AR TARGET SHEET

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Draft A

200-SW-1 Nonradioactive Landfills and Dumps Group Operable Unit and 200-SW-2 Radioactive Landfills and Dumps Group Operable Unit Remedial Investigation/Feasibility Study Work Plan

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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Draft A

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EXECUTIVE SUMMARY

This work plan supports the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) remedial investigation/feasibility study (RI/FS) activities for the 200-SW-1 Nonradioactive Landfills and Dumps Group Operable Unit (OU) and 200-SW-2 Radioactive Landfills and Dumps Group OU. This work plan also integrates the *Resource Conservation and Recovery Act of 1976* (RCRA) facility investigation/corrective measures study (RFI/CMS) requirements for specific waste sites within the OUs. The process outlined in the work plan follows the CERCLA format with modifications, as appropriate, to concurrently satisfy RCRA requirements. The application of these processes in the 200 Areas is described in DOE/RL-98-28, *200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program* (Implementation Plan).[1]

This work plan discusses OU-specific background information, defines characterization and assessment activities, defines schedules based on the framework established in the Implementation Plan, and identifies the steps required to complete the RI/FS and closure plan processes for the OUs.

As part of *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1989)[2] (Tri-Party Agreement) change packages M-013-02-01, M-015-02-01, and M-020-02-01, approved in June 2002, the 200-SW-2 OU was consolidated with the 200-SW-1 OU. Tri-Party Agreement Milestone M-13-00O requires that the draft RI/FS (or RFI/CMS) work plan for the consolidated 200-SW-1 and 200-SW-2 OU waste sites be submitted by December 31, 2004.

The 200-SW-1 and 200-SW-2 OUs are described in the Implementation Plan (DOE/RL-98-28) as having 37 and 50 waste sites, respectively (87 total). As a result of reassignments and additions before the RI/FS process began, 32 additional sites were assigned to the 200-SW-1 OU and 8 additional sites to the 200-SW-2 OU. At the beginning of the RI/FS process, the two OUs

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[1]DOE/RL-98-28, 1999, *200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

[2]Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington, as amended.

collectively included 127 waste sites. Of these, 53 were reclassified by the lead regulatory agency as rejected or requiring no action in the *Waste Information Data System*, because they met one of the following criteria:

- Duplicate of another site
- Consolidated with another site
- Already cleaned up
- Otherwise not appropriate for classification as a waste site.

Thirty of these 53 sites are in the 200-SW-1 OU and 23 are in the 200-SW-2 OU. The remaining 74 waste sites were evaluated through the data quality objective (DQO) process as candidates to be considered through the RI/FS process.

The 200-SW-1 Nonradioactive Landfills and Dumps Group OU includes 39 waste sites that will be evaluated subsequent to reclassification. Waste received includes power plant fly ash, unused laboratory and plant chemicals, construction debris, and other miscellaneous nonradioactive solid waste.

The 200-SW-2 Radioactive Landfills and Dumps Group OU includes 35 waste sites that will be evaluated subsequent to reclassification. Waste received includes dry contaminated equipment, debris, solid laboratory waste, and clothing. Wastes were largely solid materials and mostly from on site; however, off site and liquid wastes (tightly packed and sealed in drums) also have been disposed at some locations.

Sites within the 200-SW-1 and 200-SW-2 OUs will be evaluated and remediated as appropriate under a CERCLA approach. The general CERCLA RI/FS process is described in EPA/540/G-89/004, *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, (Interim Final)*, OSWER 9355.3-01.[1] The application of the CERCLA RI/FS process in the 200 Areas is described in the Implementation Plan (DOE/RL-98-28).

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[1]EPA/540/G-89/004, 1988, *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, (Interim Final)*, OSWER 9355.3-01, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C.

The 200-SW-1 and 200-SW-2 OUs consist of RCRA past-practice (RPP) sites with the Washington State Department of Ecology as the lead regulatory agency. The OUs also include two treatment, storage, and/or disposal (TSD) units. One of the TSD units (Nonradioactive Dangerous Waste Landfill) received nonradioactive wastes (200-SW-1 OU); it ceased operations in 1985. The other TSD unit (Low-Level Burial Grounds) has received radioactive and mixed wastes (200-SW-2 OU). The current and future operations of the Low-Level Burial Grounds have been affected by the recently issued Record of Decision for the Solid Waste Program (69 FR 39449, June 30, 2004).[1]

Because of the large number of waste sites remaining in the 200-SW-1 and 200-SW-2 OUs, the initial scoping through the DQO process included an assessment of the possible remedial approaches that could be applied to the various waste site configurations. Based on the conceptual contaminant distribution models and available site information, the waste sites were sorted into categories/bins to align them with the anticipated, appropriate remedial paths. Applicable streamlining concepts identified in the Implementation Plan were incorporated into the different remedial paths. The remedial paths identified for the 200-SW-1 and 200-SW-2 OU waste sites include the following bins:

- Bin 1 – Most (17) of the 20 sites in this bin are nonradioactive (200-SW-1 OU). The sites are predominantly burn pits, ash disposal sites, and locations of random contamination from miscellaneous site activities. The sites are likely to be minimally contaminated; however, the records are sufficiently ambiguous that the contamination status must be confirmed. The anticipated remedial alternatives are no action or maintain existing soil cover/monitored natural attenuation.

- Bin 2 – Two-thirds (20) of these 30 sites are nonradioactive (200-SW-1 OU). All of the sites in Bin 2 are anticipated to contain some amount of contaminated material. Most of the sites consist of material that has been disposed of near the surface and should not

[1]*Federal Register*, Vol. 69, No. 125, pp. 39449-39455, June 30, 2004, "Record of Decision for the Solid Waste Program, Hanford Site, Richland WA; Storage and Treatment of Low-Level Waste and Mixed Low-Level Waste; Disposal of Low-Level Waste and Mixed Low-Level Waste, and Storage, Processing, and Certification of Transuranic Waste for Shipment to the Waste Isolation Pilot Plant."

present significant challenges to remediation. The anticipated remedial alternative is removal, treatment, and disposal, using the observational approach during site remediation as a streamlining strategy for characterization.

- Bin 3 – All but 2 of the 24 sites in this bin contain radioactive contamination (200-SW-2 OU). Bin 3 includes most of the 200 Areas solid waste burial grounds, which typically contain multiple engineered trenches. This group includes the 200-SW-1 OU TSD unit (Nonradioactive Dangerous Waste Landfill) and the 200-SW-2 OU TSD unit (Low-Level Burial Grounds). The anticipated remedial alternative for the TSD unit sites is containment using an engineered surface barrier (i.e., a cap). Remedial alternatives for the remaining Bin 3 sites will be evaluated through the RI/FS process.

A waste site may be reassigned to a different bin if data collected during the remedial investigation indicate that it no longer meets the criteria for assignment to the initial bin.

Potential future actions include the following:

- A no-action determination
- Proceeding directly to site clean-up based on existing knowledge and supported by an observational approach for characterization
- Acquiring additional characterization data (i.e., derived principally through volatile organics, metals, and/or radionuclide screening and/or sampling and laboratory analyses to determine the appropriate remedial pathway)
- Characterization of sites through an RI and evaluation of remedial alternatives through an FS.

Preliminary conceptual contaminant distribution models for each bin in the 200-SW-1 and 200-SW-2 OUs provide an initial prediction of the nature and extent of contamination. For the 200-SW-1 and 200-SW-2 waste sites, contaminant distribution can be described as follows:

- Bin 1 – Waste (if any) is uncontaminated or contained contaminants that have decayed to innocuous levels. Contaminants (if any) are anticipated to be present at or near the ground surface. Groundwater is not impacted by disposal practices.

- Bin 2 – Wastes are disposed at the surface or shallowly buried (<4.6 m [15 ft] deep), and may be radioactive or nonradioactive. Contaminants are anticipated to be present at or near the ground surface at waste sites that contain only surface debris, or in the worst case within 1 m (3 ft) of the bottom of sites that contain buried waste. Groundwater is not impacted by disposal practices.

- Bin 3 – Wastes were disposed to unlined (historically) or lined engineered trenches. Some wastes were disposed to caissons or vertical pipe units. No bulk liquids were disposed at these sites except at one site, the Solid Waste Landfill, which is nonradioactive. Potential contaminants at other sites should be limited to a depth of <1 m (3 ft) below the bottom of the waste site, although the potential for somewhat deeper contamination of up to 3 m (10 ft) exists in some sites where snowmelt and accumulated water may have contributed to spread of contamination. Waste sites (mainly trenches contained in burial grounds) are up to 9.2 m (30 ft) deep with 4.9 to 6.1 m (16 to 20 ft) depths being typical, particularly in older burial grounds. Groundwater contamination under the Solid Waste Landfill indicates that the vapor and/or liquid phases of organic contaminants contained in the bulk liquids have migrated to the water table. Groundwater contamination is not anticipated to occur at other sites, because no bulk liquids that would drive contamination deeper into the vadose zone were disposed at these sites.

Potential receptors (human and ecological) may be exposed through several exposure pathways, including inhalation, ingestion, and direct exposure to external radiation. Potential human receptors include current and future site workers, visitors (occasional users), and inadvertent intruders. Potential ecological receptors include terrestrial plants and animals.

Most, but not all, of the waste sites associated with the 200-SW-1 and 200-SW-2 OUs are located within the Core Zone (which is defined as the 200 Areas, including B Pond [main pond] and S Ponds) as identified in Klein et al., 2002.[1] This Core Zone area has been designated in DOE/EIS-0222-F, *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement*,[2] as industrial (exclusive). For sites outside the Core Zone, the identified land use in DOE/EIS-0222-F is conservation (mining). Waste sites inside the Core Zone will be evaluated on the basis of future industrial uses. Waste sites outside the core zone will be evaluated in accordance with the Tri-Parties response to HAB advice #132 (Klein et al., 2002) and may include a range of scenarios to provide additional information to decision makers.

A DQO process was conducted for the 200-SW-1 and 200-SW-2 OUs to establish an approach for site evaluations; define the radioactive and nonradioactive constituents to be characterized; and to specify the number, type, and location of samples to be collected within the OUs. The results of the DQO process formed the basis for this consolidated work plan and the associated sampling and analysis plan (SAP) included in Appendix A. The SAP includes a quality assurance project plan and a field sampling plan for implementing the characterization activities for the 200-SW-1 and 200-SW-2 OUs.

Characterization activities identified in the DQO process include non-intrusive field sampling techniques (e.g., ground penetrating radar, electromagnetic radiography, passive soil-gas surveys), surface soil sampling, deeper soil sampling using a direct-push technology (e.g., cone penetrometer) for subsurface access and geophysical logging using spectral gamma, gamma, and neutron moisture tools. The survey and sampling strategy is structured around implementation of techniques designed to provide safe access to potentially contaminated subsurface areas and progressively define areas of interest. Less intrusive characterization techniques initially will be

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[1]Klein, K. A., Einan, D. R., and Wilson, M. A., 2002, "Consensus Advice #132: Exposure Scenarios Task Force on the 200 Area," (letter to Mr. Todd Martin, Hanford Advisory Board, from Keith A. Klein, U.S. Department of Energy; David R. Einan, U.S. Environmental Protection Agency; and Michael A. Wilson, State of Washington, Department of Ecology), Richland, Washington.

[2]DOE/EIS-0222-F, 1999, *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement*, U.S. Department of Energy, Washington, D.C.

used to help guide the location for more intrusive activities. Sample collection will be guided by field screening, direct observation, and a sampling scheme that identifies bounding conditions.

The SAP (Appendix A) directs sampling and analysis activities that will be performed to conduct characterization activities for 200-SW-1 and 200-SW-2 OU waste sites. The characterization data will be used to refine the conceptual contaminant distribution models, support an assessment of risk, and evaluate the appropriate range of remedial alternatives for waste sites in the 200-SW-1 and 200-SW-2 OUs.

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TERMS

600 CL	600 Area Central Landfill
600 OCL	600 Area Original Central Landfill
AEC	U.S. Atomic Energy Commission
amsl	above mean sea level
ALARA	as low as reasonably achievable
ARAR	applicable or relevant and appropriate requirement
c/min	counts per minute
CCU	Cold Creek unit
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
CH	contact-handled
CLARC	*Cleanup Levels and Risk Calculations under the Model Toxics Control Act Regulation* (CLARC Version 3.1) (Ecology 94-145)
CMS	corrective measures study
COC	contaminant of concern
d/min	disintegrations per minute
DCA	dichloroethane
DOE	U.S. Department of Energy
DQO	data quality objective
Ecology	Washington State Department of Ecology
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
FS	feasibility study
FY	fiscal year
HAB	Hanford Advisory Board
HASP	health and safety plan
HEIS	*Hanford Environmental Information System*
HISS	Hanford Inactive Site Survey
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
ID	identification
Implementation Plan	*200 Areas Remedial Investigation/Feasibility Study Implementation Plan - Environmental Restoration Program* (DOE/RL-98-28)
ISV	in situ vitrification
LLBG	low-level burial ground
LLW	low-level waste
MFP	mixed fission product
MLLW	mixed low-level waste
N/A	not applicable
NC	not calculated
ND	not detected

NEPA	*National Environmental Policy Act of 1969*
NRDWL	Nonradioactive Dangerous Waste Landfill
OU	operable unit
PCE	tetrachloroethylene (perchloroethylene)
PFP	Plutonium Finishing Plant
PRG	preliminary remediation goal
PUREX	Plutonium-Uranium Extraction
RAO	remedial action objective
RARA	Radiation Area Remedial Action
RAWP	remedial action work plan
RCRA	*Resource Conservation and Recovery Act of 1976*
RDR	remedial design report
RECUPLEX	Recovery of Uranium and Plutonium by Extraction
REDOX	Reduction-Oxidation
RESRAD	RESidual RADioactivity (dose model)
RFI	RCRA facility investigation
RI	remedial investigation
RL	U.S. Department of Energy, Richland Operations Office
ROD	record of decision
RR	railroad
RPP	RCRA past-practice
RTD	remove/treat/dispose
SAP	sampling and analysis plan
SWIMS	*Solid Waste Information Management System*
SWITS	*Solid Waste Information Tracking System*
SWL	Solid Waste Landfill
TCA	trichloroethane
TCE	trichloroethylene
TLD	thermoluminescent dosimeter
Tri-Parties	U.S. Environmental Protection Agency, Washington State Department of Ecology, U.S. Department of Energy
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TRU	transuranic (waste materials contaminated with more than 100 nCi/g of transuranic materials having half-lives longer than 20 years)
TRUM	TRU mixed waste
TSD	treatment, storage, and/or disposal (unit)
UNI	United Nuclear Industries (obsolete)
UPR	unplanned release
VPU	vertical pipe unit
WAC	*Washington Administrative Code*
WIDS	*Waste Information Data System*

GLOSSARY

Contact-Handled (CH) Waste – Packaged waste whose external surface dose rate does not exceed 200 mrem/h and does not create a high radiation area (>100 mrem/h at 30 cm).

Dangerous Waste – Solid waste designated in WAC 173-303-070 through WAC 173-303-100[1] as dangerous or extremely hazardous waste, or mixed waste.

Disposal – As used in this document, placement of waste with no intent of future retrieval; statutory or regulatory definitions may differ.

Hazardous Waste – Solid waste that contains chemically hazardous constituents regulated under Subtitle C of the *Resource Conservation and Recovery Act of 1976* (RCRA),[2] as amended (40 CFR 261, "Identification and Listing of Hazardous Waste"[3]), and regulated as a hazardous waste and/or mixed waste by the U.S. Environmental Protection Agency. Also may include solid waste designated by Washington State as dangerous waste.

Low-Level (Radioactive) Waste (LLW) – Radioactive waste that is not high-level waste, spent nuclear fuel, transuranic waste, byproduct material (as defined in Section 11e(2) of the *Atomic Energy Act of 1954*,[4] as amended), or naturally occurring radioactive material.

Mixed Low-Level Waste (MLLW) – Waste that meets the definition of low-level waste, and which also contains a hazardous component subject to the *Resource Conservation and Recovery Act of 1976* (RCRA), as amended, or Washington State Dangerous Waste Regulations.

Radioactive Waste – Waste that is managed for its radioactive content. Waste material that contains source, special nuclear, or byproduct material is subject to regulation as radioactive waste under the *Atomic Energy Act of 1954*.

Remedial Action – Activities conducted to reduce potential risks to people and/or harm to the environment from radioactive and/or hazardous substance contamination.

Remote-Handled Waste – Packaged radioactive waste for which the external dose rate exceeds that defined for contact-handled waste (generally 200 mrem/h at the container surface). These wastes require handling using remotely controlled equipment or placement in shielded containers to reduce the human exposures during routine waste management activities.

Retrievably Stored Waste – Waste packaged and stored in a manner that is intended to allow retrieval at a future time.

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[1]WAC 173-303-070 through 173-303-100, "Designation of Dangerous Waste," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

[2]*Resource Conservation and Recovery Act of 1976*, 42 USC 6901, et seq.

[3]40 CFR 261, "Identification and Listing of Hazardous Waste," Title 40, *Code of Federal Regulations*, Part 261, as amended.

[4]*Atomic Energy Act of 1954*, 42 USC 2011, et seq.

Transuranic Isotope – Isotopes of any element having an atomic number greater than 92 (the atomic number of uranium).

