCG) from DOE-STD-1153-2002, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota.*

[d]Listed values apply to the top 4.6 m (15 ft) and represent the most restrictive PRG derived from evaluation of the direct exposure, terrestrial wildlife, and river protection pathways. Below 4.6 m (15 ft) only groundwater values apply and alternate cleanup levels may be required to meet the remedial action objectives based on verification of protectiveness of groundwater during remedial actions.

[e]NA = Not applicable. The RESRAD (RESidual RADioactivity) (ANL 2002, *RESRAD for Windows*, Version 6.21) and STOMP (PNNL-12034, *STOMP, Subsurface Transport Over Multiple Phases, Version 2.0, User's Guide*) models predict that constituent at concentrations present in the representative sites will not reach groundwater within 1,000 years.

[f]Constituent is considered mobile. The protection of groundwater is evaluated using fate and transport modeling based on site-specific conditions. The PRG is the most conservative for the different exposure pathways. The protection of groundwater is likely the PRG for this constituent if it impacts groundwater.

4.0 IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES

The Implementation Plan Appendix D (DOE/RL-98-28) provided an initial framework to guide the RIs in the 200 Areas. The Implementation Plan identified and screened technologies that could be used to address contaminants in the soil and solid waste in the arid 200 Areas environment.

Since the Implementation Plan was issued, site characterization information was obtained and an RI Report was prepared that presented the nature and extent of contamination and the risk at the representative waste sites (DOE/RL-2002-42). Additional risk analysis was performed as part of this FS for those analogous sites with existing sampling data. This information may affect the identification and screening of remedial technologies. As a result, the Implementation Plan information was reviewed against the results of the SLERA and HHRA, and refinements were made as appropriate for this FS. A review of technologies was conducted to identify new, emerging technologies or to update information on existing technologies since the writing of the Implementation Plan. If a technology was identified and evaluated in the Implementation Plan and no modifications to this evaluation have been made, then the identified and evaluated technology is only briefly mentioned in this section. The Implementation Plan provides additional detailed information.

4.1 GENERAL RESPONSE ACTIONS

Remedial measures generally are categorized into broad groups called GRAs. The GRAs are intended to satisfy RAOs identified in Chapter 3.0. The GRAs for the representative sites are as follows:

- No action
- Institutional controls
- Containment
- Removal, treatment, and disposal
- Ex situ treatment
- In situ treatment.

These GRAs are intended to cover the range of options necessary to meet the RAOs. Based on the new information collected and evaluated in DOE/RL-2002-42, modifications to these GRAs were not necessary. Detailed descriptions of each GRA are included in the Implementation Plan.

4.2 SCREENING AND IDENTIFICATION OF TECHNOLOGIES

This section serves to screen and identify potentially viable technologies for the 200-TW-1, 200-TW-2, and 200 PW-5 OUs. The initial identification and screening of remedial technologies conducted in the Implementation Plan Appendix D (Section D5.0 to D5.6 and Table D-1) are modified for this FS based on the information obtained during the RI. The following subsections summarize the technology screening conducted: rescreening of the Implementation Plan remedial technologies that are retained for the 200-TW-1, 200-TW-2, and PW-5 OUs; and identifying and screening new technologies identified since the creation of the Implementation Plan. The technologies are discussed by GRA group. Table 4-1 represents a roadmap for technology selection between the Implementation Plan and this FS.

Potentially applicable technology types and process options were identified and screened in the Implementation Plan in accordance with CERCLA guidance using effectiveness, implementability, and relative cost as criteria to eliminate those options that are least feasible and to retain those options that are considered most viable.

4.2.1 Rescreening of Implementation Plan Remedial Technologies based on Risk Assessment Results

Because the initial screening in the Implementation Plan was preliminary, and because additional site-specific risk assessment and characterization information is available, the remedial technologies presented in the Implementation Plan were rescreened for application to the 200-TW-1, 200-TW-2, and 200-PW-5 OUs. Following is a brief screening-level discussion of the technologies and the results of the refinements.

4.2.1.1 No Action

The NCP (40 CFR 300) requires that a no-action alternative be evaluated as a baseline for comparison with other alternatives. The no-action alternative represents a situation where no restrictions, controls, or active remedial measures are applied to the site. The no-action alternative implies a scenario of walking away from the site and taking no measures to monitor or control contamination. The no-action alternative requires that a site pose no unacceptable threat to human health and the environment. The no-action alternative was retained in the Implementation Plan for the 200-TW-1, 200-TW-2, 200-PW-5, and 200-LW-1 OUs and is carried forward in this FS; however, it is not expected to be applicable to any of the waste sites.

4.2.1.2 Institutional Controls

Institutional controls consist of (1) physical and/or legal barriers to prevent access to contaminants, (2) monitoring of the groundwater and/or the vadose zone, and (3) maintaining existing soil covers. Institutional controls usually are required when contaminants remain in place in concentrations above cleanup levels; the controls likely will be a component of the remedial alternatives.

Waste at the 216-B-5 Injection/Reverse Well was injected at a depth of 74 m (243 ft) below ground surface. The depth of the contamination limits the number of technologies applicable to removing contaminants at this site. Therefore, institutional controls, especially monitoring of the groundwater near the 216-B-5 Injection/Reverse Well, will be an important component of the remediation alternatives at this site.

An engineered cap (the Hanford Prototype Barrier) was constructed at the 216-B-57 Crib as a treatability test and remedial action. Institutional controls at this site will include maintenance of the existing cap.

Based on the results of the RI activities, no changes have been made to this technology from what appeared in the Implementation Plan. The institutional controls technologies will be incorporated into remedial alternatives in Chapter 5.0.

4.2.1.3 Containment

Containment includes physical measures to restrict accessibility to in-place contaminants or to reduce the migration of contaminants from their current location. Containment technologies include surface barriers (caps) and vertical barriers, which are used to prevent or limit infiltration and/or intrusion to the contaminated zone.

4.2.1.3.1 Surface Barriers (Capping)

The surface barrier, or capping, technologies are applicable for groundwater, human health, and ecological protection. Several different types of surface barriers have been evaluated for use at the Hanford Site in separate documents.

DOE/RL-93-33, *Focused Feasibility Study of Engineered Barriers for Waste Management Units in the 200 Areas*, evaluated four conceptual barrier designs for different types of waste sites: The Hanford Barrier, the Modified RCRA Subtitle C Barrier, the Modified RCRA Subtitle D Barrier, and the Standard RCRA Subtitle C Barrier. Based on the results of this evaluation, the Implementation Plan identified three of these engineered barriers as being suitable for use at waste sites in the 200 Areas: The Hanford Barrier, the Modified RCRA Subtitle C Barrier, and the Modified RCRA Subtitle D Barrier. Further discussion of surface barriers is summarized below, because the information supports the RI data and the evaluation of capping alternatives.

Generally, capping consists of constructing surface barriers over contaminated waste sites to control the amount of water that infiltrates into contaminated media, to reduce or eliminate leaching of contamination to groundwater. In addition to their hydrological performance, barriers also may function as physical barriers to prevent intrusion by human and ecological receptors, limit wind and water erosion, and attenuate radiation. The surface barriers proposed in this FS rely predominantly on the water-holding capacity of a soil, evaporation from the near surface, and plant transpiration to control water movement through the barrier. Precipitation infiltrates at the surface, where it is retained in the soil by absorption and adsorption until evaportranspiration (ET) processes move the water back to the atmosphere. Such designs are particularly suitable for semiarid and arid climates with a low annual amount of precipitation and a relatively high ET potential. When precipitation exceeds ET, water is stored; and when ET exceeds precipitation, water is released. Key design criteria require that the soil layer be of sufficient thickness and quality in terms of water-holding capacity and ability to support native vegetation to accommodate design precipitation events or conditions. Water balance studies at the Hanford Site have shown that vegetation and soil type control the downward movement of precipitation, and for finer grained soils with a healthy plant cover of shrubs and grasses, net recharge is close to zero (Gee et al. 1992, "Variations in Recharge at the Hanford Site").

The ET barriers have been and continue to be evaluated within the DOE complex (Sandia National Laboratory, Los Alamos National Laboratory, Idaho National Engineering and Environmental Laboratory, Nevada Test Site, Hanford Site), and by the EPA. The Alternative Cover Assessment Program, under the sponsorship of the EPA, is evaluating a number of fieldscale test covers throughout the United States. Results to date indicate that alternative barrier designs at semiarid and arid sites generally exhibit little percolation (Albright et al. 2003, "Examining the Alternatives"). Other examples of barrier study include the application of a monolayered vegetative cover at the DOE Nevada Test Site and the DOE Alternative Landfill Cover Demonstration project in New Mexico, managed by the Sandia National Laboratory (Dwyer 2001, "Finding a Better Cover"). The goal of most of these efforts is to provide reliable data on design, cost, construction, and performance for alternative barriers. The intent of the FS is not to select and design the most applicable ET barrier but to evaluate their performance in general using the CERCLA process. Based on the available data cited above, ET barriers are carried forward for remedial alternative development and evaluation.

Information gained from these studies and programs, including the Hanford Barrier program at 216-B-57 Crib, will be used to support the remedial design if ET barriers are selected as the preferred remedy. Site-specific conditions establish the level of hydraulic or physical barrier performance required.