Transuranic (TRU) Waste – Radioactive waste containing more than 100 nCi (3700 Bq) of alpha-emitting transuranic isotopes per gram of waste with half-lives greater than 20 years, except for the following:

- High-level radioactive waste
- Waste that the Secretary of Energy has determined, with the concurrence of the Administrator of the U.S. Environmental Protection Agency, does not need the degree of isolation required by the disposal regulations in 40 CFR 191, "Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes"[1]
- Waste that the Nuclear Regulatory Commission has approved for disposal on a case-by-case basis in accordance with 10 CFR 61, "Licensing Requirements for Land Disposal of Radioactive Waste."[2]

TRU waste also may include hazardous constituents in which case it may be referred to as mixed TRU waste or TRUM.

[1]40 CFR 191, "Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes," Title 40, *Code of Federal Regulations*, Part 191, as amended.

[2]10 CFR 61, "Licensing Requirements for Land Disposal of Radioactive Waste," Title 10, *Code of Federal Regulations*, Part 61, as amended.

METRIC CONVERSION CHART

Into Metric Units			Out of Metric Units		
If You Know	*Multiply By*	*To Get*	*If You Know*	*Multiply By*	*To Get*
Length			**Length**		
inches	25.4	millimeters	millimeters	0.039	inches
inches	2.54	centimeters	centimeters	0.394	inches
feet	0.305	Meters	meters	3.281	feet
yards	0.914	Meters	meters	1.094	yards
miles	1.609	kilometers	kilometers	0.621	miles
Area			**Area**		
sq. inches	6.452	sq. centimeters	sq. centimeters	0.155	sq. inches
sq. feet	0.093	sq. meters	sq. meters	10.76	sq. feet
sq. yards	0.0836	sq. meters	sq. meters	1.196	sq. yards
sq. miles	2.6	sq. kilometers	sq. kilometers	0.4	sq. miles
acres	0.405	hectares	hectares	2.47	acres
Mass (weight)			**Mass (weight)**		
ounces	28.35	grams	grams	0.035	ounces
pounds	0.454	kilograms	kilograms	2.205	pounds
ton	0.907	metric ton	metric ton	1.102	ton
Volume			**Volume**		
teaspoons	5	milliliters	milliliters	0.033	fluid ounces
tablespoons	15	milliliters	liters	2.1	pints
fluid ounces	30	milliliters	liters	1.057	quarts
cups	0.24	liters	liters	0.264	gallons
pints	0.47	liters	cubic meters	35.315	cubic feet
quarts	0.95	liters	cubic meters	1.308	cubic yards
gallons	3.8	liters			
cubic feet	0.028	cubic meters			
cubic yards	0.765	cubic meters			
Temperature			**Temperature**		
Fahrenheit	subtract 32, then multiply by 5/9	Celsius	Celsius	multiply by 9/5, then add 32	Fahrenheit
Radioactivity			**Radioactivity**		
picocuries	37	millibecquerel	millibecquerel	0.027	picocuries

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1.0 INTRODUCTION

The *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1989) identifies approximately 800+ soil waste sites (and associated structures) resulting from the discharge of liquids and solids from 200 Areas processing facilities to the ground. These 800+ sites have been arranged into 23 separate waste groups that contain *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) past-practice sites, *Resource Conservation and Recovery Act of 1976* (RCRA) past-practice (RPP) sites addressed through RCRA corrective action authorities, and RCRA treatment, storage, and/or disposal (TSD) units.

This work plan supports CERCLA remedial investigation/feasibility study (RI/FS) activities for the 200-SW-1 Nonradioactive Landfills and Dumps Group Operable Unit (OU) and the 200-SW-2 Radioactive Landfills and Dumps Group OU (200-SW-1 and 200-SW-2). The Washington State Department of Ecology (Ecology) has been designated as the lead regulatory agency.

The characterization and remediation of waste sites at the Hanford Site are addressed in the Tri-Party Agreement (Ecology et al. 1989). The schedule of work at the Hanford Site is governed by Tri-Party Agreement milestones. Milestone M-13-00O requires the submittal of one RI/FS work plan that encompasses the 200-SW-1 and 200-SW-2 OU waste sites by December 31, 2004. All investigations preceding the records of decision (ROD) for non-tank farm OUs in the 200 Areas are scheduled to be completed by December 31, 2008 (Tri-Party Agreement Milestone M-15-00C).

This consolidated work plan integrates RCRA and CERCLA requirements for these OUs. The process outlined in the work plan follows the CERCLA format, with modifications to concurrently satisfy RCRA corrective action and closure TSD unit requirements as described in DOE/RL-98-28, *200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program*, (hereinafter referred to as the Implementation Plan). The Implementation Plan is summarized in Section 1.1 of this work plan.

The 200-SW-1 and 200-SW-2 OUs consist of 127 waste sites located primarily in the Hanford Site's 200 East and 200 West Areas; some of the sites are located in the 200 North and 600 Areas. The 200 Areas are located near the center of the Hanford Site in south-central Washington State, and are within one of four areas on the Hanford Site that are on the U.S. Environmental Protection Agency's (EPA) National Priorities List under CERCLA. Sites within the 200-SW-1 and 200-SW-2 OUs will be evaluated and remediated as appropriate under a CERCLA approach. The general CERCLA RI/FS process is described in EPA/540/G-89/004, *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, (Interim Final)*. The application of the CERCLA RI/FS process in the 200 Areas is described in the Implementation Plan.

The burial grounds within these OUs contain significant volumes of radionuclide and nonradionuclide inventories. The majority of waste disposed to the burial grounds originated from processes in the 200 East and 200 West Areas of the Hanford Site. The burial grounds also contain wastes that were received from the 100 and 300 Areas of the Hanford Site, as well as waste received from offsite sources.

There are two RCRA TSD units within these OUs. The low-level burial ground (LLBG) TSD unit contains eight burial grounds within its boundaries. The 218-W-6 Burial Ground was reserved for future use and never has received waste; it will not be evaluated during this investigative activity. Other portions of the LLBG sites that never have received waste also will not be evaluated (e.g., the northern portion of the 218-E-10 Burial Ground (Figure 2-11), western portions of the 218-E-12B Burial Ground (Figure 2-12), and southeastern part of the 218-W-4C Burial Ground (Figure 2-16)). The remaining seven burial grounds, 218-W-3A, 218-W-3AE, 218-W-4B, 218-W-4C, 218-W-5, 218-E-12B, and 218-E-10, were used for radioactive waste disposal. The second TSD unit, the Nonradioactive Dangerous Waste Landfill (NRDWL), was used for nonradioactive solid waste disposal.

The remaining sites within the 200-SW-1 and 200-SW-2 OUs consist of past-practice disposal sites and unplanned release (UPR) sites. The UPRs within the OUs generally consist of small volume spills to the ground surface. Many of the UPR sites in the 200 Areas resulted from loss of control and/or containment of radioactive materials during waste transfer in areas along roads and railroad lines, or within burial grounds or trenches. Causes for the releases are attributed to administrative failures, equipment failures, and operator error (WMP-22210, *Remedial Investigation Data Quality Objectives Summary Report for the 200-SW-1 and 200-SW-2 Operable Unit Waste Sites*).

The 200-SW-1 OU consists of 69 sites. The Implementation Plan (DOE/RL-98-28) originally described 37 sites. As a result of reassignments and additions before the RI/FS process, 32 sites were added to the 200-SW-1 OU. The 69, 200-SW-1 OU waste sites have been further updated in accordance with U.S. Department of Energy (DOE), Richland Operations Office (RL) RL-TPA-90-0001, *Tri-Party Agreement Handbook Management Procedures*, Guideline Number TPA-MP-14, "Maintenance of the Waste Information Data System," for reclassification of sites to "Rejected" or "No Action" status.

Historical information indicated that 30 sites were not waste management units (see Table 1-1). The majority of the 30 sites involved locations where the records indicate no history of disposal of waste that requires remediation. If a small volume was released, the affected media was cleaned up immediately. Other sites were removed from the list of waste management units, because they were duplicated by, or consolidated with, another waste site. The reclassification of these sites results in 39, 200-SW-1 OU sites remaining for consideration through the RI/FS process.

The 200-SW-2 OU originally consisted of 50 sites in the Implementation Plan (DOE/RL-98-28). Eight sites were reassigned or added before the RI/FS process, which began with 58 sites as listed in the *Waste Information Data System* (WIDS). Twenty-three sites were reclassified (Table 1-1), as described above, leaving 35, 200-SW-2 OU sites for evaluation. A combined total of 74, 200-SW-1 and 200-SW-2 OU sites were evaluated as identified in Table 1-2.

Copies of the most recently approved Part A Permit applications for the two TSD units are contained in DOE/RL-91-28, Rev. 4, *Dangerous Waste Portion Of The Resource Conservation*

And Recovery Act Permit For The Treatment, Storage, And Disposal Of Dangerous Waste Hanford Facility Dangerous Waste Permit Application, General Information Portion, Attachment 33. Publicly available portions of this document are available on the RL website, http://www.hanford.gov/docs/rl-91-28/rl91-28chp_02.htm#2.2.1.2 .

Because of the large number of waste sites remaining in the 200-SW-1 and 200-SW-2 OUs, the initial scoping for the data quality objectives (DQO) process to support this RI/FS included an assessment of the possible remedial approaches that could be applied to the various waste site configurations. Based on the contaminant distribution models, the waste sites were sorted into categories/bins to align them with the anticipated, remedial paths. Applicable streamlining concepts identified in the Implementation Plan were incorporated into the different remedial paths. The remedial approaches identified for the 200-SW-1 and 200-SW-2 OU waste sites include the following:

- Bin 1 – The anticipated remedial alternatives for Bin 1 sites are no action or maintain existing soil cover while allowing for monitored natural attenuation. Most (17) of the 20 sites in this bin are nonradioactive (i.e., 200-SW-1 OU). The sites are predominantly burn pits, ash disposal sites, and locations of random contamination from miscellaneous site activities. The sites likely are minimally contaminated; however, any contamination that is present is believed to be lower than action levels and will not require remediation. The records are sufficiently ambiguous that the contamination status must be confirmed. The objective of sampling is to determine whether the sites require remediation. The characterization approach will include screening of sites with survey techniques to establish locations for samples. Sample results will be used to establish a basis for no action, to maintain existing soil cover and allow monitored natural attenuation, or to reassign a site to Bin 2.

- Bin 2 – The anticipated remedial alternative for Bin 2 sites is removal, treatment, and disposal using the observational approach during site remediation as a streamlining strategy for characterization. Two-thirds (20) of these 30 sites are nonradioactive (200-SW-1 OU). All of the sites in Bin 2 are anticipated to contain some amount of contaminated material that will require removal. Most of the sites consist of material disposed to the surface and should not present significant challenges to remediation. In many cases, the cost associated with removal of the waste may be less than the cost of characterization.

  These sites generally are suited to a remove/treat/dispose (RTD) approach with the application of standard remediation techniques that would be applied to a commercial waste disposal site. This bin contains several sites that may need to be treated on a special-case basis, because they have different characteristics than the majority of Bin 2 sites. These sites are the three laboratory vaults (218-E-7, 218-W-7, and 218-W-8), the burial grounds at 218-E-2 and 218-E-4, and the 600 Area Original Central Landfill (600 OCL). The project will apply lessons learned from the remediation of other, similar sites at the Hanford Site when developing the RTD approach for these sites.

- Bin 3 – All but 2 of the 24 sites in this bin are radioactive (200-SW-2 OU). Bin 3 includes most of the 200 Areas solid waste burial grounds, which typically contain multiple engineered trenches. In addition to TSD units, this bin includes older (pre-1960) burial trenches and burial grounds whose inventories and burial practices are not as well documented as those for newer burial grounds. The TSD units are placed in sub-Bin 3A. This grouping includes NRDWL and the LLBG TSD units. The LLBG sites are slated to be closed with a cap ("Record of Decision for the Solid Waste Program, Hanford Site, Richland WA; Storage and Treatment of Low-Level Waste and Mixed Low-Level Waste; Disposal of Low-Level Waste and Mixed Low-Level Waste, and Storage, Processing, and Certification of Transuranic Waste for Shipment to the Waste Isolation Pilot Plant," 69 FR 39449, June 30, 2004) (*National Environmental Policy Act of 1969* [NEPA] Solid Waste ROD). The current closure pathway for NRDWL, although it has not received final regulator approval, includes construction of a cap. This approach is consistent with Tri-Party Agreement Section 5.3 and WAC 173-303-665(6), Dangerous Waste Regulations," "Landfills," "Closure and Post-Closure Care." RL is evaluating the need for interim measures to address organics disposed of at this site before a cap is constructed. The Solid Waste Landfill (SWL) also is contained in Bin 3A because of its proximity to the NRDWL, and the assumption is that the two sites will be remediated as one (see, for example, HNF-7173, *Hanford Solid Waste Landfill Closure Plan*, Chapter 1.0). The LLBG sites and NRDWL will be characterized for the parameters required to support cap design and to determine whether site conditions may require interim remedial measures before the cap is put in place.

The remaining sites are candidates for the RI/FS process, and have been placed in sub-Bin 3B. A UPR site, UPR-200-E-95, also has been placed in the Bin 3B category because of its proximity to burial grounds and because of the assumption that it will be remediated along with the burial grounds. These sites will be evaluated to generate the data required to evaluate various remedial alternatives.

The binning approach described above provides the basis for remedial decisions. The sites within each bin are identified in Table 1-2. A sampling and analysis plan (SAP) has been prepared (Appendix A) based on the sampling design developed through the DQO process. The sampling design specifies the field investigation techniques for each bin, including the following:

- Sampling and analyses required for characterization of Bin 1 sites
- Methods to support the observational approach for Bin 2 sites
- Data collection specifications to support closing Bin 3A sites with an engineered cover and the RI/FS process for Bin 3B sites.

The criteria for characterization of sites in different bins is discussed in Section 4.2. Some sites identified as candidates for no-action or requiring clean up may be reassigned to another remediation bin. This would apply, for example, if site conditions indicate the presence of contamination in a Bin 1 site or more complex conditions in a Bin 2 site than are amenable to an RTD approach.

The Bin 3A and Bin 3B waste sites will be characterized differently, because the remediation pathway (i.e., closure with an engineered barrier) for Bin 3A LLBG sites already has been established in the NEPA Solid Waste ROD (69 FR 39449). Characterization at LLBG sites and NRDWL will provide a basis for determining whether interim measures are required before caps are constructed at these sites. Characterization of the Bin 3B sites will support an RI/FS to establish the appropriate remedy for these sites.

In addition, if a 200-SW-1 or 200-SW-2 OU site is within the area of concern for a specific structure or facility that is planned for remediation, the site might be reassigned to that remediation group. This result could apply, for example, if a site would be suitably addressed by the placement of a cap that would extend from an adjacent waste unit over the top of the 200-SW-1 or 200-SW-2 site under consideration.

1.1 200 AREAS IMPLEMENTATION PLAN

The Implementation Plan outlines a strategy that is intended to streamline the characterization and remediation of waste sites in the 200 Areas, including CERCLA past-practice sites, RPP sites, and RCRA TSD units. The plan outlines the framework for implementing assessment activities and the evaluation of remedial alternatives in the 200 Areas to ensure consistency in the documentation, the level of characterization, and decision making. A regulatory framework is established in the Implementation Plan to integrate the requirements of RCRA (for corrective actions and TSD units) and CERCLA into one standard approach for cleanup activities in the 200 Areas. This approach primarily uses CERCLA terminology and documentation.

The Implementation Plan consolidates much of the information normally found in an OU-specific work plan to ensure consistency and avoid duplication of this information in each of the OU work plans for the 200 Areas. The Implementation Plan also lists potential applicable or relevant and appropriate requirements (ARAR) and preliminary remedial action objectives (RAO), and contains a discussion of potentially feasible remedial technologies that may be employed in the 200 Areas. This work plan references the Implementation Plan for further details on several topics, such as general information on the physical setting of the areas under consideration, the operational history of 200 Areas facilities, potential ARARs, RAOs, and post-work plan activities.

The Implementation Plan addressed the more than 800 waste sites that were assigned to the 23 process-based OUs, which in turn were grouped into nine major waste categories (e.g., process waste, landfills, cooling water). This categorization facilitates the use of streamlining approaches, which was a fundamental concept under the Implementation Plan. The 200-SW-1 and 200-SW-2 OUs fall within the Landfills and Dumps waste category. This category contains solid waste burial and debris sites and was subdivided into the following groups based on the radionuclide inventory:

- **Nonradioactive Landfills and Dumps Group (200-SW-1).** This group covers a number of waste sites including large volume contaminants placed in specific engineered locations, such as powerplant flyash at the ashpits in the 200 East and 200 West Areas, and unused laboratory and plant chemicals in the inactive Central Landfill complex, which consists of the NRDWL and the Solid Waste Landfill (SWL). Small to medium construction debris and dump sites are included in this group, as well as recently discovered sites, which are tracked in WIDS.