A four-year (fiscal years 1995 through 1998) treatability test was successfully completed on a prototype of the Hanford Barrier constructed in fiscal year 1994 over the 216-B-57 Crib. The primary purpose of the test was to document surface barrier constructability, construction costs, and physical and hydrologic performance in support of remedial decision making and remediation at similar waste sites at the Hanford Site. The results of the treatability test are reported in *200-BP-1 Prototype Barrier Treatability Test Report* (DOE/RL-99-11).

The principal surface barrier performance parameters evaluated during the treatability test included water balance within the barrier under ambient and extreme precipitation conditions; surface wind and water erosion; stability of the barrier foundation, surface, and riprap side slope; surface vegetation dynamics; and animal intrusion. Using irrigation techniques, extreme precipitation conditions were simulated by applying water up to three times normal, including 1,000-year storms. Treatability test objectives were achieved or exceeded by the four years of testing. Results demonstrate that the barrier is easily constructed with standard construction equipment, performance criteria have been met or exceeded, and the Hanford Barrier and associated design components are highly effective. Subsequent to the treatability test, monitoring activities have continued at the barrier. Results of the monitoring activities are reported in annual letter reports, the most recent being *200-BP-1 Prototype Hanford Barrier Annual Monitoring Report for Fiscal Year 2002* (CP-14873). Water balance, barrier stability, vegetation, and animal intrusion monitoring continue at the barrier. Results have shown essentially no drainage through upper barrier silt layers and no measurable amounts of drainage through the asphalt layer/functional barrier system. Drainage does occur at the side slopes. Barrier sideslopes and surface have remained stabile. The barrier maintains a healthy coverage of native plants. The vegetation has been shown to effectively remove water. The barrier showed minimal small mammal burrowing activity with no impact on barrier performance during the monitoring period.

The ET barriers can be divided into two categories: capillary barriers and monolithic barriers. The barriers retained in the *200 Areas Implementation Plan* (i.e., the Hanford Barrier, the Modified RCRA Subtitle C Barrier, and the Modified RCRA Subtitle D Barrier) are capillary barriers, which consist of a fine-grained soil layer overlying a relatively coarse-grained soil layer. Monolithic barriers rely on a relatively thick single layer of fine-textured soil. The distinct textural interface in capillary ET barriers between the fine and coarse soil layers creates a capillary break, which functionally increases the water-holding capacity of the fine-grained soil over that associated with unimpeded vertical drainage. Water will not flow into the coarse layer until the water content approaches saturation in the fine grain soil layer. If the textural interface is sloped, water will move laterally in the fine-soil layer above the interface, which provides an additional mechanism for water removal.

The advantage of the monolithic barrier is its simplicity. A single soil layer simplifies construction and maintenance and is better able to accommodate differential settlements or subsidence relative to a capillary barrier. A capillary barrier relies on maintaining a planar textural interface, which would be susceptible to differential settlements or subsidence. This is an important consideration for waste sites with void space or solid waste that are susceptible to subsidence. Differential settlements can disrupt the continuity of layers (i.e., offset layers), which can create large macropores. However, a broad range of options is available (e.g., dynamic compaction, compaction grouting) to mitigate the subsidence potential before barrier construction. Given the same soil type, the monolithic barrier requires additional soil thickness relative to capillary barriers for an equivalent water storage capacity. Should the thickness of the soil required for water-holding capacity exceed the rooting depth, water removal capacity diminishes. However, the additional thickness also can be advantageous in providing increased intruder protectiveness.

Advantages of capillary barriers are reduced soil thickness, greater design control for retaining water within the effective root zone, and the ability to move water laterally out of the barrier. If lateral drainage along the textural interface is desired, special design considerations must be addressed, such as the ability of the soil to conduct water laterally (unsaturated flow) over the length of the sloped interface, and the final routing and disposition of the drainage. Furthermore, capillary barriers produce relatively low moisture conditions in the lower coarse layer, which may serve to limit biointrusion and maximize root retention in the ET zone. If the capillary break is compromised, the performance of the barrier diminishes.

The three capillary cap designs retained in the 200 Areas Implementation Plan, the Hanford Barrier, the Modified RCRA Subtitle C Barrier, and the Modified RCRA Subtitle D Barrier, were designed to address various categories of waste (e.g., transuranic, low –level, hazardous, sanitary). All three designs are ET-type barriers, but include additional layers for added levels of containment or redundancy. The term "modified" reflects that the design varies in certain key respects from conventional barrier designs, but is expected to be equivalent to, or to exceed the performance of, the conventional design. At several points the regulations indicate that alternate regulatory requirements may be used to supplant the prescriptive regulations. The Modified RCRA C Barrier design was developed for sites containing hazardous, low-level waste or low-level mixed waste, to provide long-term containment and hydrologic protection for a performance period of 500 years (DOE/RL-93-33). The Modified RCRA C Barrier also was developed because the conventional RCRA C cap design is aimed at areas with much higher precipitation and is not effective for arid climates. In arid climates, the prescriptive clay barrier's performance is degraded because of the lack of moisture. The design includes the components of a capillary barrier overlying a secondary barrier system using a low-permeability layer. The secondary barrier layers are provisional, depending on the site-specific need for redundancy in hydrologic protection, a vapor barrier, and/or a more robust biointrusion layer.

The Hanford Barrier design was developed for sites containing greater-than-Class-C low-level waste, and/or significant inventories of transuranic constituents. This barrier remains functional for a performance period of 1,000 years. Also, it provides the maximum available degree of containment and hydrologic protection for the evaluated designs. The design is composed of nine layers of durable material with a combined thickness of 4.5 m (14.7 ft). The barrier layers maximize moisture retention and ET capabilities and minimize moisture infiltration and biointrusion, considering long-term variations in Hanford Site climate.

Considering the level of supporting documentation, and Hanford Site-specific field data that demonstrate that capillary barriers perform well (DOE/RL-99-11, *200-BP-1 Prototype Barrier Treatability Test Report*; PNNL-13033, *Recharge Data Package for the Immobilized Low-Activity Waste 2001 Performance Assessment*), the Modified RCRA C Barrier is considered to be an appropriate process option for the waste sites in this FS. This process option forms the basis for evaluating capping alternatives at soil waste sites not contaminated with transuranic constituents, and the Hanford Barrier is considered to be an appropriate process option for soil waste sites contaminated with significant concentrations of transuranic constituents. The standard RCRA, asphalt, concrete, and cement-type barriers were rejected in the Implementation Plan (DOE/RL-98-28) because of their limited effectiveness and duration in an arid climate; they are similarly rejected in this FS.

Although the Modified RCRA C Barrier process option is the basis for evaluating this technology, it does not preclude the use of other ET designs (e.g., monolithic barrier). The performance and design parameters would be determined during remedial design. Both the monolithic and capillary barriers have been shown to be equivalent to or to exceed the performance of the standard RCRA Subtitle C barrier design, and both have been approved or planned for use in several western states (DOE/RL-93-33).

If capping is identified as the preferred alternative, finalization of site-specific designs will occur as part of the remedial design process and will consider the RAOs and requirements defined in the ROD, regulatory design and performance standards, material availability, cost-effectiveness, current surface barrier technology information, and site-specific hydrologic and physical performance requirements to ensure waste containment. Different waste sites likely will have varying barrier performance requirements, and more than one barrier design (e.g., monolithic and capillary barrier) may be deployed to address waste site capping needs.

4.2.1.3.2 Slurry Walls and Grout Walls

Slurry walls and grout walls were retained in the Implementation Plan. Slurry walls and grout walls often are used to contain contaminated groundwater but have application in the vadose zone to limit (1) the horizontal movement of moisture into contaminated materials or (2) the vertical migration of contaminants. Vertical barriers are a supplemental element in the design of surface caps to effectively improve containment performance in deeper zones; both slurry walls and grout walls are suitable technologies for this application. While the need for horizontal control of contaminant migration has not been identified based on the RI Report, these options are retained for use in the development of remedial alternatives in Chapter 5.0 and for potential future use following the collection and evaluation of confirmatory data to confirm that the appropriate remedial action has been specified for the analogous waste sites.

Vertical migration of contaminants can be addressed through the use of directional drilling techniques. Angled grout walls can be formed beneath a waste, and new innovative materials can assist with limiting radionuclide mobility through chemical reactions. This type of barrier is limited (more so than slurry walls) by difficulties in verifying barrier continuity and identifying grouting materials suitable for use. Their potential use to form grout walls beneath contamination at the five representative sites is rejected because of the depth of the mobile contaminants, greater than 30 m (100 ft) bgs, at these sites.

4.2.1.4 Removal, Treatment, and Disposal

The Implementation Plan identified excavation of contaminated soils, with treatment as needed to meet disposal criteria, and transportation and disposal to the appropriate disposal facility, as an applicable technology for the waste sites. Excavation of materials generally is accomplished using standard earthmoving equipment, such as backhoes and front-end loaders. This technology is retained for use at sites as a standalone remedial alternative and in combination with other remedial technologies, such as capping. Most of the sites in the 200-TW-1, 200-TW-2, and 200-PW-5 OUs contain the majority of their contamination in the depth range of 4.6 to 15 m (15 to 50 ft). Excavation to 15 m (50 ft), while possible, is more difficult at depths greater than 7.6 m (25 ft), which is a normal reach for conventional excavation equipment. While excavation to greater depths is possible, additional engineering controls, such as shoring or more gradual slopes, would be needed. Terracing would be required to reach greater depths, which could interfere with nearby buildings or facilities such as the tank farms. Risks to workers increase with the depth of excavation, as well.

The levels of contamination in many of the waste sites in the 200-TW-1 and 200-TW-2 OUs pose a significant dose threat to workers. The levels of Cs-137 and Sr-90 and potentially other radionuclides may result in excavation and disposal activities being identified as nuclear activities. In addition, the levels may result in implementing remote-handled removal techniques. Whether remote handled or contact handled, special safety controls will be required to address the contaminant concentrations. Shielded excavation equipment for these wastes will be required to reduce worker dose, and the blending of less contaminated soils with the more highly contaminated soils will be required to meet as low as reasonably achievable (ALARA) and on-site disposal facility requirements. Additional measures are needed to limit the quantity of exposed soil during excavation such as a rolling excavation, where only a small portion of the waste site is excavated at a time. This time-consuming activity limits the worker risk, but has a direct impact on schedule and cost. Based on the effectiveness of such controls, construction of a containment structure to further limit airborne releases may be needed. Potential future animal intrusion/ biological uptake are also issues that will require control of open excavations and exposed contaminated soils at the end of each day. This control could be accomplished through placement of covers or fixatives. Not only are digging animals a concern, but in open trenches where cellulose was used to control dust and other airborne releases, insects like fruit flies represent a further pathway to spread contamination. These are documented pathways at the Hanford Site.

Shoring may be needed at cut intervals to reach these depths safely. Large excavations would significantly increase the time that workers are associated with the highly contaminated zones, resulting in increased doses. Also, large excavations to these depths would put a large amount of contaminated material at risk for spread associated with airborne pathways. Costs associated with these increased safety techniques would be greatly increased.

Excavation may be applicable at sites that contain contaminant concentrations exceeding the TRU waste threshold, such as the 216-B-7A Crib. Standard excavation equipment can be modified, if necessary, to protect the equipment operator and the equipment from radiation. The use of a modified excavator would be determined during design. However, the concentrations of radionuclides associated with most of the waste sites would pose a significant risk to workers. Special excavation, waste packaging and handling, and disposal techniques would be needed to protect workers from unacceptable dose rates. In addition, excavation and disposal rates would be greatly decreased to account for the added precautions.

Waste disposal is divided into (1) on-site disposal of soils without TRU constituents and (2) temporary on-site storage of soils with TRU constituents, followed by off-site disposal.

- **Waste Disposal of Soils without TRU Constituents.** The on-site disposal option for soils not contaminated with TRU constituents is at the ERDF. The waste acceptance criteria for ERDF are based on regulatory requirements (e.g., RCRA land-disposal restrictions) and risk-based considerations for long-term protection of human health and the environment. If waste cannot be accepted at the ERDF, then a suitable off-site disposal facility will be used; however, all contaminated soils from the 200-TW-1, 200-TW-2, and 200-PW-5 OUs without TRU constituents are expected to be acceptable to the ERDF.

- **Retrieval, Treatment, and Disposal of Soils with TRU Constituents.** Only small quantities, if any, of contaminated soils with TRU constituents are expected from the 216-B-7A Crib, 216-B-5 Injection/Reverse Well, 216-T-3 Injection/Reverse Well, 216-T-6 Crib, 216-T-32 Crib, and 216-B-53A Trench. If excavated soil were determined to exceed 100 nCi/g (100,000 pCi/g), it would be transported to the Waste Receiving and Processing facility for waste certification and shipment to the Waste Isolation Pilot Plant in New Mexico.

Because the Waste Isolation Pilot Plant is exempt from RCRA land-disposal restrictions, specific ex situ treatment of mixed TRU waste for organic and inorganic contaminants will not be necessary.

4.2.1.5 Ex Situ Treatment

Ex situ treatment processes retained in the Implementation Plan (DOE/RL-98-28) include thermal desorption, vapor extraction, mechanical separation, soil washing, ex situ vitrification, and solidification/stabilization. However, all of these technologies except solidification/stabilization are rejected for this FS because of limited effectiveness and applicability to contaminant types and distribution in the 200-TW-1, 200-TW-2, and 200-PW-5 OUs. Thermal desorption and vapor extraction technologies typically are applied to soils contaminated with light- to medium-range hydrocarbons and other organics. Thermal desorption also is effective on heavier range hydrocarbons (e.g., diesel, oil). Based on the RI Report (DOE/RL-2002-42) and the results of the risk assessment, the 200-TW-1, 200-TW-2, and 200-PW-5 OUs primarily are contaminated with radionuclides, nitrate, and metals; remediation for hydrocarbons or organics is not necessary. These technologies are ineffective for radionuclides and inorganic compounds and, therefore, were rejected for this FS.

The primary separation technique for solid media using mechanical separation is sieving to segregate material according to size, but other physical properties also may be used as a basis for segregation (e.g., local discoloration of soil). This technology is not deemed necessary to dispose of waste at the sites in this FS. The main disadvantage of this technology is that increased waste handling carries the potential of increased worker risk and the production of fugitive dust. This process has been used as a component of removal and disposal actions on the Hanford Site. Experience in the 300 Area burial grounds has shown that certain problems with sieving solid debris may be encountered, specifically clogging of the sieving device.

Soil washing has limited effectiveness on many radionuclides, with the risk of higher exposures to workers and potentially high costs associated with the soil washing, especially if chemicals are needed to remove contaminants. Based on the results of the RI, treatment is not required to meet ERDF or Waste Isolation Pilot Plant waste acceptance criteria.

Ex situ vitrification is costly and is deemed unnecessary to dispose of waste at the ERDF or the Waste Isolation Pilot Plant. One possible application is the sludge in the 241-B-361 Settling Tank, the 241-T-361 Settling Tank, the 200-E-14 Siphon Tank, and the 216-BY-201 Settling Tank. Ex situ vitrification is retained in the FS for this waste stream only.

Solidification/stabilization technologies generally are used to immobilize soil contaminants; this is assumed to be unnecessary for disposal to the ERDF, but may be necessary for tank sludge disposal at the Waste Isolation Pilot Plant if significant volumes of water are added to the sludge during removal. Both technologies are applicable to radionuclides and other inorganics and are, therefore, retained in this FS.

4.2.1.6 In Situ Treatment – (Vitrification, Grout Injection, Soil Mixing, Dynamic Compaction, and Natural Attenuation)

These technologies were retained in the Implementation Plan to mitigate contaminant mobility or to treat organics in situ.

Vitrification is rejected, because the depth of the majority of the contamination is at or below the 6.1 m (20 ft) process depth limit and because of the physical size of the waste sites and the implementation problems associated with this technology. In situ vitrification also is not retained for use at the tanks because of the high cost and implementation problems.

Grout injection, commonly referred to as jet grouting or in situ grouting (ISG), is a process that entails injecting a slurry-like mixture of cements, chemical polymers, or petroleum-based waxes into contaminated media. Grouts are specially formulated to encapsulate contaminants, isolating them from the surrounding environment.

As summarized in INEEL-01-00281, *Engineering Design File, Operable Unit 7-13/14 Evaluation of Soil and Buried Waste Retrieval Technologies*, ISG has been approved by regulating agencies and implemented at several small-scale sites, although ISG has not been applied to large-scale sites with many radiological and chemical hazards such as the 200-TW-1, 200-TW-2, and 200-PW-5 OU sites. Grout injection, as a stand-alone action, is rejected for this FS because of the size and depth of the waste sites and its unproven effectiveness on large-scale sites having radiological and chemical hazards.

The technology is applicable to remedial alternatives to fill voids in pipelines (e.g., 200-E-114 Pipeline), to fill voids in cribs, and to fill voids in tanks that will remain in place after contamination is removed.

Dynamic compaction is used to increase the soil density, compact the buried solid waste, and/or reduce void spaces by dropping a heavy weight onto the ground surface. The compaction process can reduce the hydraulic conductivity of subsurface soils and, correspondingly, the mobility of contaminants. Because the compactive energy attenuates with depth, dynamic compaction is limited to shallow applications typically less than 3 m (10 ft). Dynamic compaction is rejected in this FS as a standalone action, because the chemicals and radionuclides at these sites are deep and compaction would not be effective. Dynamic compaction is retained in the FS as an element of capping; this technology frequently is used to prepare a waste site for cap construction.

Deep soil mixing uses large augers (mixers) and injector head systems to inject and mix solidifying agents (cement or pozzolanic based) into contaminated soil in place. The process reduces the mobility of contaminants by entraining them in the solidifying agent. Soil mixing at depth is difficult to implement in rocky soils, and the effectiveness of solidification of the contaminated soil is difficult to monitor and ensure. Soil mixing is rejected for this FS because of the size and depth of the waste sites to be treated and the associated costs.

Natural attenuation is retained for this FS, because it is a natural component of all of the potential alternatives. Natural attenuation is most effective on sites with nonradionuclides that readily degrade in the environment and on sites with radionuclides that have short half-lives, such as Cs-137; however, it is a slow process at sites that have radionuclide with long half-lives (e.g., plutonium and uranium) or nonradionuclides that do not degrade naturally in the environment. It may be the only feasible and cost-effective technology for sites that have deep contamination, because other technologies (e.g., retrieval and in situ treatment) are difficult to implement, ineffective, and cost prohibitive.

4.2.2 Identification and Screening of New or Additional Remedial Technologies

In addition to the technologies identified in the Implementation Plan, retrieval technologies for sludge removal from tanks have been identified as applicable. These technologies are briefly discussed and screened below.

4.2.2.1 Sludge Retrieval

HNF-6354 evaluated four alternatives for retrieving tank wastes at the Hanford Site. Alternatives applicable to retrieving the sludge in the 241-B-361, 241-T-361, and 216-B-201 Settling Tanks, the 200-E-14 Siphon Tank, and the 200-E-45 Sampling Shaft are a sludge retrieval vehicle, power fluidics, sluicing to an interim receiver tank, and mechanical retrieval.