- **Radioactive Landfills and Dumps Group (200-SW-2).** Sites included in this group primarily consist of constructed (e.g., silos, caissons) or excavated sites (burial grounds) that received either low-level waste (LLW) or mixed low-level waste (MLLW). The sites also were used for the storage of transuranic (TRU)[1] wastes. Large burial grounds, each made up of a number of trenches, were used in the 200 East and 200 West Areas. While storage and retrieval activities are ongoing in multiple trenches, only three trenches continue to be used for disposal – the lined Trenches 31 and 34 in the 218-W-5 Burial Ground and Trench 94 in the 218-E-12B Burial Ground. The burial grounds received wastes such as contaminated equipment, solid laboratory or process waste, clothing, or tightly packed/sealed liquid wastes in radiological vessels. Before 1970, LLW was disposed to the same burial ground trenches as waste that would have contained TRU elements and/or mixed fission products; after 1970, wastes were segregated according to the LLW or TRU designation. After 1970, the TRU waste was placed in underground concrete caissons in the LLBG or in LLBG trenches. Wastes were largely solid materials and mostly from on site; but off site and liquid wastes (tightly packed and sealed in drums) are known to have been placed in the burial grounds. The LLBG sites are among the largest waste sites at Hanford, and some cover many acres. Unlike many highly contaminated waste sites at Hanford, large amounts of bulk liquids are not present to drive contamination throughout the soil column.

1.2 SCOPE AND OBJECTIVES

This work plan presents 200-SW-1 and 200-SW-2 OU-specific detail, including background information on the waste sites, existing data regarding contamination at the candidate RI/FS waste sites, and the approach that will be used to investigate, characterize, and evaluate the waste sites. A discussion of the RI planning and execution process is included, along with a schedule for the characterization work. Preliminary remedial action alternatives that are likely to be considered for these OUs are identified in the work plan. These preliminary remedial alternatives will be further developed and agreed to in the following:

- FS(s)
- Eventual ROD.

A DQO process (WMP-22210, *Remedial Investigation Data Quality Objectives Summary Report for the 200-SW-1 and 200-SW-2 Operable Unit Waste Sites*) was conducted to define the radioactive and nonradioactive constituents to be characterized, and to specify the number, type, and location of samples to be collected at sites within the 200-SW-1 and 200-SW-2 OUs. The results of the DQO process form the basis for the work plan and the associated SAP (Appendix A). The SAP includes a specific quality assurance project plan and a field sampling plan for implementing the field characterization activities for the 200-SW-1 and 200-SW-2 OUs.

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

After characterization data have been collected for the waste sites, results will be presented in an RI report. The RI report will include an evaluation of the characterization data for the TSD units and candidate RI/FS waste sites, including an assessment of the accuracy of the conceptual exposure model and refinement of the contaminant distribution model. The RI report will support the evaluation of remedial alternatives that will be included in the FS. The FS will use the existing and newly collected data to evaluate a range of remedial actions for the sites evaluated in the RI and for the remaining sites within the OUs that fall within the contaminant distribution model. As data are being collected and analyzed, work will proceed on the identification or development of suitable models to evaluate the cost and exposure (ALARA) aspects of the various remedial alternatives. Remedial alternatives may be applied at any or all of the waste sites in the OUs, and different alternatives may be applied to different waste sites depending on site characteristics. The FS ultimately will support a proposed plan leading to a ROD for all the waste sites in the OUs. The ROD will be reviewed and a Hanford Facility RCRA permit modification proposed, if necessary, for the two TSD units (LLBG and NRDWL). Chapter 6.0 presents the schedule for assessment activities at the 200-SW-1 and 200-SW-2 OUs.

Based on information reviewed during the DQO process (WMP-22210), presumptive remedies were established for some waste sites in the 200-SW-1 and 200-SW-2 OUs. Sites that are candidates for "No Further Action" under CERCLA (Bin 1 Sites and sites that were rejected or proposed for no action under WIDS) or proposed for RTD of the waste (Bin 2 Sites), and sites that are proposed for removal from the 200-SW-1 and 200-SW-2 OUs, are documented in this work plan. Documentation includes a description of the presumed remedial pathways used to determine the assignment of the individual waste sites to a remediation bin (Section 1.0). Furthermore, as discussed above, a remedy for Bin 3A LLBG TSD unit waste sites has been established in 69 FR 39449. Closure of the NRDWL is anticipated to be with a cap, as well, based on the closure plan for that site (DOE/RL-90-17, *Nonradioactive Dangerous Waste Landfill Closure/Postclosure Plan*). The remaining sites (Bin 3B sites) will undergo an RI/FS process to establish their preferred CERCLA remedy. A list of the candidate sites for each bin with short site descriptions is presented in Appendix B.

The information provided in this report reflects the most current, defensible data available at the time that the work plan was prepared. Where discrepancies exist with other reports, the differences generally would not result in a significant change to the proposed work scope.

1.3 EXCLUSIONS FROM SCOPE OF WORK PLAN

Several of the LLBG sites contain retrievably stored suspect TRU wastes; these include specific locations within the 218-E-12B, 218-W-3A, 218-W-4B, and 218-W-4C Burial Grounds. Retrieval of these wastes is out of scope of this work plan; this material will be retrieved in accordance with Tri-Party Agreement Milestones M-91-40 and M-91-41. Following retrieval of the suspect TRU waste, substrate soil sampling will be conducted to evaluate possible contaminant releases to the environment.

Outside the scope of this work plan, the TRU retrieval program will develop separate DQOs and SAPs for substrate sampling at each of these four burial grounds, in accordance with Tri-Party Agreement Milestone M-91-40. The substrate sampling will occur in each burial ground following retrieval of the suspect TRU waste in that burial ground. Retrieval of waste in accordance with Tri-Party Agreement Milestone M-91-40 is scheduled to be completed in 2010. As a result of this schedule, data generated from some of the substrate sampling may be available to evaluate the need for interim remedial measures before the RI/FS process for the 200-SW-2 OU is completed in 2008. However, some substrate sampling also will be conducted after the RI/FS process has been completed. Chapter 6.0 provides additional detail regarding the substrate sampling activity.

The 218-W-6 Burial Ground was reserved for future use and never has received waste; it will not be evaluated during this investigative activity. Other portions of the LLBG sites that never have received waste also will not be evaluated. Although these locations have no basis for undergoing evaluation as part of this work plan, they will be retained within the OUs for disposition through the CERCLA decision-making process.

Trench 94 in the 218-E-12B Burial Ground (within the LLBG TSD unit) also is out of scope of this work plan because the trench will be in use for disposal of Navy vessel reactor compartments beyond the timeframe (2024) the Tri-Party Agreement specifies for remediation of the 200-SW-2 OU.

Table 1-1. Sites That Have Been Reclassified "Rejected" or "No Action" in the *Waste Information Data System*[a] (53 Sites). (2 Pages)

Site Identification	Site Name	WIDS Reclassification Status
200-SW-1 OU – 31 Sites		
200-E PAP	200-E Powerhouse Ash Pit and Ash Disposal Pile	No Action
200-E-10	Paint/Solvent Dump South of Sub Trenches	No Action
200-E-12	Sand Piles from RCRA General Inspection 200E FY 95 Item #5	Rejected
200-E-3	Toluene Dump Site	Rejected
200-E-47	RCRA Permit General Inspection #200E FY 96 Item #7	Rejected
200-E-48	RCRA Permit General Inspection #200E FY 96 Item #15	Rejected
200-E-52	200 East Powerhouse Coal Pile	No Action
200-W CSLA	200-W Construction Surface Laydown Area	Rejected
200-W PAP	200-W Powerhouse Ash Pit	No Action
200-W-10	Item 10 (RCRA General Inspection) Grout Wall Test	No Action
200-W-103	201-W Concrete Silo	Rejected
200-W-17	S-Plant Project W087 Aluminum Silicate Discovery	Rejected
200-W-18	S-Plant Project W087 Aluminum Oxide Discovery	Rejected
200-W-35	Various Sites North of 201-W	No Action
200-W-4	U-Farm Landfill	No Action
200-W-41	200-W-41, Abandoned Drums, Drums found East of T Plant	No Action
200-W-62	200 West Powerhouse Coal Pile	No Action
200-W-68	RCRA General Inspection Report 200W FY 99 Item #3, Historic Disposal Site	Rejected
200-W-70	Old Burn Pit Southeast of Z-Plant, 200 West Original Burn Pit	Rejected
218-E-6	B Stack Shack Burning Pit	No Action
218-W-6[b,c,d]	218-W-6 Burial Ground	Accepted
600 BPHWSA	600 Area Batch Plant HWSA, Hazardous Waste Storage Area	Rejected
600 ESHWSA	600 Area Exploratory Shaft Hazardous Waste Storage Area	Rejected
600-223	Military Camp South of 200 W, H-50 Gun Site Pit	Rejected
600-236[e]	Soil Cell 607 Site, Petroleum Contaminated Soil, Bioremediation Site	Rejected
600-266	Trash Dump West of Gate 117-A	Rejected
622-1	Construction and Demolition Debris	Rejected
UPR-200-E-106	Contamination at a Burning Ground, UN-200-E-106	Rejected
UPR-200-W-37	Contaminated Boxes found in a Burn Pit (Z-Plant Burn Pit)	Rejected (Consolidated)
Z PLANT BP	Z-Plant Burning Pit	Rejected
200-SW-2 OU – 23 Sites		
200-E-20	218-E-10 Borrow Pit	Rejected
200-E-21	218-E-12A and 218-E-12B Borrow Pit	Rejected
200-W-30	218-W-1A Borrow Pit	Rejected
200-W-31	218-W-2A Borrow Pit	Rejected

Table 1-1. Sites That Have Been Reclassified "Rejected" or "No Action" in the *Waste Information Data System*[a] (53 Sites). (2 Pages)

Site Identification	Site Name	WIDS Reclassification Status
200-W-32	216-Z-19 Borrow Pit	Rejected
200-W-5	Burial Ground/Burning Pit, U Plant Burning Pit, UPR-200-W-8	Rejected
218-E-3	Construction Scrap Pit	Rejected
600-25	Susie Junction	Rejected
600-268	200 East Pipe Yard Drum Accumulation Area	Rejected
UPR-200-E-23	Burial Box Collapse at 218-E-10, UPR-200-W-158	Rejected (Consolidated)
UPR-200-E-24	Contamination Plume from the 218-E-10 Burial Ground, UN-200-E-24	Rejected (Consolidated)
UPR-200-E-30	Contamination within 218-E-12A, UN-200-E-20	Rejected (Consolidated)
UPR-200-E-53	Contamination at 218-E-1	Rejected (Consolidated)
UPR-200-E-61	Radioactive Contamination from Railroad Burial Cars	Rejected
UPR-200-W-11	218-W-1 Burial Ground Fire	Rejected
UPR-200-W-134	Improper Drum Burial at 218-E-3A	Rejected (Consolidated)
UPR-200-W-137	218-W-7, UN-200-W-137	Rejected
UPR-200-W-16	Fire at 218-W-1 Burial Ground	Rejected (Consolidated)
UPR-200-W-26	Contamination Spread During Burial Operations	Rejected (Consolidated)
UPR-200-W-45	Burial Box Collapse	No Action
UPR-200-W-53	Burial Box Collapse	Rejected (Consolidated)
UPR-200-W-72	Contamination at 218-W-4A	Rejected (Consolidated)
UPR-200-W-84	Ground Contamination During Burial Operation at 218-W-3A	Rejected

[a]Sites that have been determined not to be waste management units in the 200-SW-1 and 200-SW-2 Operable Units (i.e., "Rejected" or "No Action" sites, or moved to a different operable unit).

[b]Sites that are within a treatment, storage, and/or disposal unit boundary.

[c]Sites that currently are within the boundary depicted on the Low-Level Burial Ground Treatment, Storage, and Disposal Unit Part A Permit Application (DOE/RL-88-20, *Hanford Facility Dangerous Waste Permit Application, Low-Level Burial Grounds*).

[d]The 218-W-6 Burial Ground was reserved for future use and never has received waste; it will not be evaluated during this investigative activity.

[e]Site 600-236 has been proposed for reclassification as a "Rejected" site under the *Waste Information Data System*. Acceptance of the reclassification status by the Washington State Department of Ecology is expected to be received by the time work commences in accordance with this work plan.

FY = fiscal year.
RCRA = *Resource Conservation and Recovery Act of 1976*.
WIDS = *Waste Information Data System*.

Table 1-2. 200 SW-1 and 200-SW-2 Operable Unit Remediation Bins. (3 Pages)

Site Identification (Operable Unit)	Site Name	WIDS Reclassification Status
Bin 1 (20 Sites) – No Remediation Planned – Samples Required to Confirm		
200 CP (200-SW-1)	200 Area Construction Pit	Accepted
200-E BP (200-SW-1)	200-E Burn Pit	Accepted
200-E-1 (200-SW-1)	284-E Landfill	Accepted
200-E-2 (200-SW-1)	Soil Stains at the 2101M SW Parking Lot, MO-234 Parking Lot	Accepted
200-N-3 (200-SW-1)	200-N-3 Ballast Pits	Accepted
200-W ADB (200-SW-1)	200-W Ash Disposal Basin	Accepted
200-W BP (200-SW-1)	200-W Burn Pit	Accepted
200-W-1 (200-SW-1)	REDOX Mud Pit West	Accepted
200-W-12 (200-SW-1)	201-W Soil Mound and Plastic Pipe	Accepted
200-W-2 (200-SW-1)	REDOX Berms West	Accepted
200-W-3 (200-SW-1)	2713-W North Parking Lot, 220-W-1	Accepted
200-W-6 (200-SW-1)	200-W Painter shop paint solvent disposal area	Accepted
218-E-9 (200-SW-2)	200E Regulated Equipment Storage Site No. 009, Burial Vault (HISS)	Accepted
291-C-1 (200-SW-2)	291C Stack Burial Trench	Accepted
600-146 (200-SW-1)	Steel Structure NW of Gable Mt	Accepted
600-228 (200-SW-1)	H-40 Gun Site	Accepted
600-70 (200-SW-1)	Solid Waste Management Unit #2	Accepted
628-2 (200-SW-1)	100 Fire Station Burn Pit	Accepted
UPR-200-W-63 (200-SW-2)	Contamination S. Shoulder 23rd St.	Accepted
UPR-200-W-70 (200-SW-1)	Contamination Found at the 200 West Burning Ground East of Beloit Ave.	Accepted
Bin 2 (30 Sites) – Remove/Treat/Dispose Using Observational Approach		
200-E-122 (200-SW-1)	Construction Forces Bullpen	Accepted
200-E-13 (200-SW-1)	Rubble Piles	Accepted
200-E-46 (200-SW-1)	Solid Debris	Accepted
200-W-101 (200-SW-2)	Contaminated Material W of 216-S-12 Crib	Accepted
200-W-11 (200-SW-1)	S-Farm Concrete Foundation	Accepted
200-W-33 (200-SW-1)	Solid Waste Dumping Area	Accepted
200-W-55 (200-SW-1)	Dump N of 231Z	Accepted
200-W-75 (200-SW-2)	Rad Logging System Silos	Accepted
200-W-92 (200-SW-2)	Soil Mound W of TY Farm	Accepted
218-E-2 (200-SW-2)	Equip Burial #2	Accepted
218-E-4 (200-SW-2)	Equip Burial #4	Accepted
218-E-7 (200-SW-2)	222B Vaults	Accepted
218-W-7 (200-SW-2)	222S Vaults	Accepted

Table 1-2. 200 SW-1 and 200-SW-2 Operable Unit Remediation Bins. (3 Pages)

Site Identification (Operable Unit)	Site Name	WIDS Reclassification Status
218-W-8 (200-SW-2)	222T Vaults	Accepted
218-W-9 (200-SW-2)	Dry Waste Burial #9	Accepted
600 OCL (200-SW-1)	600 Original Central Landfill	Accepted
600-218 (200-SW-1)	H-61 Anti-Aircraft Dump	Accepted
600-220 (200-SW-1)	H-51 Anti-Aircraft Dump	Accepted
600-222 (200-SW-1)	H-60 Gun Site	Accepted
600-226 (200-SW-1)	H-42 Gun Site	Accepted
600-281 (200-SW-1)	Scattered Debris South of Army Loop Road	Accepted
600-36 (200-SW-1)	Ethel RR Siding Burn Pit	Accepted
600-38 (200-SW-1)	Susie Junction	Accepted
600-40 (200-SW-1)	W of W Lake Dumping Area	Accepted
600-51 (200-SW-1)	Chemical Dump	Accepted
600-65 (200-SW-1)	607 Batch Plant Drum Site	Accepted
600-66 (200-SW-1)	607 Batch Plant Orphan Drums	Accepted
600-71 (200-SW-1)	607 Batch Plant Burn Pit	Accepted
OCSA (200-SW-1)	Old Central Shop Area	Accepted
UPR-200-E-35 (200-SW-2)	Buried Pipe, Contaminated	Accepted
Bin 3A (9 Sites) – Characterize to Support Landfill Closure		
218-E-10[a,b] (200-SW-2)	Equip Burial #10	Accepted
218-E-12B[a,b,c] (200-SW-2)	Dry Waste #12B	Accepted
218-W-3A[a,b,c] (200-SW-2)	Dry Waste #3A	Accepted
218-W-3AE[a,b] (200-SW-2)	Dry Waste #3AE	Accepted
218-W-4B[a,b,c] (200-SW-2)	Dry Waste #4B	Accepted
218-W-4C[a,b,c] (200-SW-2)	Dry Waste #4C	Accepted
218-W-5[a,c] (200-SW-2)	Low Level Radioactive Mixed Waste Burial Ground	Accepted
600 CL[d] (200-SW-1)	600 Area Central Landfill	Accepted
600 NRDWL[a] (200-SW-1)	600 Area Non Radioactive Dangerous Waste Landfill	Accepted

Table 1-2. 200 SW-1 and 200-SW-2 Operable Unit Remediation Bins. (3 Pages)

Site Identification (Operable Unit)	Site Name	WIDS Reclassification Status
Bin 3B (15 Sites) – Characterize to Support Remedial Investigation/Feasibility Study		
218-C-9 (200-SW-2)	Dry Waste & 216-C-9 Pond	Accepted
218-E-1 (200-SW-2)	Dry Waste #1	Accepted
218-E-12A (200-SW-2)	Dry Waste #12A	Accepted
218-E-2A (200-SW-2)	Regulated Equip Storage	Accepted
218-E-5 (200-SW-2)	Equip Burial #5	Accepted
218-E-5A (200-SW-2)	Equip Burial #5A	Accepted
218-E-8 (200-SW-2)	200E Construction Burial	Accepted
218-W-1 (200-SW-2)	Solid Waste Burial #1	Accepted
218-W-11 (200-SW-2)	Regulated Storage Site	Accepted
218-W-1A (200-SW-2)	Equip Burial #1	Accepted
218-W-2 (200-SW-2)	Dry Waste #2	Accepted
218-W-2A (200-SW-2)	Equip Burial #2	Accepted
218-W-3 (200-SW-2)	Dry Waste #3	Accepted
218-W-4A (200-SW-2)	Dry Waste #4A	Accepted
UPR-200-E-95 (200-SW-2)	Ground Contamination on RR Spur Between 218-E-2A and 218-E-5	Accepted

[a]Sites that are within a treatment, storage, and disposal unit boundary.