A sludge retrieval vehicle is a hydraulic, motorized, track-driven device that acts as the platform for a high-pressure-water dislodging device and a hydraulic scavenging pump to remove sludge from inside tanks. The vehicle is tethered by an umbilical system that consists of the pump's discharge line, the high-pressure water line, and various hydraulic lines. The vehicle is sized to pass through a tank's center manhole. An umbilical management and hoisting system can be located on the surface. An operator viewing the vehicle through a closed circuit television camera located in one of the tank's smaller risers remotely controls the vehicle.

This vehicle is similar to that demonstrated in past Hanford demonstration test programs and has been demonstrated in radioactive tanks using an on-board pump and dislodger. The Oak Ridge National Laboratory (ORNL) has successfully deployed a similar vehicle in a 15 m (50-ft) diameter radioactive waste tank. The ORNL vehicle uses a confined sluicer and jet pump to remove waste from the tank. The vehicle can be modeled after commercially available hardware that is used routinely in private industry to clean out large hydrocarbon tanks. One vendor (Environmental Specialties Group) has 600 units in use with over 30,000 hours of operating time in total.

Power fluidics is the technology of moving and controlling large-scale fluid flows of process fluids including sludge, using devices with no mechanical moving parts that operate on fluid phenomena such as the Bernoulli effect, entrainment, vortex, and surface tension. Such devices have been used with good reliability in the United Kingdom for the past 20 years in 400 systems of pumps, mixers, and samplers. They are particularly well suited to sludge pumping because of the absence of moving parts as the primary pumping equipment.

A successful application of a pulse jet system at the Bethel Valley Evaporator Service Tanks at Oak Ridge, in which approximately 20,000 gal of sludge were removed, is presented in Schwart and Billingsley 1998, "Technology and Teamwork Equal Empty Tanks."

Another retrieval method is sluicing to an interim receiver tank. This concept would include removal of sludge from tanks by sluicing with a suitable nozzle mounted from the top of the tank, employing a submersible pump lowered to the bottom of the tank through one of the existing manholes, and having an interim storage tank on the surface that would act as a sluicing source tank. This tank would have to incorporate a sluicing pump and an agitator to mix the slurry feed to facilitate transfer to a cementation process.

This concept requires waste slurry handling on the surface, including the pumping of contaminated supernatant back into the tank and decanting the slurry on the surface. The amount of new water introduced to the waste slurry would be equal to or greater than that for the sludge retrieval method.

Direct pumping, for example with a pneumatic diaphragm pump or a septic tank-type suction pump adapted for radiological service, is another method of sluicing.

Finally, mechanical retrieval of sludge from the Hanford Site tanks would include a robotic tracked vehicle equipped with a plow blade that would dislodge the waste sludge and introduce it to a mechanical conveyor, which then would transfer the waste to the surface. The potential advantage of this option is that little additional water would be added to the sludge. A significant amount of water would have to be used to decontaminate the conveyor upon completion of the retrieval process. This concept would require a relatively complex mechanical conveyor to move the sludge on the surface. The conveyor would become highly contaminated and might prove difficult to decontaminate.

4.3 SUMMARY OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS RETAINED FOR 200-TW-1, 200-TW-2, AND 200-PW-5 OPERABLE UNIT ALTERNATIVE DEVELOPMENT

Based on the screening presented in Section 4.2, the following remedial technologies and process options were retained for development of the 200-TW-1 OU, 200-TW-2 OU, and 200-PW-5 OU-specific remedial alternatives (see Table 4-1 also):

- No action
- Land use restrictions – technology
  - Deed restrictions – process option
- Access control – technology
  - Signs/fences – process option
  - Entry control – process option
- Monitoring – technology
  - Groundwater – process option
  - Vadose zone – process option
  - Air – process option
- Surface barrier – technology
  - Soil cover – process option
- Surface barrier/cap – technology
  - ET barriers – process option
  - Hanford Barrier – process option
  - Modified RCRA Type C Barrier – process option
- In situ grouting – technology (fill tanks and pipeline voids)
- Excavation – technology (including sludge removal)

  - Onsite and offsite landfill disposal – process option
- In situ treatment – technology
  - Natural attenuation. – process option

Table 4-1. Technology Types and Process Options for Soil and Sludge. (2 Pages)

General Response Action	Technology Type	Process Option	Retained in Implementation Plan	Retained in Feasibility Study for 200-TW-1, 200-TW-2, and 200-PW-5 Operable Units
No Action	None	Not Applicable	Yes	Yes
Institutional Controls	Land Use Restrictions	Deed Restrictions	Yes	Yes
	Access Controls	Signs/Fences	Yes	Yes
		Entry Control	Yes	Yes
	Monitoring	Ground Water	Yes	Yes
		Air	Yes	Yes
	Surface Barriers	Existing Soil Cover	No	Yes
Containment, Including Evapotranspiration Barriers	Surface Barriers	Hanford Barrier	Yes	Yes
		Modified RCRA and other ET Caps	Yes	Yes
		Standard RCRA Caps	No	No
		Asphalt, concrete, or cement-type cap	No	No
	Vertical Barriers	Slurry Walls	Yes	Yes
		Grout Curtains	Yes	Yes
Removal	Excavation	Conventional	Yes	Yes
		High contamination	No	Yes
		Sludge Retrieval	No	Yes
Disposal	Landfill Disposal	Onsite Landfill	Yes	Yes
		Offsite Landfill/Repository	Yes	Yes
Ex Situ Treatment	Thermal Treatment	Thermal Desorption	Yes	No
		Vitrification	Yes	No
	Physical/Chemical Treatment	Vapor Extraction	Yes	No
		Soil Washing	Yes	No
		Mechanical Separation	Yes	No
		Solidification/ Stabilization	Yes	No
		Soil Mixing	Yes	Yes

Table 4-1. Technology Types and Process Options for Soil and Sludge. (2 Pages)

General Response Action	Technology Type	Process Option	Retained in Implementation Plan	Retained in Feasibility Study for 200-TW-1, 200-TW-2, and 200-PW-5 Operable Units
In Situ Treatment	Thermal Treatment	Vitrification	Yes	No
	Chemical/Physical Treatment	Vapor Extraction	Yes	No
		Grout Injection (pipelines and tanks)	Yes	Yes
		Deep Soil Mixing	Yes	No
		Dynamic Compaction (component of capping)	Yes	Yes
	Natural Attenuation	Natural Attenuation	Yes	Yes

ET = evapotranspiration.

RCRA = *Resource Conservation and Recovery Act of 1976.*

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5.0 REMEDIAL ACTION ALTERNATIVES

The EPA guidance for conducting feasibility studies under CERCLA recommends that a limited number of technologies be carried forward from the technology identification and screening activity; these technologies then are grouped into remedial alternatives to address the site-specific conditions. In Chapter 4.0, technologies were identified and screened based on site-specific characteristics and contaminants of concern. In this chapter, these technologies are grouped into remedial alternatives to address site contamination problems. Several remedial alternatives are developed and described in this chapter for the waste sites in the 200-TW-1, 200-TW-2, and 200-PW-5 OUs. The applicability of these alternatives to the individual waste sites also is considered.

5.1 DEVELOPMENT OF ALTERNATIVES

Significant efforts and evaluations have contributed to defining applicable technologies and process options that address the 200-TW-1, 200-TW-2, and 200-PW-5 OU representative and analogous waste sites. The Implementation Plan (DOE/RL-98-28), Appendix D, provides initial information on identification and screening of remedial technologies for 200 Areas waste sites. The Implementation Plan, in conjunction with Chapter 4.0 of this FS, represents a Phase I FS and thus forms the basis for the development of remedial alternatives. The Implementation Plan also preliminarily develops remedial alternatives based on the results of the technology screening and the GRAs identified for the waste sites. Remedial alternatives identified in the Implementation Plan for the 200-TW-1, 200-TW-2, and 200-PW-5 OUs include the following:

- No action
- Monitored natural attenuation/institutional controls
- Removal, treatment, and disposal (onsite disposal and geologic repository)
- Containment using surface barriers
- In situ grouting or stabilization
- In situ vitrification.

Table 5-1 illustrates the process of identifying technology types, combining process options, and presenting the elements of each alternative. The no-action alternative is a requirement under CERCLA. The monitored natural attenuation/institutional controls alternative is retained and further developed in this FS for sites where existing remedial actions are in place or where contamination is expected to reach RAOs within a reasonable institutional controls period. The removal, treatment, and disposal alternative and the containment using surface barriers alternative also are retained and further developed in this FS. The in situ grouting or stabilization and in situ vitrification alternatives, as stand-alone alternatives, are screened out of this FS because of implementation problems associated with the depth of contamination at the waste sites, because of effectiveness issues with ensuring a complete stabilization of contaminated materials, and because of high cost in relation to other alternatives. These technologies are, however, retained for inclusion as elements of other remedial actions. One additional alternative is developed in this FS that was not identified in the Implementation Plan. This alternative is a combination alternative that includes partial removal, treatment, and disposal with subsequent capping. The following subsections further develop and describe the alternatives.

One important factor in the development of site-specific remedial alternatives is that radionuclides, heavy metals, and some inorganic compounds cannot be destroyed. As such, these compounds must be physically immobilized, contained, or chemically converted to a less mobile or less toxic form to meet the RAOs.