[b]Sites that are currently within the boundary depicted on the Low-Level Burial Ground Treatment, Storage, and Disposal Unit Part A Permit Application (DOE/RL-88-20, *Hanford Facility Dangerous Waste Permit Application, Low-Level Burial Grounds*).

[c]Sites that contain retrievably stored waste.

[d]The 600 CL waste site is not a treatment, storage, and disposal unit but will be closed in conjunction with the adjacent treatment, storage, and disposal unit, the NRDWL.

CL = Central Landfill.
HISS = Hanford Inactive Site Survey.
NRDWL = nonradioactive dangerous waste landfill.
REDOX = Reduction-Oxidation.
RR = railroad.
WIDS = *Waste Information Data System.*

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2.0 BACKGROUND AND SETTING

This chapter describes the 200-SW-1 and 200-SW-2 Nonradioactive and Radioactive Landfills and Dumps Group OUs. Waste site information and the hydrogeologic framework associated with these OUs are summarized to provide a fundamental understanding of the physical setting and potential impacts on the environment. Background and setting information includes the physical setting, waste site descriptions and history, and waste-generating processes. Information in this chapter is summarized from numerous reports.

To streamline this report, much of the summary information for these OUs is included by reference to other documents. The individual Bin 3 waste sites within the 200-SW-1 and 200-SW-2 OUs are described in Section 2.2.6 of this document.

2.1 PHYSICAL SETTING

The following section provides a synopsis of the geology and hydrology associated with the 200-SW-1 and 200-SW-2 OUs. The 200-SW-1 and 200-SW-2 OUs are centered on the 200 Areas Plateau, which is a relatively flat, prominent terrace (Cold Creek Bar) near the center of the Hanford Site (Figure 2-1). The Cold Creek Bar trends generally east-west with elevations between 198 and 230 m (650 to 755 ft) above mean sea level (amsl). The plateau drops off rather steeply to the north and northwest and decreases more gently in elevation to the south into the Cold Creek valley and to the east toward the Columbia River. Plateau escarpments have elevation changes of between 15 to 30 m (50 to 100 ft). The following sections provide descriptions for the major physical features of these OUs. The Implementation Plan (DOE/RL-98-28, Appendix F) provides more detail on the physical setting of the 200 Areas and vicinity.

2.1.1 Topography

The 200 Areas, which contain most of the waste sites comprising the 200-SW-1 and 200-SW-2 OUs, are located in the Pasco Basin of the Columbia Plateau. The 200 Area Plateau is the term commonly used to describe the Cold Creek Bar that was formed during the last cataclysmic flood from glacial Lake Missoula, about 13,000 yr ago (Figure 2-1). The cataclysmic floodwaters that deposited sediments of the Hanford formation also locally reshaped the topography of the Pasco Basin. The floodwaters deposited the thick sand and gravel deposits of the Cold Creek Bar, and in the waning stages, the floodwaters eroded a channel between the 200 Areas and Gable Mountain. The northern half of the 200 East Area is located within this ancient flood channel. The southern half of the 200 East Area and most of the 200 West Area are situated on the Cold Creek Bar. A secondary flood channel running southerly from the main channel bisects the 200 West Area.

Most of the 200-SW-1 and 200-SW-2 OU waste sites are located in or near the 200 East and 200 West Areas on the plateau. Surface elevations of the waste sites in the 200 West Area range from approximately 188 m (615 ft) amsl in the Cold Creek valley to 238 m (780 ft) amsl in the northwest part. Waste site surface elevations in the 200 East Area range from approximately 180 m (590 ft) amsl in the northeast part to 226 m (740 ft) in the western part.

One of the waste sites (200-N-3) is located in the 200 North Area where the surface elevation is about 174 m (570 ft) amsl. Three of the waste sites are located north of Gable Mountain (Figure 2-1) where surface elevations range from 131 m (430 ft) amsl in the south to 165 m (540 ft) amsl in the north. Five of the waste sites are located in the 600 Area between the 200 Areas and the Wye Barricade. Surface elevations at these waste sites range from about 158 m (520 ft) amsl in the east to 177 m (580 ft) amsl in the west.

Plate 1 (Appendix C, in pocket) shows the waste site locations outside the 200 Areas. Plate 2 (Appendix C, in pocket) shows the 200-SW-1 and 200-SW-2 OU waste site locations that are part of the 200 West Area. Plate 3 (Appendix C, in pocket) identifies the 200-SW-1 and 200-SW-2 OU sites located within the 200 East Area.

2.1.2 Geology

The 200-SW-1 and 200-SW-2 OUs are located in the Pasco Basin, one of several structural and topographic basins of the Columbia Plateau. Basalts of the Columbia River Basalt Group and a sequence of suprabasalt sediments underlie the 200-SW-1 and 200-SW-2 OU waste sites. From oldest to youngest, the major geologic units of interest are the Elephant Mountain Member of the Columbia River Basalt Group, the Ringold Formation, the Cold Creek unit (CCU), the Hanford formation, and surficial deposits. Figure 2-2 provides a generalized stratigraphic column for the 200-SW-1 and 200-SW-2 OU waste sites.

Elephant Mountain Member. The Elephant Mountain Member is the uppermost basalt unit (i.e., bedrock) in the majority of the OU areas. Except for the Gable Gap area (between Gable Butte and Gable Mountain) where it has been eroded away, the Elephant Mountain Member is laterally continuous throughout the OUs. The Elephant Mountain Member is overlain by the Ringold Formation, except in the northern part of the 200 East Area, where the basalt is directly overlain by the Hanford formation (PNNL-12261, *Revised Hydrogeology for the Suprabasalt Aquifer System 200-East Area and Vicinity, Hanford Site, Washington*).

Ringold Formation. The Ringold Formation consists of an interstratified fluvial-lacustrine sequence of unconsolidated to semi-consolidated clay, silt, sand, and granule-to-cobble gravel deposited by the ancestral Columbia River. These sediments consist of four major hydrostratigraphic units (from oldest to youngest, see Figure 2-2): the fluvial gravel and sand of Unit 9 (basal coarse), the buried soil horizons, overbank, and lake deposits of Unit 8 (lower mud), the fluvial sand and gravel of Unit 5 (upper coarse), and the lacustrine mud of Unit 4 (upper fines). Units 9 and 5 consist of silty-sandy gravel with secondary lenses and interbeds of gravelly sand, sand, and muddy sand to silt and clay. Unit 8 (lower mud) consists mainly of silt and clay. Unit 4 (upper fines) consists of silty over-bank deposits and fluvial sand. Units 6 and 7 are not present within the 200 West and 200 East Areas (PNNL-12261; PNNL-13858, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-West Area and Vicinity, Hanford Site, Washington*). The Ringold Formation is overlain by the CCU in the 200 West Area, in parts of the 200 East Area and 200 North Area, beneath the 600 Area waste sites, and beneath the waste sites north of Gable Mountain (DOE/RL-2002-39, *Standardized Stratigraphic Nomenclature for*

Post-Ringold Formation Sediments Within the Central Pasco Basin; WHC-SD-EN-EE-004, *Revised Stratigraphy for the Ringold Formation, Hanford Site, South-Central Washington*).

Cold Creek Unit. The CCU includes several post-Ringold Formation and pre-Hanford formation units present within the central Pasco Basin (DOE/RL-2002-39). The CCU includes the units formerly referred to as the Plio-Pleistocene unit, caliche, early Palouse soil, Pre-Missoula gravels, and sidestream alluvial facies described in previous site reports. The CCU has been divided into five lithofacies: fine-grained, laminated to massive (fluvial-overbank and/or eolian deposits, formerly the early Palouse soil); fine- to coarse-grained, calcium-carbonate cemented (calcic paleosol, formerly the caliche); coarse-grained, multilithic (mainstream alluvium, formerly the Pre-Missoula gravels); coarse-grained, angular, basaltic (colluvium); and coarse-grained, rounded, basaltic (sidestream alluvium, formerly sidestream alluvial facies) (DOE/RL-2002-39). The CCU present beneath the 200 West Area waste sites and the 600 Area waste sites west and south of the 200 West Area includes the overbank/eolian, calcic paleosol, and sidestream alluvial facies. The CCU present beneath part of the 200 North Area, the 200 East Area, and the 600 Area waste sites southeast of the 200 East Area is the mainstream alluvium (DOE/RL-2002-39). The CCU lithofacies have not been studied north of Gable Mountain (DOE/RL-2002-39).

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

Surficial deposits. Surficial deposits include Holocene eolian sheets of sand that form a thin veneer over the Hanford formation across the site, except in localized areas where the deposits are absent. Surficial deposits consist of very fine- to medium-grained sand to occasionally silty sand. Fill material was placed in and over various waste sites as cover and for contamination control. The fill consists of reworked Hanford formation sediments and/or surficial sand and silt.

2.1.3 Vadose Zone

The vadose zone is approximately 104 m (340 ft) thick in the southern part of the 200 East Area and thins to the north to 0.3 m (1 ft) near West Lake by the west end of Gable Mountain. The vadose zone includes sediments of the Ringold Formation and the Hanford formation. Because erosion during cataclysmic flooding removed much of the Ringold Formation north of the central part of the 200 East Area, the vadose zone is composed primarily of Hanford formation sediments between the northern part of the 200 Areas and Gable Mountain (the 200 North Area). The top of basalt and some units of the Ringold Formation project above the water table between the northern part of the 200 East Area and Gable Mountain.

In the 200 West Area and the adjacent 600 Area, the vadose zone thickness ranges from about 48 m (157 ft) in the Cold Creek valley area to about 100 m (328 ft) in the northwest corner. In these areas, sediments in the vadose zone include the Ringold Formation, the CCU, and the Hanford formation. Erosion during cataclysmic flooding removed some of the Ringold Formation and the CCU north of the 200 West Area.

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

In the 600 Area southeast of the 200 East Area, the vadose zone is about 35 to 54 m (115 to 177 ft) thick and is composed entirely of sediments of the Hanford formation. In the 600 Area north of Gable Mountain, the vadose zone is about 32 m (105 ft) thick and also consists of sediments of the Hanford formation (WHC-SD-EN-EE-004).

2.1.4 Groundwater

The unconfined aquifer in the OUs occurs within the Hanford formation 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 (toward the Columbia River) (Figure 2-3). In general, groundwater flow through the 200 Area Plateau occurs in a predominantly easterly direction, from the 200 West Area to the 200 East Area; from there it flows east to southeast through the 600 Area to discharge into the Columbia River.

North of Gable Butte and Gable Mountain, groundwater generally flows from west to east and also discharges to the Columbia River (Figure 2-3). Groundwater flow from the 200 North Area enters this region through the gap between Gable Butte and Gable Mountain, and from the gap between Umtanum Ridge and Gable Butte. West of the 100-B/C Area, the Columbia River recharges the aquifer and then becomes the discharge location for the aquifer southeast of the 100-F Area (Figure 2-3; PNNL-14187, *Hanford Site Groundwater Monitoring for Fiscal Year 2002*).

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) above the surrounding water table. Discharges to the 216-B-3 Pond created a hydraulic barrier to groundwater flow coming from the 200 West Area, deflecting it either northward through the 200 North Area and through Gable 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*). From March 2001 to March 2002, the water-table elevation declined by an average of 0.19 m (0.6 ft) in the 200 East Area and 0.36 m (1.18 ft) in the 200 West Area (PNNL-14187).

Recharge to the unconfined aquifer is from artificial and, possibly, natural sources. Any natural recharge on the Hanford Site originates from precipitation except west of the 100-B/C Area where the Columbia River recharges the aquifer as discussed above. Estimates of recharge from precipitation range from 0 to 10 cm/yr (0 to 4 in/yr) and are largely dependent on soil texture and the type and density of vegetation. Artificial recharge occurred when effluent such as cooling water and liquid wastes from Hanford Site process operations were disposed to the ground. Most sources of artificial recharge have been halted.

Groundwater in the 200 West Area occurs primarily in the Ringold Formation. The depth to the water table varies from about 50 m (164 ft) in the southwest corner near the 216-U-10 Pond to greater than 100 m (328 ft) in the north.

In the northern half of the 200 East Area, the water table is present within the Hanford formation except in areas where basalt or the Ringold Formation lower mud unit are present above the water table. In the central and southern sections of the 200 East Area, the water table is located near the contact of the Ringold Formation and the overlying Hanford formation. Depth to the water table in the vicinity of the 200 East Area ranges from about 54 m (177 ft) near the B Pond to more than 100 m (328 ft) at the BC Cribs.

In the 200 North Area, the depth to the water table is about 38 m (125 ft) and is present within the Hanford formation. In the 600 Area southeast of the 200 East Area, the depth to the water table ranges from about 35 to 54 m (115 to 177 ft) and it is present within the lower part of the Hanford formation.

2.1.5 Summary of Hydrogeologic Conditions at Bin 3 Sites

Because contamination is not anticipated to be present at the Bin 1 sites and will be removed to below action levels at Bin 2 sites, this work plan will not address hydrogeologic conditions for sites in those bins. The hydrogeology for the 24 Bin 3 waste sites is summarized in this section. The annual groundwater monitoring reports for the Hanford Site (e.g., PNNL-14187; PNNL-14548, *Hanford Site Groundwater Monitoring for Fiscal Year 2003*) provide the hydrogeologic setting and results for all RCRA TSD units being monitored. These reports, PNNL-13080, *Hanford Site Groundwater Monitoring: Setting, Sources and Methods*, and two reports updating the hydrogeology of the 200 Areas (PNNL-12261; PNNL-13858) were the primary references for the summary information presented in this section. The following summaries are based on the descriptions provided in those reports.

The stratigraphy at representative boreholes near the Bin 3 sites in the 200 West Area, 200 East Area, and 600 Area is shown in Figure 2-4. The shallow vadose zone (upper 23 m [75 ft]) at the Bin 3 sites is composed predominantly of sand and gravel of the Hanford formation. The predominantly coarse-grained nature of the shallow vadose zone at the Bin 3 sites is an important feature considered in the conceptual contaminant distribution models for these sites, which are discussed in Section 3.2.

2.1.5.1 218-E-2A, 218-E-5, 218-E-5A, and 218-E-10 Burial Grounds and Unplanned Release UPR-200-E-95

These sites are located in the northwestern corner of the 200 East Area. The following summary is from the investigations and groundwater monitoring conducted at the 218-E-10 Burial Ground.

The ground surface elevation is approximately 192 to 207 m (630 to 680 ft) amsl and slopes to the northeast. These sites are underlain by the Hanford formation (DOE/RL-2000-72, *Performance Assessment Monitoring Plan for the Hanford Site Low-Level Burial Grounds*). The depth to the water table ranges between 71 and 87 m (233 and 285 ft) below ground surface and the unconfined aquifer is ~3 to ~8 m (~10 to ~26 ft) thick. The unconfined aquifer is contained in the sand and gravel of the Hanford formation, which directly overlie the basalt. Determining the direction of groundwater flow in this area, using only water-level data from monitoring wells, is unreliable, because the gradient[1] in this area is extremely low. A better estimate of the flow direction can be inferred from contaminant plume maps, which suggest that the general direction of flow is to the northwest (PNNL-13080). The mean of the calculated gradients using different sets of wells in the 218-E-10 Burial Ground monitoring network was 0.00006. The estimated flow rate of groundwater underlying these burial grounds is ~0.01 to 0.5 m/day (~0.03 to 1.6 ft/day) (PNNL-14187).

2.1.5.2 218-C-9, 218-E-1, 218-E-8, 218-E-12A, and 218-E-12B Burial Grounds

These burial grounds are located in the northeastern corner and the east-central part of the 200 East Area. The following summary is from the investigations and groundwater monitoring conducted at the 218-E-12B Burial Ground.

The ground surface elevation is approximately 178 to 216 m (585 to 710 ft) amsl and slopes to the northeast. These burial grounds are underlain by the Hanford formation. The Ringold Formation also may be present beneath the 218-E-1 Burial Ground (PNNL-12261). The depth to the water table is 57 to 94 m (187 to 308 ft) below ground surface and the aquifer thickness ranges from 0 to ~2 m (0 to ~6.6 ft) thick (PNNL-13080) at the 218-E-12B Burial Ground and about 21 to 34 m (70 to 110 ft) thick (PNNL-12261) at the 218-E-1 Burial Ground. The unconfined aquifer is contained in the sand and gravel of the Hanford formation, which directly overlie the basalt,

[1] Gradient, or hydraulic gradient, is essentially the slope of the water table and is calculated between two wells in a monitoring network as the difference in elevation of the water levels divided by the distance between the wells.

except near the 218-E-1 Burial Ground where the Ringold Formation may be present above the basalt and also would be part of the aquifer (PNNL-12261). In this area, the groundwater flows primarily from east to west, based on water-table contours of the regional flow system. The flow regime in this area is influenced by the basalt subcrop to the north and east and, because of the extremely flat gradient, it is difficult to use water level data to determine flow direction. The gradient calculated from wells along the south boundary of the 218-E-12B Burial Ground is 0.00003. Using this gradient, the estimated flow rate of groundwater underlying these burial grounds is ~0.04 to 0.5 m/day (~0.13 to 1.6 ft/day) (PNNL-14187).

2.1.5.3 218-W-1A, 218-W-2A, 218-W-3, 218-W-3A, 218-W-3AE, 218-W-4A, and 218-W-5 Burial Grounds

These burial grounds are located in the northwestern part of the 200 West Area. The following summary is from the investigations and groundwater monitoring conducted at the 218-W-3A, 218-W-3AE, and 218-W-5 Burial Grounds.

The ground surface elevation is approximately 204 to 226 m (670 to 740 ft) amsl and generally slopes to the east. These burial grounds are underlain by the Hanford formation, the CCU, and the Ringold Formation. The depth to the water table is ~64 to 74 m (~210 to 243 ft) below ground surface and the aquifer thickness ranges from ~62 to ~75 m (~203 to ~246 ft) thick (PNNL-13080). The unconfined aquifer is entirely within the upper coarse gravels of the Ringold Formation (Unit 5). The aquifer is locally semi-confined beneath fine-grained sediment in the northern portions of the 218-W-3A, 218-W-3AE, and 218-W-5 Burial Grounds (PNNL-13080). The base of the aquifer is the Ringold Formation lower mud unit, except where this unit is not present in the northern portions of the 218-W-3A, 218-W-3AE, and 218-W-5 Burial Grounds; there the aquifer base is the top of basalt. The groundwater flow in this portion of the 200 West Area is to the east-northeast (66 degrees) with a calculated gradient of 0.0012. The flow direction is returning to the pre-Hanford Site conditions and will continue to change until the direction is predominately west to east. Groundwater velocity is in the range of 0.0001 to 0.12 m/day (0.0003 to 0.39 ft/day) (PNNL-14187).

2.1.5.4 218-W-1, 218-W-2, 218-W-4B, 218-W-4C, and 218-W-11 Burial Grounds

These burial grounds are located in the west-central part of the 200 West Area. The following summary is from the investigations and groundwater monitoring conducted at the 218-W-4B and 218-W-4C Burial Grounds.

The ground surface elevation is approximately 204 to 213 m (670 to 700 ft) amsl and generally slopes to the east. These burial grounds are underlain by the Hanford formation, the CCU, and the Ringold Formation. The depth to the water table is ~64 to 74 m (~210 to 243 ft) below ground surface and the aquifer thickness ranges from ~62 to ~75 m (~203 to ~246 ft) thick (PNNL-13080). The unconfined aquifer is entirely within the upper coarse gravels of the Ringold Formation (Unit 5), and the base of the aquifer is the Ringold Formation lower mud unit. The groundwater flow beneath these burial grounds is generally to the east (77 to 89 degrees) with a mean gradient of 0.0024.

The groundwater flow is affected to a large degree by the 200-ZP-1 Pump-and-Treat System, which has extraction wells to the east and injection wells to the west of these burial grounds. The groundwater velocity is 0.2 to 0.6 m/day (0.66 to 1.97 ft/day) (PNNL-14187).

2.1.5.5 Nonradioactive Dangerous Waste Landfill and 600 Area Central Landfill

The NRDWL and 600 Area Central Landfill (also called the SWL) are located in the central part of the Hanford Site about 5.5 km (3.4 mi) southeast of the 200 East Area. The ground surface elevation is approximately 162 m (530 ft) amsl. These landfills are underlain by the Hanford formation and the Ringold Formation. The depth to the water table is ~38 to 41 m (~125 to 135 ft) below ground surface and the uppermost unconfined aquifer thickness ranges from ~16 to ~25 m (~52 to ~82 ft) thick (PNNL-12227, *Groundwater Monitoring Plan for the Nonradioactive Dangerous Waste Landfill*). The uppermost unconfined aquifer is within the Hanford formation and the upper fines of the Ringold Formation Unit 4. The base of the uppermost unconfined aquifer is a 1 to 4 m (3 to 13 ft) thick clayey silt layer in the Ringold Formation Unit 4 (PNNL-12227). The direction and rate of groundwater flow are difficult to determine from water-table maps because of the extremely low hydraulic gradient (0.00005 [PNNL-12227]). The best indicators of flow direction are the major plumes of I^{129}, nitrate, and tritium from the 200 Areas. These plumes flow to the southeast (~125 degrees east of north) in the vicinity of the landfills. The rate of groundwater flow is ~0.026 to 0.23 m/day (~0.08 to 0.75 ft/day) (PNNL-14187).

2.2 WASTE SITE DESCRIPTIONS AND HISTORY

The DQO process considered 74 waste sites in the 200-SW-1 and 200-SW-2 OUs. Thirty-one sites are located in the 200 West Area; 23 waste sites are located in the 200 East Area; one, the Old Central Shop Area, is located about halfway between the 200 East and West Areas; one is in 200 North; and 18 are located in the surrounding 600 Area. The active TSD unit within the 200-SW-2 OU, the LLBG, contains seven burial grounds that have received waste (218-E-10, 218-E-12B, 218-W-3A, 218-W-3AE, 218-W-4B, 218-W-4C, and the 218-W-5 Burial Grounds) and one burial ground (218-W-6) that never has received waste. The other TSD unit, the 600 Area NRDWL (in the 200-SW-1 OU), is located south of the 200 Areas and received waste until 1985.

As described previously, Plate 1 (Appendix C, in pocket) shows the 200 Areas, the location of the Core Zone, and 200-SW-1 and 200-SW-2 OU site locations outside the 200 Areas and the Core Zone. Plate 2 (Appendix C, in pocket) shows the 200-SW-1 and 200-SW-2 site locations that are part of the 200 West Area. Plate 3 (Appendix C, in pocket) identifies the 200-SW-1 and 200-SW-2 OU sites located within the 200 East Area. A listing of the 53 previously reclassified sites in the 200-SW-1 and 200-SW-2 OUs, including short site descriptions, is provided in Appendix B, Table B-1. Summary information for the 74 waste sites considered in the DQO process is presented in Appendix B, Table B-2.

The following paragraphs provide an overview of the waste generation processes and disposal activities at these OUs, and summarize their histories.

2.2.1 History of Facilities Generating Solid Waste

The sources of wastes (both Hanford Site and offsite operations) that contributed to the burial grounds' inventory varied over time. The following section provides an overview of the various process activities that contributed waste to the 200-SW-1 and 200-SW-2 OU sites.

2.2.1.1 200 Areas History

The process history of the 200 Areas facilities changed over time; consequently the chemical and radionuclide waste streams produced by the specific facilities changed. Three chemical extraction methods were used to recover plutonium in 45+ yr of process operations:

- The bismuth phosphate batch process at the 221/224-B and -T Plants
- The Reduction-Oxidation (REDOX) continuous solvent extraction process at the 202-S Building
- The Plutonium-Uranium Extraction (PUREX) continuous solvent extraction process at the 202-A Plant.

All processes were characterized by the initial dissolution of the fuel rod jackets; (1) sodium hydroxide was used for aluminum-clad fuels, (2) ammonium nitrate/ammonium fluoride was used for zirconium-clad fuels, and (3) the plutonium-bearing uranium fuel rods were dissolved using concentrated nitric acid.

The chemical extraction of plutonium from the fuel rod solution then proceeded on either a batch or continuous basis depending on the plant. Multiple steps usually were required to separate plutonium from the associated uranium and fission products (DOE/RL-98-28). Fuel decladding wastes were processed and routed to underground tank storage. A detailed discussion of the 200 Areas processing operations may be found in Appendix H of the Implementation Plan (DOE/RL-98-28).

Types of solid waste generated varied greatly and included the following materials:

- Large contaminated vehicles, debris, and equipment (such as railway cars, pipes or ducts, tanks, ovens, pumps, columns, and other failed or outdated processing equipment)
- Uncontaminated sanitary solid wastes such as paper, broken office furniture, food cans, building rubble, light bulbs, and other ordinary trash
- Small contaminated wastes such as filters, rags, small tools, paint cans, rubber gloves, and clothing
- Metals and dry chemicals such as depleted uranium and lead
- Contaminated soil from UPR clean ups

- Very small amounts of liquid wastes (usually sealed in drums with stabilizers and/or absorbents) such as liquid plutonium or tritium solutions
- Small amounts of highly radioactive packaged wastes (usually from laboratory operations) stored in caissons.

2.2.1.2 100 Area History

Nine graphite-moderated, light-water-cooled reactors were constructed near the Columbia River in the Hanford Site 100 Areas over a period of 20 yr commencing in 1943. The reactors were used to produce plutonium by irradiating metallic uranium fuel elements with neutrons during the fission reaction in the reactor core. These nine production reactors were constructed from 1943 to 1963. The first eight reactors at the Hanford Site, designated 105-B, -C, -D, -DR, -F, -H, -KW, and -KE, were similar in design using a once-through light-water cooling system. The ninth reactor, 105-N, used a closed-loop light water cooling system.

Although 100 Area waste typically was disposed to trenches and burial grounds in the 100 Area, small amounts of it may have been buried in the 200 Areas after 1968 (for example at the 218-W-4B Burial Ground) (PNL-6820, *Hydrogeology of the 200 Areas Low Level Burial Grounds, An Interim Report*). These wastes are described as solid wastes such as rags, paper, plastic, pumps, tanks, equipment, and other miscellaneous dry waste presumably generated in support of reactor operations.

More detailed histories, including descriptions of facilities and waste sites in the 100 Areas, may be found in technical baseline reports that were written for the 100-B, 100-D, 100-H, 100-K, and 100-N Areas. The reports (BHI-00127, *100-H Area Technical Baseline Report*; WHC-SD-EN-TI-181, *100-D Area Technical Baseline Report*; WHC-SD-EN-TI-220, *100-B Area Technical Baseline Report*; WHC-SD-EN-TI-239, *100-K Area Technical Baseline Report*; and WHC-SD-EN-TI-251, *100-N Area Technical Baseline Report*) are listed in the reference section of this work plan.

2.2.1.3 300 Area History

The 300 Area contains facilities, particularly laboratories, that may have placed solid wastes and small amounts of liquids to 200-SW-1 and 200-SW-2 OU waste sites (particularly caissons) during the 1953 through 1968 time frame. These facilities include the 308, 309, 324, 325, 326, 327, and 329 Buildings. The missions that these facilities supported varied. No report exists detailing the history of the 300 Area burial grounds (WHC-EP-0912, *The History of the 200 Area Burial Ground Facilities*). A summary of the types of operations that were ongoing when solid wastes from the 300 Area facilities were sent to waste sites may be found in the *Chemical Laboratory Waste Group Operable Unit RI/FS Work Plan, Includes 200-LW-1 and 200-LW-2 Operable Units* (DOE/RL 2001-66, *Chemical Laboratory Waste Group Operable Units RI/FS Work Plan, Includes: 200-LW-1 and 200-LW-2 Operable Units*). Radioactive waste burials were stopped in the 300 Area in 1972; from that time forward, 300 Area wastes were disposed to the 200 Areas.

2.2.1.4 Offsite Sources

The amount of wastes accepted by the Hanford Site from offsite generators is small in proportion to the total amount of buried waste. These generators included a variety of government processes and programs. Contaminants associated with waste from offsite sources is not expected to differ significantly in form or content from waste generated at the Hanford Site.

A detailed discussion of offsite wastes, their source, location, volume, type, and history may be found in WHC-EP-0912 and WHC-EP-0225, *Contact-Handled Transuranic Waste Characterization Based on Existing Records*.

2.2.2 Overview of Solid Waste Operations

Hanford Site production processes and support activities used and disposed of a large variety of chemical and/or radioactively contaminated waste. When the Hanford Site began operations, each of the operational areas (100, 200 East, 200 West, and 300 Areas) had its own disposal facilities. With the exception of the 300 Area, each had burial grounds within or in the proximity of their perimeter fence. The 300 Area facilities were as far away as the current location of the Energy Northwest generating plant and close to the 400 Area. By 1970, increasing attention to reducing potential contamination to groundwater led to a decision to send all LLW to burial facilities within the 200 Areas, 200 to 300 ft above ground water. The last 300 Area burial ground (618-7) was closed in 1972. The last 100 Area burial ground closed in 1973 (WHC-EP-0912). Figure 2-5 shows a timeline illustrating the operational periods for the various burial grounds and processes, as well as key regulatory milestones.

From 1944 to 1970, low-level radioactive wastes were disposed of through shallow land burial, potentially including some wastes containing transuranic radionuclides. Records and inventory of waste disposal practices from this period are incomplete. The disposal site was considered to be the location for final disposition for solid wastes. Packaging was designed for transport, with little regard for long-term integrity; early radioactive waste was contained in wooden or cardboard boxes, 55-gal drums, and steel cans that were randomly dumped into trenches. Waste was not segregated. The waste was considered dry waste and did not contain significant volumes of liquid (see, e.g., HW-77274, *Burial of Hanford Radioactive Wastes*). There were numerous alternatives for disposal of large volumes of liquid (e.g., cribs, trenches, ditches, reverse wells), therefore, it is unlikely that the early burial grounds were used for disposal of bulk liquids. Occasionally, small volumes of bottled, highly contaminated liquids were placed inside a 55-gal drum and the drum was filled with concrete to provide shielding and to stabilize the liquid waste (DOE/RL-96-81, *Waste Site Grouping for 200 Areas Soil Investigations*). These wastes often were covered with less than 1.2 m (4 ft) of soil cover.

In 1970, the Atomic Energy Commission (AEC) defined TRU waste as a separate waste category and declared that it must be stored in a retrievable form in contamination-free packages designed to last for 20 yr, pending a decision on permanent disposal (AEC Immediate Action Directive 0511-21, *Policy Statement Regarding Solid Waste Burial*). From 1970 to 1973, any alpha-bearing waste with a half-life greater than 20 yr was considered TRU waste. In 1973, DOE established 10 nCi/g as the lower limit for TRU. Waste with TRU content greater than that limit was stored as retrievable TRU waste, and waste less than that limit was buried as LLW in the Hanford Site burial grounds. Subsequent to 1970, procedures were developed for recording waste generation, form, packaging, and placement to ensure that TRU waste could be located and retrieved. The data were entered into the Richland *Solid Waste Information Management System* (SWIMS) database via parent (shipment) records. In 1984, the TRU limit was revised upward to the present value of 100 nCi/g. The equipment required to assay waste against the 100 nCi/g limit was not installed in the TRU Storage and Assay Facility until 1985. Thus, a portion of the waste stored between 1970 and 1985 was not assayed and is believed to be LLW and not TRU waste because of the different criteria that were applied initially and the lack of assay equipment. The waste will be assayed and categorized as it is retrieved.

At the time that many of the Hanford Site's wastes were generated; however, there were no definitions or regulations governing the chemical constituents. In the early 1980s, low-level liquid organic waste was banned from land disposal at the Hanford Site burial grounds (WHC-EP-0912). Although many of these constituents subsequently have been classified as hazardous or dangerous wastes by EPA and Ecology, only waste disposed after RCRA regulations went into effect is termed mixed, hazardous, or dangerous. Where regulated chemical and radioactive constituents are combined in a waste form, waste disposed of (after RCRA regulations went into effect) is termed "mixed waste." Ecology has regulated mixed waste since August 19, 1987, the date that RCW 70.105.109, "Regulation of Wastes with Radioactive and Hazardous Components," went into effect. In 1987, the DOE issued a mixed byproduct waste rule stating that the hazardous components of mixed waste are regulated by RCRA (10 CFR 962, "Byproduct Material," and 52 FR 15937, "Radioactive Waste, Byproducts Material Final Rule"). On November 23, 1987, the EPA authorized Ecology to regulate the hazardous constituents of mixed wastes at the Hanford Site (52 FR 35556, September 22, 1987, "Final Authorization of State Hazardous Waste Management Program; Washington"). In 2003, the DOE and Ecology signed a tentative agreement establishing a time table for retrieval and packaging of suspect TRU waste. Retrieved waste found not to be TRU will be disposed of within the Hanford Site. TRU waste containing hazardous components (TRU mixed waste [TRUM]) may require treatment before shipment off site.