5.2 DESCRIPTION OF ALTERNATIVES

This section provides a description of the alternatives considered for evaluation in this FS, including the following:

- Alternative 1 – No Action
- Alternative 2 – Maintain Existing Soil Cover, Monitored Natural Attenuation, and Institutional Controls
- Alternative 3 – Removal, Treatment, and Disposal
- Alternative 4 – Capping
- Alternative 5 – Partial Removal, Treatment, and Disposal With Capping.

5.2.1 Alternative 1 – No Action

The NCP (40 CFR 300), requires that a no-action alternative be evaluated as a baseline for comparison with other remedial alternatives. The no-action alternative represents a situation where no legal restrictions, access controls, or active remedial measures are applied to the site. No action implies "walking away from the waste site" and allowing the wastes to remain in their current configuration, affected only by natural processes. No maintenance or other activities are instituted or continued. Selecting the no-action alternative would require that a waste site pose no unacceptable threat to human health or the environment.

Based on the waste site evaluations and the results of the risk assessment, none of the representative sites meet the RAOs using the no-action alternative. The no-action alternative is carried forward in this FS for comparison purposes and to address analogous waste sites that are expected to meet the RAOs and PRGs without any action.

5.2.2 Alternative 2 – Maintain Existing Soil Cover, Monitored Natural Attenuation, and Institutional Controls

This alternative takes advantage of existing soil covers and the nature of the contaminants (such as the natural attenuation of Cs-137 and Sr-90, which have relatively short half-lives), in combination with institutional controls, to provide protection of human health and the environment. Monitoring is also an element of this alternative. For most of the waste sites in these OUs, an existing soil cap is present that is associated with the actual construction of the waste site (i.e., the waste site was constructed at depth and clean backfill was placed in the excavation to the surface) and with surveillance and maintenance activities, where additional soil was added to stabilize the waste sites. Under this alternative, these existing soil covers would be maintained and/or augmented as needed to provide protection from intrusion by human and/or biological receptors. Institutional controls, including legal and physical barriers, also would be used to prevent human access to the site. The existing soil covers and/or caps would break the pathway between human and ecological receptors and the contaminants. WAC 173-340-745(7), "Soil Cleanup Standards for Industrial Properties," "Point of Compliance," identifies the points of compliance for different pathways as follows.

- "For soil cleanup levels based on protection of groundwater, the point of compliance shall be established in the soils throughout the site."
- "For soil cleanup levels based on protection from vapors, the point of compliance shall be established in the soils throughout the site from the ground surface to the uppermost groundwater saturated zone."
- "For soil cleanup levels based on human exposure via direct contact or other exposure pathways where direct contact with the soil is required to complete the pathway, the point of compliance shall be established in the soils throughout the site from the ground surface to fifteen feet below the ground surface."

WAC 173-340-7490, "Terrestrial Ecological Evaluation Procedures," specifies a standard point of compliance at 4.6 m (15 ft) for ecological receptors; institutional control is not required under this option. WAC 173-340-7490 also specifies a conditional point of compliance at the biologically active soil zone, with a requirement for institutional controls. The regulation assumes a 1.8 m (6-ft) bgs biologically active zone, but a site-specific zone may be established.

Based on literature searches regarding the root and burrowing depths of vegetation and animals present on the Hanford Site, a sufficient soil thickness to prevent biological intrusion generally would be 2.4 to 3.0 m (8 to 10 ft). Many of the 200-TW-1, 200-TW-2, and 200-PW-5 OU waste sites have a soil cover (i.e., surface stabilization, backfill) over the contaminated zone of 3 m (10 ft) or more. Table 2-7 provides the depth to the top of the contamination at the waste sites. This depth is also the thickness of the clean cover for most of the sites.

Institutional controls involve the use of physical barriers (fences) and access restrictions (deed restrictions) to reduce or eliminate exposure to contaminants of concern. Institutional controls also can include groundwater, vadose, surface soil, biotic, and/or air monitoring. Institutional controls for this alternative include periodic surveillance of the waste sites for evidence of contamination and biologic intrusion; emplacement of vegetation, herbicide application, manual removal, or other activities to control deep-rooted plants; control of deep-burrowing animals; maintenance of signs and/or fencing; maintenance of the existing soil cover (including an assumed periodic addition of soil); administrative controls; and site reviews.

For sites having a clean soil cover of less than 4.6 m (15 ft), more stringent institutional controls (e.g., physical and legal barriers) would need to be implemented to address potential risks from direct human and ecological contact with the contaminants. Water- and land-use restrictions also would be used to prevent exposure.

Contaminants remaining beneath the clean soil cover would be allowed to naturally attenuate until remediation goals are met. Natural attenuation relies on natural processes to lower contaminant concentrations until cleanup levels are met. Monitored natural attenuation would include sampling and/or environmental monitoring, consistent with EPA guidance (EPA/540/R-99/009, *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites November 1997*, OSWER Directive No. 9200.4-17P*)*, to verify that contaminants are attenuating as expected. Attenuation monitoring activities could include monitoring of the vadose zone using geophysical logging methods or groundwater monitoring to verify that natural attenuation processes are effective.

The existing network of groundwater monitoring wells in the Central Plateau is adequate for monitoring most sites, in coordination with the groundwater OUs (200-BP-5, 200-PO-1, 200-UP-1, and 200-ZP-1). Where the existing network is unsatisfactory (e.g., the BC Cribs and Trenches Area), additional monitoring wells are planned. If remediation activities result in the decommissioning of groundwater monitoring wells in the area of remediation, an evaluation of future monitoring needs will be conducted.

5.2.3 Alternative 3 – Removal, Treatment, and Disposal

Under this alternative, contaminated soil would be removed, treated as required to meet PRGs and waste acceptance criteria, and disposed of to an appropriate facility. A generalized cross-section is shown in Figure 5-1. The disposal facility chosen depends on the type of waste to be disposed. The majority of the waste generated under this alternative would be disposed of at the ERDF. For waste sites with transuranic constituents above levels of concern (i.e., 100 nCi/g), disposal to a geologic repository would be required. One of the representative sites, 216-B-7A Crib, was found to have concentrations of Pu-239/240 above 100 nCi/g. Process knowledge indicates the potential for five other suspected waste sites to contain transuranic constituents above levels of concern: the 216-B-5 Injection/Reverse Well, the 216-T-3 Injection/Reverse Well, the 216-T-6 Crib, the 216-T-32 Crib, and the 216-B-53A Trench.

5.2.3.1 Sites Without Concentrations of Transuranic Constituents at Levels of Concern

Soil and associated structures (such as cribs) with contaminant concentrations above the PRGs would be removed using conventional excavation techniques where appropriate, or specialized excavation techniques where contamination levels require added protection (these specialized techniques are discussed in greater detail in Chapter 4.0). Excavated materials would be disposed of at an approved disposal facility, currently envisioned as the ERDF. Precautions would be used to minimize the generation of onsite fugitive dust. Depending on the configuration and depth of the area to be excavated, shoring might be required to comply with safety requirements and to reduce the quantity of excavated soil. The depth, and therefore the volume, of soil removed largely depend on the categories of PRGs that are exceeded. For example, if human health direct-contact or ecological PRGs are exceeded, removals generally would be conducted to a maximum of 4.6 m (15 ft) in line with the points of compliance identified in WAC 173-340-745 and WAC 173-340-7490. Conversely, if groundwater protection is required, soils would be removed to meet groundwater protection PRGs, as shown in Table 5-2. Below-grade structures extending below 4.6 m (15 ft) would be removed, if practicable, or stabilized in place.

The remediation of soil and associated structures for this alternative would be guided by the observational approach. The observational approach is a method of planning, designing, and implementing a remedial action that relies on information (e.g., samples, field screening) collected during remediation to guide the direction and scope of the effort. Data are collected to assess the extent of contamination and to make "real-time" decisions in the field. Targeted (or hot spot) removals could be considered under this alternative if contamination were localized in only a portion of a waste site.

Based on existing information, soil and/or debris removed from the waste sites do not require ex situ treatment to meet ERDF waste acceptance criteria (BHI-00139, *Environmental Restoration Disposal Facility Waste Acceptance Criteria*). However, additional activities are required to meet health and safety requirements during excavation, handling, transportation, and disposal. Highly contaminated soil will be blended with less contaminated soil to achieve ALARA goals and to reduce worker risks at all points in the removal and disposal process. Contaminated soil, structures, and well casings will be containerized (e.g., containers, burrito wraps, bulk shipment) on site and transported to the ERDF, located in the 200 West Area.

After the PRGs are met, uncontaminated soil would be used to backfill the excavation. The backfill material could be found at a variety of sources, including local borrow pits and any remaining excavated material that is determined to be clean (verified as clean by meeting the PRGs). Following remediation, the site will be recontoured, resurfaced, and/or revegetated to establish natural site conditions. Maintenance of the site is required until the vegetation is sufficiently established to prevent intrusion by noxious, non-native plants such as cheatgrass or Russian Thistle.

5.2.3.2 Sites Potentially Contaminated with Transuranic Constituents at Levels of Concern

The 216-B-7A Crib has plutonium levels that exceed the TRU definition (>100nCi/g) as identified through DOE/RL-2002-42. The plutonium contamination is confined to a relatively thin layer at the bottom of the crib, approximately 5.6 m (18.5 ft) bgs. The associated 216-B-7B Crib also may contain transuranic constituents above 100 nCi/g, but this is less likely because the 216-B-7A Crib is believed to have received the majority of the waste that went to these sites. The following waste sites may have concentrations of transuranic constituents above levels of concern: 216-B-5 Injection/Reverse Well, 216-T-3 Injection/Reverse Well, 216-T-6 Crib, 216-T-32 Crib, and 216-B-53A Trench. All the waste sites with transuranic constituents potentially above 100 nCi/g are classified as pre-1970s waste sites, because disposal to all these waste sites occurred in the 1950s and 1960s.

Under this alternative, contaminated soil would be retrieved, verified as non-TRU waste or TRU waste by sampling and analysis, treated if necessary, temporarily stored, and disposed of at the Waste Isolation Pilot Plant, if required. Excavation of soil and waste containing transuranic constituents at levels of concern has been performed at many DOE sites, including Hanford, Idaho National Engineering and Environmental Laboratory, Rocky Flats, Savannah River, and others (INEEL-01-00281). For soil sites, standard or modified excavation equipment would be used to retrieve the soil and waste until PRGs are met. Equipment for removal of transuranic-contaminated soil and waste is proven and available. Any clean overburden soil removed would be stockpiled in an adjacent on-site area. Precautions would be used to minimize the generation of onsite fugitive dust. Depending on the configuration of the area to be excavated, shoring might be required to comply with safety requirements and to reduce the quantity of excavated soil. Characterization before excavation would be required to confirm that TRU levels exist at the waste site and to minimize the amount of soil and waste classified as TRU. TRU and non-TRU soils and waste would be segregated during retrieval and would be tested further to minimize the amount disposed of at the Waste Isolation Pilot Plant. Wastes acceptable for disposal at the Waste Isolation Pilot Plant would be sent there, and treatment is not deemed necessary to meet waste acceptance criteria. Packaging of the soil and waste for disposal at the Waste Isolation Pilot Plant most likely would occur at the site during excavation, but also could be performed in a separate storage facility. Details would be determined during design, once more precise information on the location, volume, and concentration of TRU contamination were determined.

Following retrieval of the waste, the site would be backfilled with clean soil and recontoured, resurfaced, and/or revegetated to establish natural site conditions. Maintenance of the site is required until the vegetation is sufficiently established to prevent intrusion by noxious, non-native plants such as cheatgrass or Russian Thistle.

5.2.4 Alternative 4 – Capping

The capping alternative consists of constructing surface barriers over contaminated waste sites to control the amount of water that infiltrates into contaminated media, to reduce or eliminate leaching of contamination to groundwater. In addition to their hydrological performance, barriers also can function as physical barriers to prevent intrusion by human and ecological receptors, limit wind and water erosion, and attenuate radiation. Additional elements to the capping alternative include institutional controls, discussed earlier, and monitored natural attenuation, where contamination undergoes natural processes in a reasonable amount of time. This is particularly important for waste sites that have elevated contamination levels with depth that pose a threat to groundwater or to potential intruders past the institutional controls period. For example, many of the waste site bottoms are located below 4.6 m (15 ft), so the soil above the waste site is clean backfill. However, in association with the waste site bottoms, sampling has shown elevated concentrations of radionuclides (mainly Cs-137 and Sr-90) extending from the bottom of the waste site for tens of feet. More mobile contaminants also are found at depth in the waste sites. This contamination presents a zone of exposure to future intruders to the waste sites and a potential threat to the groundwater. Therefore, the capping alternative would have to consider layers or other actions that would prevent, or at least warn, potential intruders of the hazard.

The preferred capping technology for the Hanford Site is an ET barrier, as shown in Figure 5-2. The ET surface barriers rely on the water-holding capacity of a soil, evaporation from the near-surface, and plant transpiration to control water movement through the barrier. The TRU sites would require the Hanford Barrier (Figure 5-3). Non-TRU sites could have a variety of ET barriers; the most appropriate one would be determined during design. The Modified RCRA C Barrier design (Figure 5-4) is used as the basis for evaluating this alternative; this does not preclude the use of other ET designs (e.g., monolithic barrier). Both monolithic and capillary barriers have been shown to be equivalent to or to exceed the performance of the standard RCRA Subtitle C Barrier design, and both have been approved or planned for use in several western states (EPA 2003, *Remediation Technology Descriptions*, "Alternative Landfill Cover Project Profiles"; and DOE/RL-93-33). If capping is identified as the preferred alternative, finalization of site-specific designs will occur as part of the remedial design process and will consider the RAOs and requirements defined in the ROD, regulatory design and performance standards, material availability, cost effectiveness, current surface barrier technology information, and site-specific hydrologic and physical performance requirements to ensure waste containment. Different waste sites likely will have varying barrier performance requirements, and more than one barrier design (e.g., monolithic and capillary barrier) may be deployed to address waste site capping needs.

When groundwater protection is required, the cap will limit the infiltration of precipitation. When the prevention of ecological and human intrusion is a performance requirement, then the physical barrier components to the cap become more important. The capping alternative includes provisions for groundwater monitoring for those waste sites with contamination predicted to threaten groundwater maximum concentration levels.

Performance monitoring of the Hanford Barrier, installed at the 216-B-57 Crib in 1994, has shown essentially no water infiltration through the barrier (CP-14873). The effectiveness of the cap is related to the design, which must be specific to the conditions at the waste site, and to continued monitoring activities. Some recent preliminary fate and transport modeling for the BC Cribs and Trenches area has shown that reducing the infiltration rate to 0.1 mm/yr by use of a cap would cause a five-fold reduction in the resulting groundwater concentration versus that for uncapped sites. Additional modeling will be needed to design an appropriate cap to achieve the most effective protection of groundwater.

Use of a capping alternative would require an assessment of the lateral extent of contamination during the confirmatory and/or remedial design sampling phases to properly size the cap to ensure containment. The site-specific extent of contamination can be assessed using a variety of approaches including, but not limited to, process knowledge, previous site investigations, geophysical logging, and/or soil sampling. Some degree of oversizing of the barrier beyond the footprint of the waste zone (referred to as overlap) is expected and is dependent on the barrier design used and the depth of contamination. For the purposes of this FS, an overlap of 6.1 m (20 ft) is assumed based on the performance of the Hanford Barrier. The type and availability of barrier construction materials also is a design consideration. The results of the most recent investigation (BHI-01551, *Alternative Fine-Grained Soil Borrow Source Study Final Report*) will be considered during remedial design for selection of the barrier construction materials.

Caps require surveillance and maintenance throughout their life to ensure continued protection. To ensure that the cap is performing as designed, performance monitoring will be conducted. The performance monitoring for this alternative will be twofold. The first component is groundwater monitoring. The second component is vadose zone monitoring, if practical. This FS assumes a fairly robust performance monitoring effort during the first 5 years after construction, followed by a more focused effort in subsequent years. The effectiveness of institutional controls to maintain the cap becomes uncertain past 150 years. For the majority of the sites in this FS, a design life of 500 years is considered sufficient, because the contaminants decay to protective levels at the surface within 500 years. For barriers that use naturally stable geologic materials, the key factor establishing life expectancy is projected wind-erosion rates, which will be minimized by maintaining the vegetation cover, adding gravel to the upper portion of the surface layer, or by using other armoring methods.

5.2.5 Alternative 5 – Partial Remove and Disposal with Capping

Under Alternative 5, contaminants would be removed to the maximum depths listed in Table 5-3. Following excavation, the waste site would be backfilled with clean borrow soil and capped as discussed above. These activities would remove a fraction of the near-surface contaminant load. The removal, treatment, disposal, and capping activities would be the same as or similar to those described in Chapter 4.0 and in the preceding subsections. However, removal activities would not be aimed at removing all contaminants in the vadose zone. They would be aimed at reducing the mass of contaminants associated with the bottom of the waste site, which would, in turn, reduce the potential intruder risk. The disposal options would be the same. The required cap would be less rigorous than if these contaminants were left in place because the inadvertent intruder risk is significantly reduced. For example, instead of a Hanford Barrier, a monofill soil barrier may be appropriate. The actual design of the barrier would be determined through the detailed design activities. Table 5-3 lists the contamination zone for each representative site and for those analogous sites with sampling data. If contaminants are not in the 0 to 4.6 m (0 to 15-ft) zone, then the resulting risk reduction to humans and ecological receptors from direct contact to shallow-zone contamination would be zero. The point of compliance for direct exposure is the 0 to 4.6 m (0 to 15-ft) zone, so contaminants deeper than this only would reduce the risk to intruders. Contaminants that impact the groundwater are located deeper in the vadose zone than 6.1 m (20 ft). Therefore, the removal of contaminants from the 0 to 6 (0 to 20-ft) zone would not significantly change the risk to groundwater. The capping activity provided in this alternative would address protection of groundwater from the remaining contaminants in the vadose zone. Institutional controls would be an additional requirement for this alternative, because contamination above PRGs is left on site.

5.3 INDEPENDENT WORK ACTIVITIES

This section provides discussion of additional work activities that are independent of the remedial actions. Sludge removal is assumed in this FS, given the potential nature and volume of sludge material in the four tanks in these OUs. However, further analysis during the confirmatory sampling activities may result in other options for the sludge. These options will be evaluated following the confirmatory sampling activities at the tanks.