Waste management practices at Hanford Site burial grounds have varied over time. Record keeping was minimal in the early days of the Hanford Site, with little information on the amounts and types of waste buried. Some documents on waste disposal activities were issued in the 1950s and 1960s, but these are not complete. Beginning in the late 1960s, routine reports of low-level radioactive waste became more complete, often including the amount of land area used, volume of waste, curie content of the various radionuclides, and coordinates of the burial location. In addition to the radioactive waste, nonhazardous and hazardous nonradioactive wastes have been generated over the years, much of which was generated before the inception of regulation of wastes at the Hanford Site in 1987. Certain laboratory wastes, for example, fell into this category. Debris piles from the demolition of old buildings are another typical, although usually smaller, waste site type found in and around the 200 Areas. Large pits for the powerplant ash were placed close to the respective facilities. With the advent of environmental regulations in the 1960s and 1970s, the segregation of hazardous and dangerous wastes was partially accomplished, independent of legal application to the Hanford Site. This resulted in the construction/operation of the NRDWL and the adjacent SWL (DOE/RL-98-28).

Management practices have changed over the years as shown in Table 2-1. Since 1971, the contents of burial grounds have been tracked on databases, culminating in the current *Solid Waste Information Tracking System* (SWITS) database.

2.2.3 Historical Disposal Practices and Facilities

2.2.3.1 Informal Disposal Areas and Miscellaneous Disposal Sites

A number of miscellaneous and/or informal disposal areas exist on the Hanford Site. Most of these are small (less than half-acre) sites with scattered nonradioactive or radioactive surface or shallowly buried debris. This group covers a number of waste sites, including the following:

- Large-volume contaminants placed in specific engineered locations, such as powerplant flyash at the ashpits in the 200 East and 200 West Areas
- Construction debris sites
- Miscellaneous debris sites
- Sites of small chemical spills
- Small structures such as vaults or foundations
- Ash/debris burn pits dug to burn and then bury or transport the remaining rubble for burial and disposal (RHO-CD-78, *Assessment of Hanford Burial Grounds and Interim TRU Storage*)
- Miscellaneous small structures such as concrete foundations, silos, or wooden structures
- Dedicated dry waste vaults associated with each early 200 Area laboratory (DOE/RL-96-81). These waste sites are the 218-E-7, 218-W-7, and 218-W-8 sites (222-B, 222-S, and 222-T Vaults, respectively).

Most sites contain only waste, either on level ground or in a pit. A minority of these types of sites is radioactively contaminated.

2.2.3.2 Burial Grounds and Trenches

Burial grounds were used at the Hanford Site beginning in 1944. They generally consist of one or more type of burial trench(es) and/or solid waste disposal facilities such as caissons (discussed below). From 1944 to the late 1980s, solid LLW (including waste that might have contained chemical constituents) was disposed of in unlined burial trenches in the 200 Areas burial grounds. Since 1987, disposal of MLLW has been to lined trenches in the LLBG. Retrievable TRU wastes originally were (from 1970) stored in retrievable storage units in unlined trenches in the LLBG or at the Transuranic Waste Storage and Assay Facility until 1988, when they began to be sent to the Central Waste Complex (CWC) and other locations for storage before being repackaged for offsite disposal. After 1988, some remote-handled TRU waste continued to be stored in the LLBG on a case-by-case basis. The Waste Receiving and Processing Facility accepts waste from the CWC, as well as TRU waste received from the LLBG, for repackaging and shipment to an offsite disposal facility.

Before construction of RCRA-compliant disposal units in the 1990s, most of the wastes sent to the 200 Area Burial Grounds were disposed of and/or retrievably stored in unlined trenches. Figure 2-6 shows a typical solid waste burial trench. Non-TRU waste (LLW, MLLW, nonradioactive waste) typically was disposed to unlined earthen trenches approximately 4 to 5 m (12 to 16 ft) deep; some TRU trenches are up to 7.6 m (25 ft) deep. The Hanford Site soil, which consists largely of gravel and sand, sloughs off to an angle of repose of about 45 degrees during excavation. This required the movement of significant volumes of earth for the preparation and back filling of waste trenches. The wide top and relatively narrow bottom of the resulting trench, coupled with the practice of covering all radioactive wastes by the end of the day, has resulted in a low ratio of waste volume to land area (BHI-00175, *Z-Plant Aggregate Area Management Study Technical Baseline Report*).

Before TRU waste storage activities were transferred to the CWC, TRU wastes were stored at Transuranic Waste Storage and Assay Facility or in earthen trenches in modules that were physically separated from each other with soil. Later trenches did not use the soil divider, but used plywood and/or plastic tarps to protect the containers (usually 55-gal drums). The modules were 12 drums deep and 4 drums high. One early 1970s burial ground practice (218-W-4B) involved stacking the TRU-containing drums in a V-configuration, putting pressure on the lower drums; this practice was abandoned after its use in the one burial ground. Storage containers are intermixed in some trenches; several contain both LLW and TRU waste.

Burial trench locations are marked only by external survey marker monuments every 7.6 m (25 ft) around the perimeter; markers are about 4.9 m (16 ft) above the trench floor (WHC-EP-0225). Waste-module coordinates are included on burial forms. Module container-location forms also have been filled out since about 1975 to show container locations within each module. These forms were not used for TRU waste V-style trenches or trenches that had waste emplaced horizontally. Only overall module coordinates are tracked on the automated SWIMS, not individual container locations within the module. Waste retrieval experience to date indicates that the records have accurately recorded the location of waste packages.

Records were not kept on the amount and types of radionuclides buried as solid waste in the early days of the Hanford Site project. BHI-00175 indicates that only a few incomplete records on waste disposal activities from the 1950s and 1960s still exist. Since the late 1960s, routine reports of radioactive waste disposal in the 100 and 200 Areas have been more complete, including the land area, the volume of waste, the curies of the specific radionuclides, and the coordinates of the burial sites. Studies that estimate volume and radioactivity of previously unrecorded waste buried in the 100 and 200 Areas have been made based on the ratio of the nuclides present in fuel elements and other known and deduced waste generation and disposal information. Records suggest that the 200 Area sites contain 338 kg of plutonium in approximately 98,400 m^3 (128,702 yd^3) of waste; errors in accountability procedures suggest that there may be as much as an additional 200 kg of plutonium disposed in these burial grounds (RHO-CD-194, *A Study of the 234-S Building Inventory Difference for the Years 1956 through 1966*).

Inventories have been kept on the SWIMS database and its more updated version, the SWITS (BHI-00175).

2.2.3.3 Waste Packaging

Typical onsite waste packages historically used for LLW at the Hanford Site are summarized below (WHC-EP-0225).

- Cardboard boxes: Used for slightly contaminated mixed fission product (MFP) wastes, such as wiping tissue.
- Plastic shrouds: Failed equipment that could not be repaired was wrapped in sheet plastic and placed into the burial trench.
- Metal drums: Used for grossly contaminated MFP wastes, such as rags and small pieces of hardware.
- Wooden, concrete, and metal boxes: Used for large equipment contaminated with MFP, depending on size, weight, and radioactivity.
- Casks: Used for shielding high dose materials.

The containers vary in size from 115 L (30-gal) drums to 64,000 L (16,700 gal), 2.7 by 3.9 by 6.1 m (9- by 12.7- by 20-ft) boxes. Boxes of up to 12.2 m (40 ft) in length have been anecdotally reported. Containers were emplaced at burial sites on a "by-shipment basis" from 1970 to 1982 (WHC-EP-0225).

Labeling methods for containers emplace before 1981 are not long-lived, were not tracked, and would provide little positive container identification information during retrieval operations (WHC-EP-0912). Since 1982, burial records have been maintained in SWIMS and SWITS to provide individual container location (WHC-EP-0225).

After 1987, fiberboard and cardboard boxes were not allowed in the burial grounds. Containers were required to be at least 90 percent full so that subsidence would not occur. Some bulk (non-containerized) wastes such as soil, vegetation, building rubble, and other homogeneous waste having relatively low concentrations of radionuclides and chemical constituents were allowed in the burial grounds.

2.2.3.4 Caissons

Caissons were used to receive remote-handled high dose rate and TRU wastes. Several types of caissons historically were used at the Hanford Site.

- Alpha and MFP caissons received wastes that were transported to the caisson in a truck-mounted cask that was shielded. The waste consisted of packaged 5-gal paint cans. Small metal wastes such as fuel element clips and spacers were placed directly, without packaging, into a caisson. Separate caissons usually were provided for the packaged and non-packaged wastes. Caissons consisted of concrete/steel chambers set below ground surface with an associated steel riser pipe through which waste packages were dropped into the caisson. Caissons typically are ventilated to reduce exposures to personnel depositing waste packages.

- A type of caisson called a vertical pipe unit was configured in one of two ways: as vertical steel casing or by welding together two to five open-ended 55-gal drums end-to-end and setting them vertically in the ground. After filling the vertical pipe unit with solid waste packages, the caissons were backfilled and capped with concrete (BHI-00175). They sometimes received small quantities of liquid wastes (RHO-CD-78).
- Crib pits were 2.7 m^2 (29 ft^2) and constructed of railroad ties. They were used for the disposal of small reactor hardware (RHO-CD-78).
- Concrete block buildings were constructed and configured to hold boxes of contaminated equipment. The boxes often were covered with vermiculite for fire protection (RHO-CD-78).
- Buried vaults were constructed of vertical cylindrical concrete culvert sections for disposal of laboratory wastes (RHO-CD-78). These are different from the laboratory vaults described in the section on miscellaneous disposal sites (Section 2.2.3.1), and are located within some of the burial grounds.

Various types of solid waste burial facilities are illustrated in Figures 2-7, 2-8, and 2-9.

2.2.3.5 Drag-Off Boxes

Drag-off boxes were used from the earliest days at the Hanford Site. The first boxes were made of wood, placed in a trench, and covered with soil. Drag-off disposals were performed in burial grounds next to railroad tracks. A cable was connected to a box at the location where the waste was generated and stretched along spacer cars, which were used to keep the train crew at a safe distance from the radioactive box. When the train reached the burial site, a tractor in the burial ground dragged the box to the end of a trench.

The early wooden boxes often collapsed after disposal. In cases where a large radiation field was present, this occurrence could overexpose workers. If the collapse should occur when workers were on top of the trench, there would be danger of suffocation of the workers. Some drag-off boxes failed while they were being pulled to the end of the trench, also potentially overexposing workers. The boxes were redesigned, and eventually upgraded to the concrete burial box that became standard (WHC-EP-0912).

2.2.3.6 Liquid Wastes

For the 200-SW-2 OU (radioactive) waste sites, a review of historical records (WIDS) has shown that bulk disposal of liquid waste was not a significant contributor to the waste loading at sites receiving LLW (see also HW-77274). Most waste sites do not have detailed records. However, a Rockwell International internal letter (RHO-65462-80-035, "Description of Waste Buried in Site 218-W-4B") documents disposal activities over a 3-yr period (1968-1970) at the

218-W-4B Burial Ground, including the disposal of minimal volumes of liquid wastes in drums. The liquid waste consisted mostly of the following:

- Tritium contained in metal cylinders
- Lithium co-product (tritium) target elements
- Plutonium liquids in cartons.

A total volume of about 6 m^3 (including the solid material associated with the liquids) was recorded. In all known cases, the volumes of liquid historically were small, because until 1973 bulk organic liquids could be disposed more conveniently to cribs and trenches. Occasionally, small volumes of bottled, highly contaminated liquid were placed inside a 208 L (55-gal) drum and the drum filled with concrete. The concrete shielded the radiation and stabilized the liquid waste. The concrete drums were placed in the trenches along with the other wastes (DOE/RL-96-81).

Reportedly, no bulk liquids or free liquids (other than lab packs packed with absorbents) have been allowed into the 200-SW-1 landfills (WIDS). The only exception is bulk liquid in the SWL, which received principally solid waste, but also received up to 5,000,000 L (1,320,000 gal) of sewage and 380,000 L (100,000 gal) of garage wash water (1100 Area Catch Tank waste liquid).

NOTE: The SWL is discussed in more detail in Section 2.2.6.1.1. This site is located directly adjacent to the NRDWL in the 200-SW-1 OU, so the liquid flux may have impacted contaminant distributions in that site.

2.2.4 Current Disposal Practices

In 1987, the State of Washington, through WAC 173-303, "Dangerous Waste Regulations," began enforcing EPA's hazardous waste program for mixed waste at the Hanford Site. Before this time, some burial records contained information on some nonradioactive constituents, but these records are incomplete.

The RL operates the lined, MLLW disposal trenches as RCRA Subtitle C land disposal units. These two trenches (Trench 31 and Trench 34) are located at the southern end of the 218-W-5 Burial Ground, in the 200 West Area and are permitted for both storage and disposal activities. Treatment activities in these two trenches also are under consideration. As RCRA-compliant land disposal units, these trenches are constructed with double-liners and a leachate collection system. In September 1999, storage ended and disposal began of MLLW (predominantly macroencapsulated debris) in Trench 34, constituting the first RCRA-compliant disposal of Hanford-generated MLLW at the Hanford Site (McDonald et al. 2001, "Hanford Site Mixed Waste Disposal").

The two MLLW disposal trenches have a combined disposal capacity of approximately 42,000 m^3 (55,000 yd^3). This disposal capacity is estimated to be sufficient to meet Hanford Site MLLW disposal needs through fiscal year (FY) 2007. Construction of additional capacity is planned at another location on the Hanford Site outside of the current LLBG TSD unit boundaries (McDonald et al. 2001). Trenches 31 and 34 are expected to be filled to capacity before beginning the scheduled 200-SW-2 OU CERCLA remedial actions.

The two trenches are nearly identical in design. Each trench is 76.2 by 30.5 m (250 by 100 ft) at the base, with a side slope ratio of three horizontal to one vertical. The bottom of the landfill excavation is sloped to facilitate leachate collection, giving a variable depth of between 7.6 m and 9.1 m (25 ft and 30 ft). Each trench has a disposal capacity of approximately 21,000 m^3 (27,500 yd^3) of waste, although this volume can vary significantly based on the waste form and other criteria such as the need for shielding to reduce the dose from remote-handled waste (McDonald et al. 2001).

Each trench is equipped with a double liner and leachate collection system. The primary leachate collection system is composed of drainage gravel and perforated drainage pipes that lie along the centerline of the trench bottom and at the base of the side slopes. A secondary leachate collection system is installed below the primary liner and above the secondary liner system. The leachate collection systems are designed to direct leachate to the sump area located at the east end of the trench. Pumps are located in the sump area, and provide for removal and storage of leachate in a tank outside the trench. The trench has been fitted with a rain curtain to divert rainwater for collection and non-regulated disposal (because it never contacts waste), minimizing the generation of leachate (McDonald et al. 2001).

2.2.5 Summary Descriptions of 200-SW-1 and 200-SW-2 Operable Units

The following discussion provides an overview of the 200-SW-1 and 200-SW-2 OUs. These summaries are provided in the context of the preceding information to assist the reader in understanding the basis for their groupings.

2.2.5.1 Nonradioactive Landfills and Dumps Group – 200-SW-1 Operable Unit

The 200-SW-1 OU includes a number of nonradioactive landfills and dump sites that were created during the construction and operation of the 200 Area facilities. Although a few sites were excavated, engineered structures, which were operated in a manner to contain waste releases, most sites simply were accumulation points for materials not regarded at the time to be potentially hazardous (DOE/RL-96-81).

Non-engineered landfills and dump sites generally consist of surface areas or pits containing a variety of non-contaminated items; examples include wire, pipes, cans, cardboard, concrete, wood, and construction debris. Most of the contents were randomly dumped and are not contained. Steam generating plants produced large quantities of ash that were discarded into ash pits that later grew into aboveground surface mounds; the Waste Site Grouping Report (DOE/RL-96-81) reports that the ash was found to be non-hazardous.

Tumbleweeds, office waste, paint, and solvents were burned in pits to reduce volume. Burn pits were also sometimes used to detonate shock-sensitive and potentially explosive chemicals; these sites were later closed in accordance with RCRA (DOE/RL-96-81).

Three engineered structures included in this group are the SWL, NRDWL, and the 600 OCL. All three are inactive and are located southeast of the 200 Areas.

2.2.5.2 Radioactive Landfills and Dumps Group – 200-SW-2 Operable Unit

Most of the 200 Area burial grounds are inactive and have been backfilled and surface stabilized with at least 0.6 m (2 ft) of clean dirt and seeded with grasses. Before 1960, detailed inventory records were not maintained; specific information about the early burial grounds is often not available (DOE/RL-96-81). Before 1970, the burial grounds in the 200 Areas included the following categories:

- Dry Waste Burial Grounds – received radioactive waste packaged primarily in fiberboard boxes. All types of miscellaneous wastes, ranging from contaminated soils and potentially contaminated rags, paper, and wood to gloveboxes containing multigram quantities of plutonium, have been placed in these facilities.

- Industrial Burial Grounds – received radioactive waste that was usually packaged in large wooden or concrete boxes, containing large quantities of fission products. For the most part, these sites were restricted to burial of large pieces of failed or obsolete equipment from the chemical processing facilities, although some items came from the 100 Areas.

- Construction Burial Grounds – mainly limited to burial of low-activity wastes resulting from construction work on existing facilities.

- Vaults – small waste vaults near the 222-B, 222-T, and 222-S Analytical Laboratories used for the disposal of small quantities of high dose rate solid laboratory wastes containing mixed fission products and some plutonium.

- Caissons or Vertical Pipe Units – used for disposal of hot cell waste or high plutonium waste in the 218-W-4A and 218-W-4B Burial Grounds. The caissons in the 218-W-4A Burial Grounds were made of welded 55-gal drums; the ones in the 218-W-4B Burial Grounds were made of corrugated metal or cement (WHC-EP-0912).