5.3.1 Sludge Removal at the 241-B-361 and 241-T-361 Settling Tanks

Alternatives for these tanks were evaluated by comparing two previous studies. The first study, HNF-6354, *Tank 241-Z-361 Sludge Retrieval and Treatment Alternatives*, was reviewed to assess applicable sludge-removal options with respect to the 241-B-361 and 241-T-361 Settling Tanks and the follow-up report *Tank 241-Z-361 Engineering Evaluation/Cost Analysis*. Based on the review, all the options studied in HNF-6354 could apply to the tanks. DOE/RL-2003-52 looked at three options, in situ vitrification, in situ stabilization, and ex situ retrieval, treatment, and storage. All options present challenges. However, because of the amount and nature of material in the tanks (as predicted by BHI-01018, Rev. 2, *Environmental Restoration Contractor Management Plan for Inactive Miscellaneous Underground Storage Tanks*, removal and ex situ treatment of the sludge is assumed. Furthermore, by opening the 241-B-361and 241-T-361 Settling Tanks, 10 CFR 830, "Nuclear Safety Management," implementation is expected to result in the tanks being classified as nuclear facilities. Based on the predicted inventory in the tanks, special safety precautions are required. These requirements will be developed during the remedial design phase.

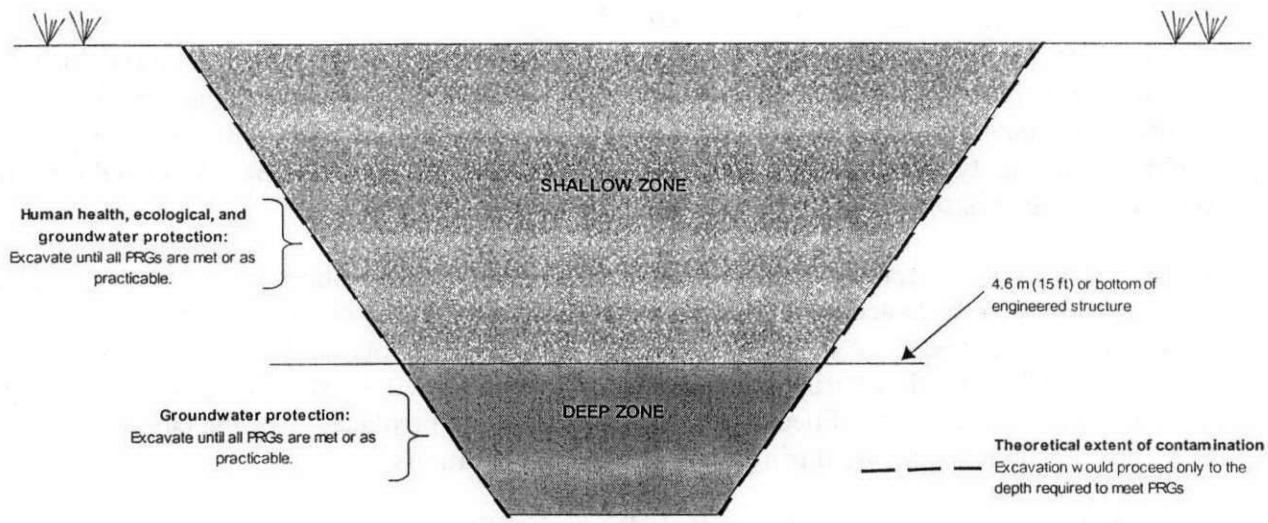
As currently envisioned, removal and disposal of the sludge will be implemented by excavating to the top of the tanks to access the 1.2 m (4-ft) diameter manhole covers. The sludge then can be mixed and retrieved from the manholes into an applicable container (e.g., high-integrity containers [HIC] with dewatering capabilities). These HICs will be shielded as needed, using a section of concrete culvert. If necessary, shielding also can be placed over the tank and manhole to reduce personnel exposure during sludge-removal operations.

Water removed during dewatering of the sludge in the HICs can be returned to the tanks to assist in sluicing sludge from the tanks. The water removed during dewatering can be contained and transported for treatment and disposal at the 200 Areas Effluent Treatment Facility. During sludge-removal operations, high-efficiency particulate air (HEPA) -filtered exhausters can be attached to a riser to control airflow through the manholes, into the tanks, and out the risers, thereby reducing potential airborne contamination at the work areas.

The tank contents would be sampled before they were removed to determine sludge handling, packaging, treatment, and disposal options. If, subsequent to sampling and analysis, the waste were verified to be TRU, solidification likely would be required to meet the waste acceptance criteria at the Waste Isolation Pilot Plant. The containers would be stored on the Hanford Site at the T Plant Canyon Building and shipped to the Waste Isolation Pilot Plant.

If sludge is present in the 216-BY-201 Settling Tank and/or the 200-E-14 Siphon Tank, then they would be addressed the same as the 241-B-361 and 241-T-361 Settling Tanks.

Figure 5-1. Generalized Removal, Treatment, and Disposal Alternative.



PRG = preliminary remediation goal.

Figure 5-2. Evapotranspiration Barrier.

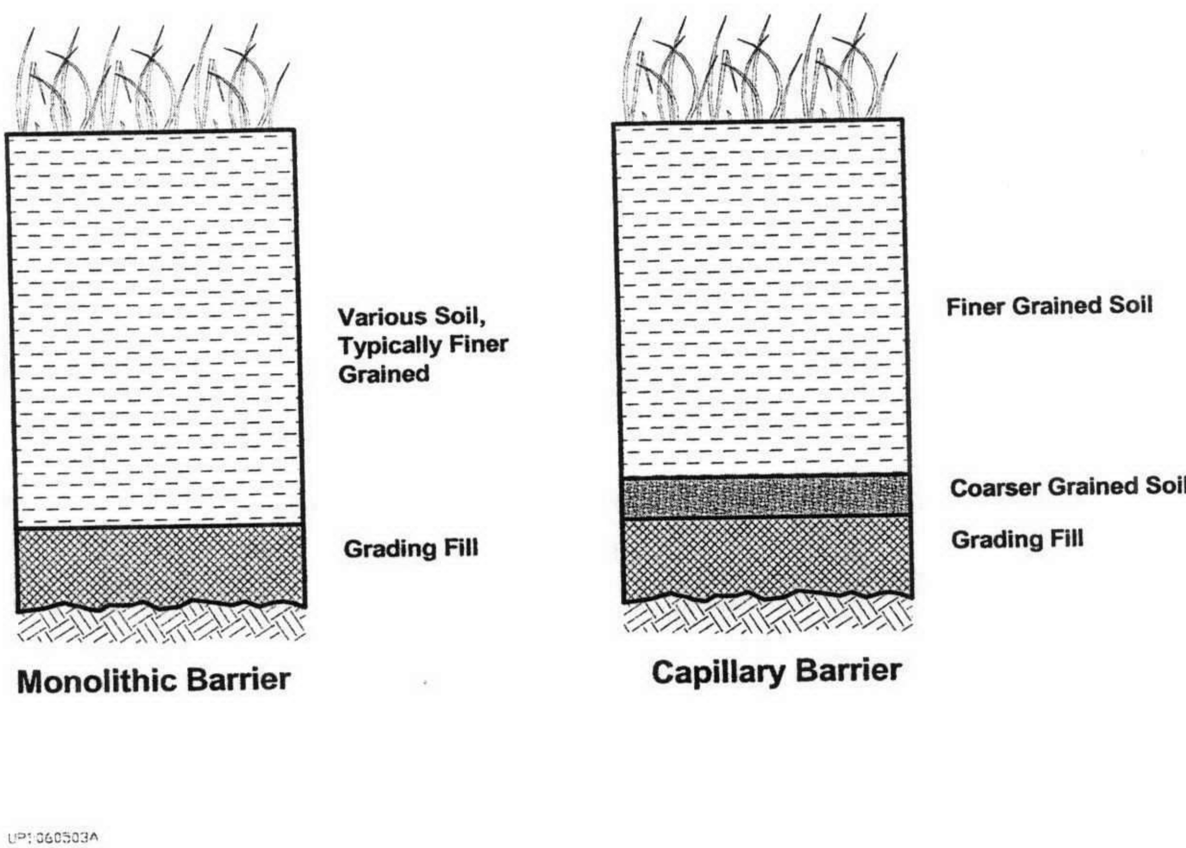


Figure 5-3. Hanford Barrier.

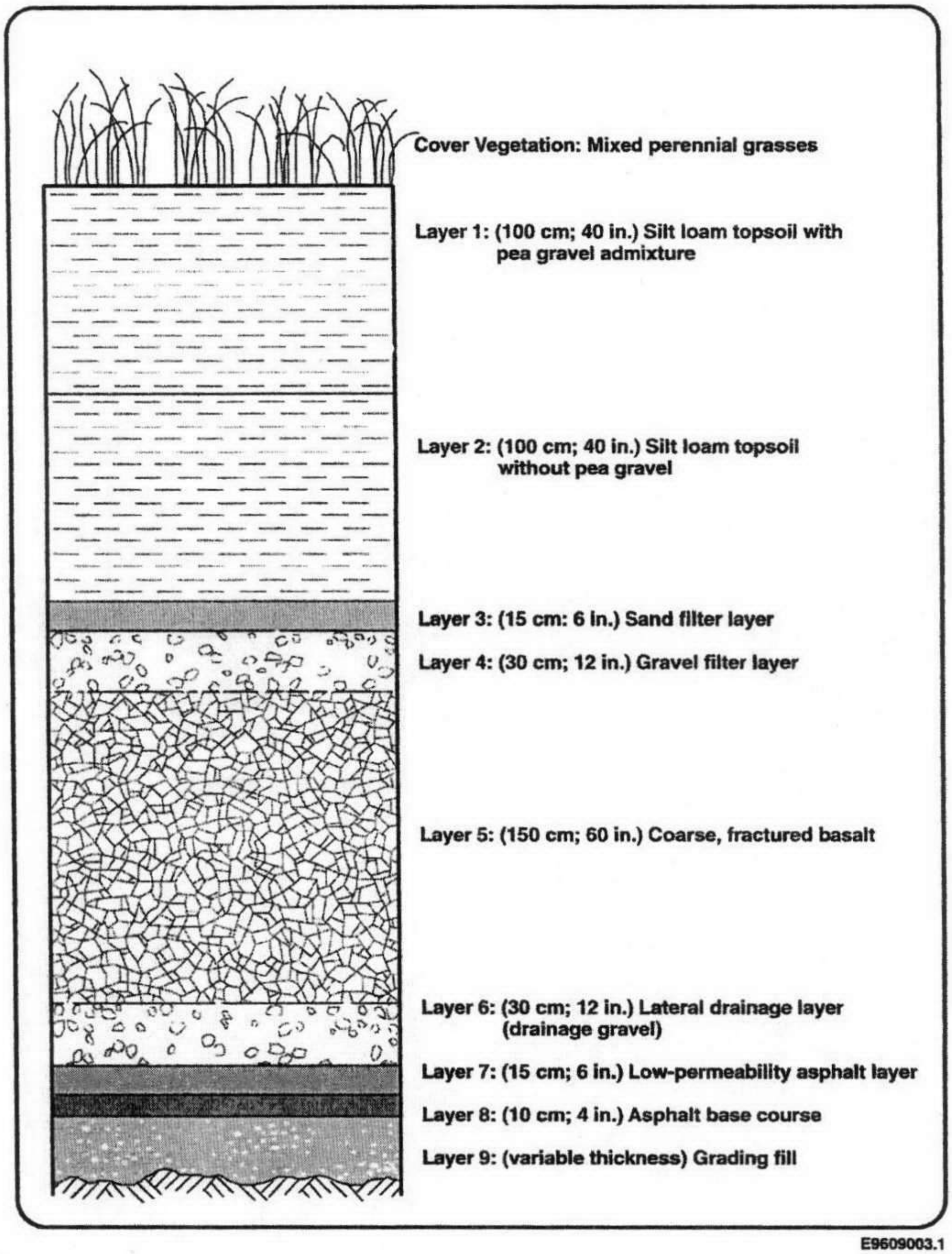


Figure 5-4. Modified RCRA C Barrier.

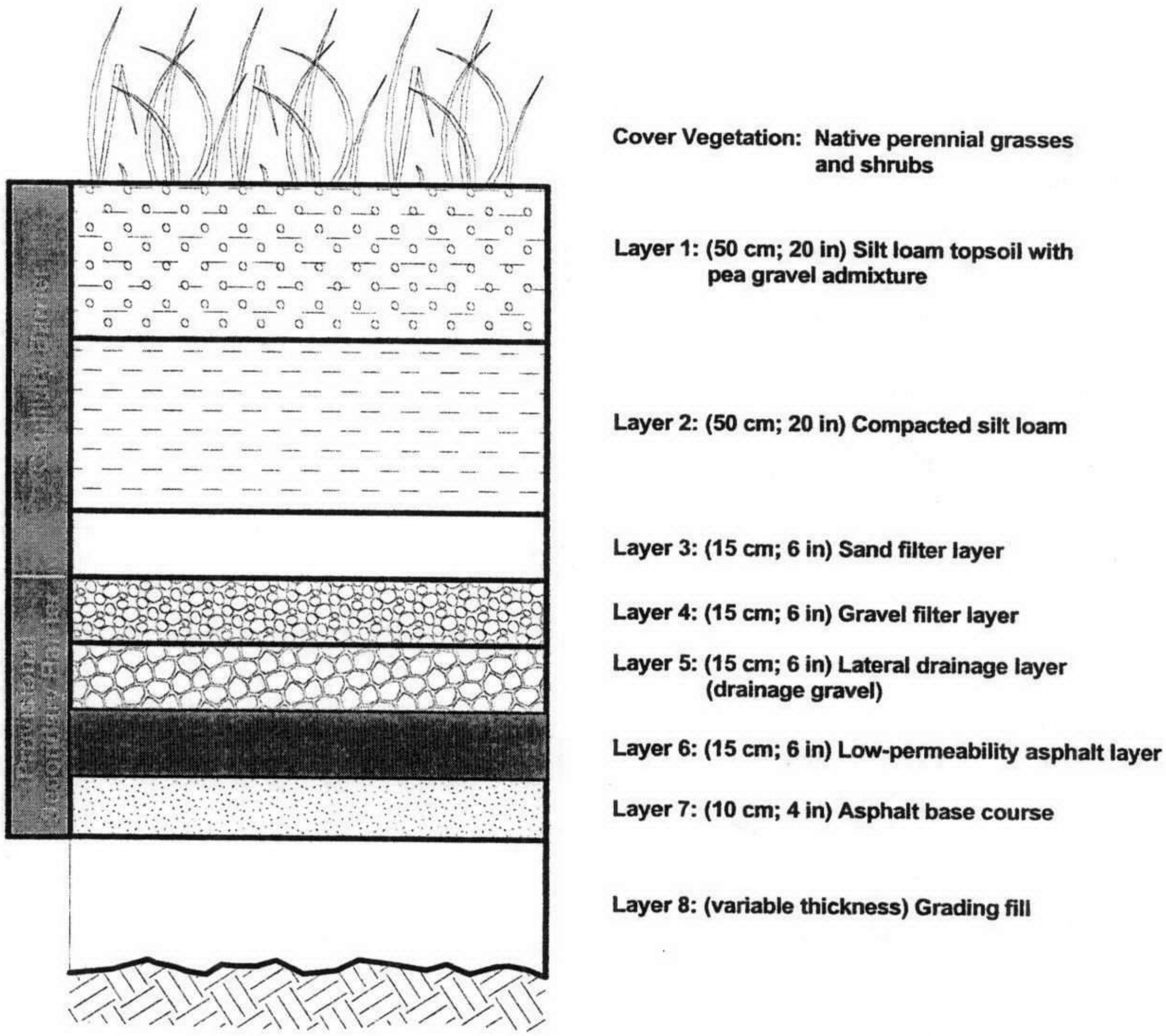


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Table 5-1. Summary of Remedial Alternatives and Associated Components.

Technology Type	Process Option	Alternative 1 - No Action	Alternative 2 - Maintain Existing Soil Cover, Monitored Natural Attenuation, and Institutional Controls	Alternative 3 – Removal, Treatment, and Disposal	Alternative 4 - Capping	Alternative 5 - Partial Removal, Treatment, and Disposal with Capping
No action	No action	X				
Land-use restrictions	Deed restrictions		X	X	X	X
Access controls	Signs/fences		X	X	X	X
	Entry control		X	X	X	X
Monitoring	Groundwater		X	X	X	X
	Vadose zone				X	X
	Air		X	X	X	X
Surface barriers	Existing soil cover		X			
	Evapotranspiration barriers				X	X
	Engineered arid climate barriers				X	
In situ physical treatment	Grouting				X[a]	
Ex situ physical treatment	Soil mixing			X		X
Removal	Conventional excavation			X		X
	Excavation in high-contamination areas			X		X
	Sludge removal		X	X	X	X
Landfill disposal	Onsite landfill			X		X
	Offsite landfill/repository			X[b]	X[b]	X[b]
Monitored natural attenuation	Monitored natural attenuation	X	X	X	·X	X

[a]For filling pipelines or tanks or for stabilizing cribs or other structures to prepare for placement of a cap.
[b]Disposal of sludge from 241-B-361 and 241-T-361 Settling Tanks and of soils from waste sites with transuranic constituents at concentration of concern (i.e., greater than 100 nCi/g).

Table 5-2. Depth of Excavation for Alternative 3 - Removal, Treatment, and Disposal.

Representative Site	Depth of Overburden (ft bgs)	Depth of Contaminated Soil (ft bgs)	Total Depth of Excavation (ft bgs)
216-B-46 Crib	18	220	220
216-T-26 Crib	18	200	200
216-B-58 Trench	10	24	24
216-B-43 Crib	18	220	220
216-B-44 Crib	18	220	220
216-B-45 Crib	18	220	220
216-B-47 Crib	18	220	220
216-B-48 Crib	18	220	220
216-B-49 Crib	18	220	220
216-B-5 Injection/Reverse Well	271	285	285
216-B-7A Crib	18	222	222
216-B-38 Trench	15	220	220
216-B-57 Crib	15	177	177
216-B-50 Crib	22	220	220

Table 5-3. Representative Site Partial Removal Alternative.

Representative Site	Depth of Clean Overburden (ft bgs)	Depth of Contaminated Soil (ft bgs)	Potential Greatest Radionuclide Peak (ft bgs)	Total Depth of Excavation (ft bgs)
216-B-46 Crib	18	220	20	25
216-T-26 Crib	18	200	35	40
216-B-58 Trench	10	24	20	25
216-B-43 Crib	18	220	20	25
216-B-44 Crib	18	220	20	25
216-B-45 Crib	18	220	20	25
216-B-47 Crib	18	220	20	25
216-B-48 Crib	18	220	20	25
216-B-49 Crib	18	220	20	25
216-B-5 Injection/Reverse Well	271	285	N/A	N/A
216-B-7A Crib	18	222	23	28
216-B-38 Trench	15	220	20	36
216-B-57 Crib	15	177	35	45
216-B-50 Crib	22	220	20	25

N/A = not applicable.