The 200-SW-2 OU contains burial grounds from each category. All of the low-level radioactive waste burial grounds are located inside the 200 East and 200 West Area fenced boundaries. Each burial ground consists of one or more trenches; sizes of burial grounds range from less than 0.4 to 70 hectares (1 to 173 acres).

2.2.6 Descriptions of Waste Sites

Tables B-1 and B-2 in Appendix B present brief summaries extracted from WIDS for all 127 sites in the OUs. The sites in Appendix B, Table B-1 have been reclassified as "Consolidated" or "No Action" under WIDS. The accepted sites (under WIDS) in Appendix B, Table B-2, are categorized by bin. The Bin 3A (TSD unit) and 3B waste sites in the 200-SW-1 and 200-SW-2 OUs are described in more detail in the following sections. More detailed descriptions are not provided for the Bin 1 and 2 sites. None of the Bin 1 or Bin 2 sites are anticipated to present a concern for human health or environmental exposure. Individual site descriptions for those sites are less significant in terms of establishing an approach for characterization under this work plan. A general description of Bin 1 and Bin 2 sites may be found in Chapter 1.0.

Assignment to bins is based on conceptual models of contaminant distribution. Anticipated remedial alternatives and remedial paths are based on the conceptual models.

2.2.6.1 Treatment, Storage, and/or Disposal Units (Bin 3A)

There is one (600 Area) RCRA TSD unit in the 200-SW-1 OU and one (200 Area) RCRA TSD unit (consisting of seven radioactive burial grounds and one unused burial ground) in the 200-SW-2 OU. As noted in Chapter 1.0, these units are the NRDWL (600 Area) in the 200-SW-1 OU, and the LLBG (218-E-10, 218-E-12B (with the exception of Trench 94), 218-W-3A, 218-W-3AE, 218-W-4B, 218-W-4C, 218-W-5, and 218-W-6 Burial Grounds) in the 200-SW-2 OU. The units are described in detail in the following sections. All TSD units have been assigned to Bin 3A, because they will each require a cap for closure. Copies of the most recently approved Part A Permit applications for the two TSD units are contained in DOE/RL-91-28, Revision 4, *Dangerous Waste Portion Of The Resource Conservation And Recovery Act Permit For The Treatment, Storage, And Disposal Of Dangerous Waste Hanford Facility Dangerous Waste Permit Application, General Information Portion,* Attachment 33. Publicly available portions of this document are available on the DOE, Richland Operations Office website, http://www.hanford.gov/docs/rl-91-28/rl91-28chp_02.htm#2.2.1.2 .

2.2.6.1.1 600 Area Nonradioactive Dangerous Waste Landfill

The NRDWL is an inactive TSD unit site. Although a site closure plan was written in 1990, the closure plan has not been approved. Therefore, NRDWL is classified as "Active" in WIDS. The site provided disposal of dangerous waste generated from process operations, research and development laboratories, maintenance activities, and transportation functions throughout the Hanford Site (WIDS). Figure 2-10 illustrates the present configuration of the trenches in the NRDWL, trench identification numbers, trench types, and operational dates.

The NRDWL is located about 5.6 km (2.5 mi) southeast of the 200 East Area on Army Loop Road, southwest of the Route 4 intersection and southeast of the 200 East Area. The landfill began operation in 1975 and has an area of 4.5 hectares (11 acres). It consists of 19 parallel trenches, each 122 m (400 ft) long, 4.9 m (18 ft) wide at the base, and 4.6 m (15 ft) deep. A triangular column of undisturbed soil with approximately 1:1 side slopes separated the trenches as they were constructed. The final profile of the trench varied depending on the type of waste received. The trenches were typically backfilled and covered with 2 to 3 m (6 to 10 ft) of soil at the end of each operating day. Beginning in 1975, chemical waste was disposed of in six trenches, asbestos in nine trenches, nonhazardous solid waste in one trench, and three were unused. The last receipt of dangerous waste was in May 1985, and the last receipt of asbestos occurred in May 1988. A permanent 2.4 m (8 ft) high fence with lockable gates surrounds the NRDWL.

The SWL is adjacent to NRDWL on the south side. It is a larger facility (27 hectares [67 acres]) that received principally solid waste, including paper, construction debris, asbestos, and lunchroom waste. It also received up to 5,000,000 L (1,320,000 gal) of sewage and 380,000 L

(100,000 gal) of garage wash water. The liquid waste was discharged to east-west oriented trenches at the perimeter of the main solid waste area, along the northeast and northwest boundaries of the SWL.

Both landfills were operated as a single landfill, known as the Central Landfill. Because of the presence of dangerous waste in the chemical trenches, the 19 northernmost trenches (1N, 2N, 18N, 19N, and 20-34) were designated as the NRDWL under the RCRA Part A Permit Application. The southern two-thirds of the area was later designated as the SWL,[1] which is not a TSD unit. The boundary line separating the NRDWL from the SWL is located halfway between the trench designated as "JA Jones" and the southern border of NRDWL (DOE/RL-90-17).

A geophysical survey of the NRDWL was conducted in 2000. It was noted that some of the trench centers vary significantly from the previous documentation and, in some locations, the buried debris is covered by only 0.6 m (2 ft) of fill. Unused portions of Trenches 19N and 26 have remained open since 1985.

Trenches 18N, 24, and 32 were not used for disposal. Trenches 19N, 26, 28, 31, 33, and 34 received an unknown volume of liquid waste consisting of laboratory chemicals, bulk organic waste, solvent waste, paints, paint thinners, waste oils, and empty containers. The chemical trenches were constructed with an access ramp to the bottom of the trench to allow transfer vehicles to access the working face. A 20 to 30.5 cm (8- to 12-in.) layer of gravel and cobble was placed over the bottom of the trench to form a temporary roadbed. The containerized chemical waste was off-loaded from transport trucks that had backed down the access ramp and up to the working face of the trench. Placement of the waste was supervised by a landfill operator. Containers (the majority of which were 55-gal lab packs) were arranged in rows, standing end-to-end in the bottom of the trenches. Containers normally were placed in a single layer along the bottom of the trench; however, when a large shipment of drums was received, drums were stacked two high. At the end of the day, a portion of the spoil pile was pushed over the waste containers with a crawler/tractor to form the operational cover. Typically, the operational cover for the chemical trenches was approximately 3 m (10 ft) thick. When drums were stacked two high, the cover was reduced to approximately 2 m (6 ft) (DOE/RL-90-17).

Trenches 2N, 20, 21, 22, 23, 25, 27, 29, and 30 received friable and non-friable asbestos solid waste from building demolitions/renovations. Miscellaneous trash and debris from offices, lunchrooms, and construction/demolition activities were disposed of in Trench 1N and approximately 5,300 L (1,400 gal) of nondangerous/nonradioactive septic tank sludge was disposed to Trench 34. Waste at the asbestos and sanitary waste trenches were unloaded at the base of the working face (as was done with the chemical trenches) or at the top edge of the working face. When waste was unloaded at the top edge, a tractor was used to push the waste into the trench to the desired height. In both cases, at the end of a day of operation, a portion of the spoil pile was pushed over the refuse to form an operational cover. The cover was typically

[1]The combined two landfills (NRDWL and SWL) were referred to as the Central Landfill; however, the SWL is referred to in WIDS as the Central Landfill or 600 CL.

1.2 m (4 ft) thick, but varied from about 1.2 to 2 m (4 to 6 ft) depending on the thickness of the waste layer (DOE/RL-90-17).

Reportedly, no bulk liquids or free liquids (other than lab packs packed with absorbents) have been allowed into the landfill. All dangerous wastes were containerized, with the exception of asbestos and sanitary solid wastes, before to disposal (WIDS).

Quarterly surveillance and maintenance inspections are done by the Radiation Area Remedial Action (RARA) group. NRDWL is also routinely monitored by groundwater wells.

2.2.6.1.2 218-E-10 Burial Ground

The burial ground began service in 1960, covers 90 acres, and contains remote-handled (RH)-LLW and contact-handled (CH)-LLW, most in concrete boxes (DOE REG-0271, *Low-Level Burial Grounds Fact Sheet*). One source (HNF-SD-WM-ISB-002, *Solid Waste Burial Grounds Interim Safety Basis*) reports that this burial ground contains suspect pre-1970 RH waste containing transuranic constituents.

The 218-E-10 Burial Ground is located approximately 610 m (2,000 ft) northwest of the B Plant and directly west of the 218-E-5A Burial Ground. The 218-E-10 Burial Ground consists of 13 trenches running north to south and one trench running east to west (Figure 2-11). Trench 1 is 7.3 m (24 ft) deep with bottom dimensions of 400 m (1,300 ft) long by 4.6 m (15 ft) wide. Trenches 2 through 18 are 4.6 m (15 ft) deep, 5 m (16 ft) wide at the bottom, and vary in length from 245 to 350 m (805 to 1,145 ft). The backfilled trench running east-west has bottom dimensions of 30 m (100 ft) long by 4.6 m (15 ft) wide (WIDS).

The 218-E-10 Burial Ground, also known as 200 East Industrial Waste No. 10, has received approximately 26,388 m^3 (35,514 yd^3) of waste from PUREX, B Plant, and N Reactor and other failed equipment and mixed industrial wastes (e.g., concrete canyon cover blocks, centrifuge blocks, tubing bundles, jumper vessels, pumps, columns, and filters) (SWITS). Waste was last placed in a 218-E-10 Burial Ground trench in the year 2000. The trenches contain low-level radioactive waste, MLLW, and unsegregated, RH waste. Trench 9 contains the MLLW disposed after the effective date of mixed waste regulation, August 19, 1987. There is no retrievably stored waste under Tri-Party Agreement Milestone M-091-40 in the 218-E-10 Burial Ground.

In 1960, a partially covered burial box containing PUREX tube bundles caused an airborne contamination spread (UPR-200-E-23). The southeastern section (Trenches 1 through 5) was backfilled and surface stabilized by the RARA group and revegetated with grasses in 1980. Surveillance and maintenance of the surface-stabilized portion was performed by the RARA group. From April to September 1980, surface stabilization activities were done on the eastern 10 hectares (25 acres) of this burial ground. The northern portion of this burial ground never has been used for waste disposal (WIDS).

These burial ground trenches are contained within the proposed groundwater monitoring system for the low-level burial grounds. Routine airborne radionuclide monitoring is performed. A perimeter radiological survey is done annually (WIDS).

Hanford Site drawings that describe this site include H-2-92004, Sheets 1 and 2, *Industrial Burial Ground 218-E-10 Site Plan and Details*; H-2-34762, *Area Map*; and H-2-31269, *218-E-Waste Burial Sites Plot Plan.*

2.2.6.1.3 218-E-12B Burial Ground

The burial ground began service in 1967 (WIDS), covers 173 acres, and contains LLW, suspect retrievably stored TRU waste in two trenches, and defueled Navy reactor compartments in Trench 94 (DOE REG-0271). The burial ground is located approximately 305 m (1,000 ft) north of the C Tank Farm and south of 12th Street (Figure 2-12).

The 218-E-12B Burial Ground, Trench 94, is currently receiving defueled U.S. Navy reactor compartments as an active RCRA TSD unit in the 200-SW-2 Radioactive Landfills and Dumps Group OU (DOE/RL-98-28). Trench 94 is not addressed in this document, because operations are expected to continue beyond the beginning of the scheduled time period for remedial actions in the 200-SW-2 OU.

The original burial ground was designed to have 29 trenches. An expansion to the north and west enlarged the burial ground to include the potential for 138 trenches oriented in a north-south direction.

The trenches vary in length from 94 to 580 m (307 to 1,901 ft). The first six trenches were 0.9 m (3 ft) wide and 1.2 m (4 ft) deep. The rest of the trenches were designed to be 4.8 m (16 ft) deep. The burial ground is marked and radiologically posted (WIDS).

The 218-E-12B Burial Ground has received 168,266 m^3 (220,083 yd^3) of solid LLW, generated mostly from facilities located in the 200 East Area including PUREX failed equipment, vent risers, filter boxes, liquid level risers from the 216-B-14 Crib, and Sr-90 contaminated soil dredged from the 216-B-63 Crib after UPR-200-E-138 occurred (DOE/RL-92-05, *B Plant Source Aggregate Area Management Study Report*) (SWITS). Only 36 trenches have been filled completely and two were partially filled. The last waste trench at the 218-E-12B Burial Ground was closed in 2004, with the exception of Trench 94.

The 218-E-12B Burial Ground is the second burial ground out of four under Tri-Party Agreement Milestone M-091-40 scheduled to have the retrievably stored waste removed.

The southeastern portion of the burial ground (Trenches 1 to 17) was interim-stabilized in 1981 with 46 to 61 cm (18 to 24 in.) of uncontaminated soil. Surveillance and maintenance of the stabilized portion are performed periodically. In January 2000, two contaminated tumbleweeds were removed from the site. The tumbleweeds read from 29,000 to 59,000 d/min per 100 cm^2 beta/gamma, less than 20 d/min alpha. In addition, 13 tumbleweed fragments read from 2,500 to 399,000 d/min per 100 cm^2 beta/gamma.

Hanford Site drawings that describe this site include H-2-33276, Sheets 1 and 2, *Dry Waste Burial Ground 218-E-12B*; and H-2-96660, *East Area Dry Waste Burial Ground.*

2.2.6.1.4 218-W-3A Burial Ground

The burial ground was placed in service in 1970, covers 50 acres, and contains LLW, MLLW, TRU, and TRUM (DOE REG-0271).

The 218-W-3A Burial Ground is an active TSD unit located on Dayton Avenue and 27th Street, immediately southeast of their intersection. It is west of the 221-T Building and immediately north of the 218-W-3 Burial Ground (Figure 2-13). The site is 380 m (1,250 ft) long and of irregular shape (BHI-00175).

The site is a burial ground that was designed to contain 61 dry and industrial waste trenches running in an east-west direction. However, the irregularly shaped unit actually consists of eight trenches of varying sizes. Trenches range from 123 m (403 ft) to (900 ft) long. The side slopes are 1:1 or as required to match the natural angle of repose. Trench depths range from 3.7 to 5.8 m (12 to 19 ft) (BHI-00175).

The site contains approximately 101,634 m^3 (132,932 yd^3) of solid, dry, industrial wastes (SWITS). Trench 7 contains waste from the clean-up activities at the Three Mile Island Nuclear Plant. Trench 8 contains non-TRU and TRU waste. Trenches 5 and 17 contain TRU waste. Trench 17 also contains fiberglass-reinforced plywood boxes in various sizes from weapons decommissioning programs. Trench 14 contains 10 large concrete burial boxes of radioactive soil from the S Tank Farm generated from a salt waste spill from the 102-S Tank transfer piping in 1973. Dose rates at the site of the spill before removal of the contaminated soil ranged to a maximum of 9 mR/h. Trench 40 contains industrial waste. This TSD unit also received irradiated fuel elements from General Electric, Vallecitos, California; waste from Livermore National Laboratory; General Electric, Walla Walla, Washington; 100 N Areas; Hanford Environmental Health Foundation; Energy Systems Group, Battelle Columbus Laboratory, and various other on site and off site locations (BHI-00175). The last open trenches at the 218-W-3A Burial Ground were closed in 1993.

Trenches 19 and 6S contain MLLW disposed of after the effective data of mixed waste regulation at the Hanford Site (August 19, 1987). The 218-W-3A Burial Ground is the third burial ground out of four under Tri-Party Agreement Milestone M-091-40 scheduled to have the retrievably stored waste removed.

This burial ground was flooded in the winter of 1979 to 1980, when several inches of snow on top of solidly frozen ground were followed by a quick warming. The burial ground was covered with standing water, almost continuous from the dirt road on the east side to the asphalt road on the west side of the burial ground.

On January 21, 1997, a radiological control technician discovered contamination levels to 60,000 d/min beta-gamma (no alpha) per 100 cm^2 in pieces of wind-blown tumbleweed at Trench 26. The area in which the contamination was found is posted as an Underground Radioactive Materials Area.

Hanford Site drawings that describe this site include H-2-34880, *Dry Waste Burial Ground 218-W-3A*, Sheets 1 and 2; H-2-31268, *Solid Waste Burial Grounds Plot Plan*; and H-2-44511, *Area Map – 200 West "T" Plant Facilities*, Sheets 151, 152, 160, and 167 (BHI-00175).

2.2.6.1.5 218-W-3AE Burial Ground

The burial ground covers approximately 50 acres and began receiving waste in 1983. It contains MLLW and LLW including large equipment.

The 218-W-3AE Burial Ground is located directly east of and adjacent to the 218-W-3A Burial Ground in the 200 West Area (Figure 2-14). The site has received 34,330 m^3 (44,901 yd^3) of waste (SWITS). The irregularly shaped unit consists of 8 trenches of varying sizes. Each trench location is identified by a concrete post with brass name plate (BHI-00175). The last trenches at the 218-W-3AE Burial Ground were closed in 2004.

This burial ground includes Trenches 5 and 8, which are wide-bottom stacking trenches, and Trench 26, which was dug with a wide bottom to dispose of LLW railroad cars and large tanks. The burial ground received miscellaneous wastes such as rags, paper, rubber gloves, disposable supplies, broken tools, etc. and industrial waste such as failed equipment, tanks, pumps, ovens, agitators, heaters, hoods, jumpers, and accessories. Trenches 2, 3, 13, and 16 have received RH-LLW.

The location designated as the 218-W-3AE Burial Ground includes an area that had previously been the 216-T-4B seepage ponds for T Plant condensate effluent. The pond area was often dry, because the majority of the effluent was absorbed in the 216-T-4-2 Ditch.

In the summer of 2000, contaminated tumbleweeds were found growing in the 216-T-4B seepage pond area. As of 2002, no burial trenches have been excavated into this portion of the designated burial ground property.

Trenches 5 and 8 have received MLLW disposed after the effective data of mixed waste regulation at the Hanford Site (August 19, 1987). There is no retrievably stored waste in the 218-W-3AE Burial Ground under Tri-Party Agreement Milestone M-091-40.

Hanford Site drawings that describe this site include H-2-75351, *Dry Waste Burial Ground 218-W-3AE*; Sheets 1, 2, and 3, and H-2-44511, *Area Map – 200 West "T" Plant Facilities*; Sheet 150, 152, 160, and 167. Typical trench cross sections are described on H-2-75351, Sheet 2.

2.2.6.1.6 218-W-4B Burial Ground

The burial ground began receiving wastes in 1970. It covers 9 acres, and contains TRU and TRUM, some in caissons (DOE REG-0271).

The 218-W-4B Burial Ground is located in the central portion of the 200 West Area, about 150 m (500 ft) northwest of the 234-5Z Building, directly west of the 231-Z Building (Figure 2-15). It consists of 14 trenches (one containing 12 caissons, of which 4 caissons contain suspect TRU waste). Trenches are approximately 490 m (1,600 ft) long and 3.7 m (12 ft) deep (Hanford Site drawing H-2-33055, *Dry Waste Burial Ground 218-W-4B*).

The burial ground received miscellaneous radioactive waste from the 100, 200, and 300 Areas as well as offsite shipments from 1967 to 1990. The burial ground has received 10,461 m^3 (13,682 yd^3) of waste. Solid waste disposed at the site consists of rags, paper, cardboard, plastic, pumps, tanks, process equipment, and other miscellaneous high dose rate and TRU dry waste (BHI-00175). The last waste trench at the 218-W-4B Burial Ground was closed in 1990.

The site contains 3,200 m^3 (4,186 yd^3) of retrievably stored (post-1970) suspect TRU waste (BHI-00175). It also contains unsegregated suspect TRU waste and suspect CH-TRU waste stored on an asphalt pad, mostly in 210 L (55-gal) drums.

A series of documents published in approximately 1980 describes the number of trenches, and the number and contents of the caissons. Some caissons contain TRU and some contain non-TRU wastes. The documents do not consistently describe the number or contents of trenches and caissons. However, a 1980 internal letter report, RHO-65463-80-126, "Inconsistencies in 218-W-4B Site Data," indicates that to the author's best knowledge the 218-W-4B Burial Ground is composed of 13 trenches and one row (Trench 14) of 12 caissons. Trenches 7 and 11 and four caissons contain the post-1970 TRU waste. Ten remaining trenches contain unsegregated low-level and TRU waste, and one contains LLW. Trenches 1 through 6 and 8 contain unsegregated mixed TRU and non-TRU waste. Trench 9 contains unsegregated TRU waste. Trenches 10, 12, and 13 contain non-TRU waste. All the trenches in this burial ground are covered with earth (DOE/EIS-0286F, *Final Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement, Richland, Washington*).

A very small volume of liquid was disposed of, in the form of tritium contained in metal cylinders, or plutonium liquid. Known quantities of liquid are noted in RHO-65462-80-035. This document contains an inventory of caisson and trench contents for the period between May 1, 1968, through May 1, 1970.

Trench 14 contains 12 caissons that are underground storage structures for the disposal of 3.8 L to 18.9 L (1 gal to 5 gal) cans of RH waste (DOE/EIS-0286F). The caisson wastes were received from 200 Area facilities, the 300 Area, and the 100-N Area (DOE/RL-96-81).

The caissons have been used as explained below. This information is judged (RHO-65463-80-126) to be the most accurate at the current time, based on the available information.

- Caissons 1 through 5 (also called alpha caissons) were planned for TRU waste. From 1970 to 1988, retrievably stored TRU waste was placed in four of the five. The caissons have been isolated; one caisson (Alpha #5) never has been used. The five alpha caissons are approximately 2.7 to 3 m (8.75 to 10 ft) in diameter, 3 m (10 ft) high concrete-and-steel covered vaults with steel lifting lugs and a 0.9 m (3 ft) diameter access chute. The alpha caissons weigh approximately 11,800 kg (26,000 lb).

- Six general (also called dry waste or MFP) caissons in this burial ground containing LLW were filled from 1968 to 1979. Dry waste or MFP-type caissons are 2.4 m (8 ft) in diameter and 3.1 m (10 ft) high. The last shipment of waste was deposited into MFP Caisson #6 in 1990. According to WIDS, two of these caissons were constructed the same way as the alpha caissons, except with corrugated metal instead of steel and concrete.

- There is one caisson referred to in the literature as a United Nuclear Industries (UNI) below-grade silo-type caisson used for high activity N Reactor waste. The UNI silo-type caisson is 3 m (10 ft) in diameter and 9 m (30 ft) tall with corrugated pipe containers placed on a concrete foundation with a top concrete shielding slab. It has a 1.1 m (3.5 ft) diameter access chute. Waste is placed beneath a concrete slab 4.6 m (15 ft) below grade.

All three of the above caisson types are equipped with air filter systems (Figures 2-7 and 2-8).

Starting from the southeast corner of the burial ground, the caissons are in order: MFP #1, MFP #2, UNI, MFP #6, Alpha #3, MFP #5, MFP #3, MFP #4, Alpha #2, Alpha #5, Alpha #4, and Alpha #1 (DOE/EIS-0286F). Literature sources conflict on placement of caissons. No additional waste placement is planned for any of these caissons.

This burial ground was flooded in the winter of 1979 to 1980. Several inches of snow, followed by quick warming, caused the burial grounds to flood deeply (WHC-EP-0912).

Trenches 1 through 6 were backfilled and surface stabilized with clean fill in 1983. The surface was revegetated with grass. Trench 7 is covered with a 1.2 m (4 ft) soil mound. The remaining trenches were backfilled after use and stabilized with clean gravel in 1995. The site is monitored for surface contamination and for subsidence. The caissons are monitored for airborne radionuclides. A radiological survey is performed annually.

The site appears today as a fenced field with an apparently undisturbed surface. It has been seeded with field grass and some rabbit brush growth has occurred. No UPRs are known to have occurred at this site. The fenced area includes 218-W-1, 218-W-2, 218-W-4A, 218-W-4B, and 218-W-11 (BHI-00175).

No trenches in this burial ground contain MLLW disposed of after the effective data of mixed waste regulation at the Hanford Site (August 19, 1987). The 218-W-4B Burial Ground is the fourth burial ground out of four in priority under Tri-Party Agreement Milestone M-091-40 scheduled to have the retrievably stored waste removed.

In addition to the drawings discussed in this section, Hanford Site drawing H-2-44511, *Area Map – 200 West "T" Plant Facilities*, Sheet 104, gives more detail on the waste site.

2.2.6.1.7 218-W-4C Burial Ground

The 218-W-4C Burial Ground started receiving waste in 1978. It covers approximately 50 acres and contains TRU (some combustible) and test reactor fuel waste (DOE REG-0271).

The largest portion of the 218-W-4C Burial Ground is located west and southwest of the Plutonium Finishing Plant (PFP), east of Dayton Avenue. A smaller section is located directly south of the PFP, and north of 16th Street (Figure 2-16). The unit is designed to contain up to 65 trenches. Forty-eight trenches run east-west. Twenty-four of these are 184 m (602 ft) long, 19 are 220 m (719 ft) long, 4 are 180 m (594 ft) long, and 1 trench is 91 m (300 ft) long. Seventeen trenches run north-south. Of these, 14 trenches are 200 m (665 ft) long and 3 trenches are 155 m (508 ft) long. Only 15 trenches ranging from 91 to 219 m (300 to 719 ft) long have been used for waste storage and/or disposal.

The 218-W-4C Burial Ground began accepting packaged waste materials from 200 West Area operations, other Hanford Site areas, and from offsite sources in 1974 (WIDS). According to burial records, the 218-W-4C Burial Ground contains approximately 20,473 m^3 (26,777 yd^3) of low-level, TRU, and mixed waste (SWITS). TRU waste has been segregated from other burial ground waste since 1970 and placed in separate burial trenches and/or areas of burial trenches where the packages are retrievably stored. In 2004, the last open trench at the 218-W-4B Burial Ground was closed.

Trenches 1, 4, 7, 20, 29, and the east end of Trench 24 contain suspect TRU-retrievable waste. Trenches 19, 23, 28, 33, 48, and 53 and the remainder of Trench 24 received buried LLW. Trenches NC, 14, and 58 received LLW. In addition, Trenches NC, 14 and 58 are identified as containing the MLLW disposed after the effective date of mixed waste regulation at the Hanford Site (August 19, 1987).

Trench 1 contains drums generated from mining the 216-Z-9 Crib/Trench and approximately 500 cans of ash received in the early 1980s. The ash was generated by the Contaminated Waste Recovery Facility (232-Z) that incinerated miscellaneous waste (e.g., rubber gloves, rags, paper, spent solvent, cutting oils).

Trench 7 is at the location of a former waste site. The Z Plant Burning Pit was a disposal site for combustible nonradioactive construction, office, and non-hazardous laboratory waste, including unnamed chemicals. The burn pit is reported to have received 2,000 m^3 (2,600 yd^3) of waste for burning, including less than 1,000 m^3 (1,300 yd^3) of laboratory chemicals. The burning pit was 15 m (50 ft) long, 12 m (40 ft) wide, and 3 m (10 ft) deep. The burning pit was used from 1950 to 1960 (WIDS; BHI-00175). Trench 7 also contains drums of Test Reactor and Isotope Production General Atomics fuel waste.

This unit also received waste from the 100-N Area, 100-K Area, 100-B Area, General Electric, Babcock & Wilcox, Fermi National Laboratory, Exxon, Bartleville Energy Technology Center, Battelle Columbus Laboratory, and Chemical Nuclear Systems. Spent fuel is stored at this site.

The eastern portion of this unit never has received waste.

During the latter part of calendar year 1979 and the early part of 1980, a heavy snowfall and rapid melting caused flooding within some of the 218-W-4C Burial Ground trenches. Transuranic drums were observed to be floating in the burial ground. Workers retrieved the drums undamaged (WHC-EP-0912, WHC-EP-0225). Despite the volume of water observed during the flood, there has been no discernable impact on groundwater, as shown in the groundwater monitoring data presented in Section 3.4.4.4.

Areas of the TRU-retrievable-waste trenches are known to have subsided, or to have the potential to subside, after placement of the waste containers. The condition of the waste containers in these subsidence areas is unknown.

These units are contained within the proposed groundwater monitoring system for the LLBG TSD unit. Routine airborne radionuclide monitoring is performed. Radiological surveys of the perimeter site boundaries also are performed annually.

No UPRs are associated with this site. Hanford Site drawings that describe this site include H-2-44511, *Area Map – 200 West "T" Plant Facilities*, Sheet 96; and H-2-37437, *Dry Waste Burial Ground 218-W-4C*, Sheets 1 through 4.

2.2.6.1.8 218-W-5 Burial Ground

In 1979, a large area adjacent to the northwest corner of 200 West Area was annexed and designated the Central Waste Complex and the 218-W-5 Burial Ground. The annexed area extended north from 16th Street to 27th Street and westward to coordinates E564176/N137630. Within the large annex, 84 acres currently are permitted as low-level solid waste burial grounds. Original plans called for the area to contain 18 LLW trenches and 4 MLLW trenches.

The burial ground is at the southwest corner of the intersection of 27th Street and Dayton Avenue (Figure 2-17). The site began receiving waste on August 29, 1986. It covers approximately 37.2 hectares (91.9 acres). Two trenches (Trenches 31 and 34) in the 218-W-5 Burial Ground currently are operated as RCRA-compliant land disposal units for MLLW.

The unit was expanded by annexing land to the west and north and now consists of 56 trenches, all oriented east-west. Of these, 11 unlined trenches have had wastes placed in them. The last open unlined trench was closed in 2004. In addition, there are two active MLLW trenches, which are large rectangular excavations in the southwest corner of the burial ground. They are constructed with a polyethylene liner and leachate collection system. The active trenches were described in detail in Section 2.2.4. Operations at the active MLLW trenches (Trenches 31 and 34) are expected to end before the time CERCLA remedial actions are scheduled to begin. The 218-W-5 Burial Ground has received approximately 73,940 m^3 (96,709 yd^3) of waste.

The trenches (other than the currently active MLLW trenches) range from 4.6 m (15 ft) to 12 m (40 ft) wide at the bottom and from 5.2 to 6.1 m (17 to 20 ft) deep. The length of the trenches varies from 350 m (1,160 ft) to 130 m (430 ft) long.

A reported 204 kg (450 lb) of lead are buried in Trench 21 and 1,684 kg (3,710 lb) in Trench 9 (BHI-00175). There is an unused expansion area located in the northwest section (BHI-00175).

The 218-W-5 Burial Ground is contained within the proposed groundwater monitoring system for the LLBG TSD unit. Routine airborne radionuclide monitoring is performed.

No UPRs are associated with this site.

Trench 22 currently is identified as containing MLLW disposed after the effective date of mixed waste regulation at the Hanford Site (August 19, 1987). The disposal of MLLW to Trench 22 will be confirmed.

Hanford Site drawings that describe this site include H-2-44511 Series, *Area Map -- 200 West Area Facilities*; and H-2-94677, Sheets 1 and 2, *Dry Waste Burial Ground 218-W-5*.

2.2.6.1.9 218-W-6 Burial Ground

The 218-W-6 Burial Ground, although included within the LLBG Part A Permit, never has received waste. Figure 2-18 illustrates the general configuration of this burial ground.

2.2.6.2 Remedial Investigation/Feasibility Study Sites (Bin 3B)

There are 14 remaining burial grounds and 1 UPR site in Bin 3, assigned to Bin 3B. The sites are 218-C-9, 218-E-1, 218-E-2A, 218-E-5, 218-E-5A, 218-E-8, 218-E-12A, 218-W-1, 218-W-1A, 218-W-2, 218-W-2A, 218-W-3, 218-W-4A, 218-W-11, and UPR-200-E-95. These sites are described in detail in the following paragraphs.

2.2.6.2.1 218-C-9 Burial Ground

The 218-C-9 Burial Ground is located north of 7th Street and north of the C Plant/Hot Semiworks Plant. The site's approximate dimensions are 76 m by 66 m (251 ft by 217 ft). It received approximately one billion liters (264 million gal) of radioactive liquid discharge from 1953 to 1983 as the 216-C-9 Pond, and was used for burial as the 218-C-9 Burial Ground from 1985 to 1989 (WIDS). Source facilities include 201-E (200 Area Effluent Treatment Facility Exhauster Stack) and C Plant (221-C). Wastes disposed to this site included steam condensate liquid discharges (216-C-9 Pond) and 2,265 m^3 (2,963 yd^3) of miscellaneous solid debris and soil (218-C-9 Burial Ground).

The burial pit is located at the east end of the dried 216-C-9 Pond. The dried pond was covered with a layer of washed gravel, and material from the deactivation and demolition of the Hot Semiworks Plant. In August 1986, a fire was discovered in the burial pit. It was determined that metal frames that had been cut with a torch were placed in the pit before fully cooling and ignited flammable material. The entire site has been backfilled and surface stabilized. A routine radiological survey is performed annually. Debris at the site consists of radioactively contaminated concrete rubble, large equipment, roofing material, metal scrap, and other Hot Semiworks Plant demolition wastes. Contaminated soil from UN-216-E-37 and UN-216-E-39 also was placed in the pit.

Hanford Site drawings that describe this site include H-2-32523, *C-Plant Liquid Waste Disposal Sites*; and H-2-4606, *216-C-9 Pond Modifications*.

2.2.6.2.2 218-E-1 Burial Ground

The 218-E-1 Burial Ground is an inactive burial ground that originally was called the Dry Waste Burial Garden #1 and Dry Waste Burial Ground #3. This burial ground received packaged waste materials from the B Plant complex from 1945 to March 1953. It is located approximately 150 m (500 ft) west of PUREX. There are 21 trenches running north-south, approximately 60 m (200 ft) long. There were waste trenches that were filled to ground level with cinders from the 200 East Area powerhouse cinder pile. The cinders make a comparatively sterile seed bed, which acts as a deterrent against plant growth that could take up some of the radioactivity through the roots. The surface of the cinders was covered with coarse gravel to guard against wind erosion, and a dry moat was bladed around the zone perimeter inside the post line to discourage vehicle travel over the surface of the burial ground (WHC-EP-0912).

The site was surface stabilized in 1981 with 0.5 m (1.5 ft) of clean fill and load tested.

Reference drawings for this site are H-2-00124, *218-E-1 Dry Waste Burial Ground*; H-2-31269; and H-2-34761, *Area Map*. Figure 2-19 illustrates the general configuration of this burial ground.

2.2.6.2.3 218-E-2A Burial Ground

The 218-E-2A Burial Ground is an inactive burial ground that originally was called the Regulated Equipment Storage Site #2A. This burial ground was used for the aboveground storage of equipment that has been since removed. Service dates are not known. It is located directly south of the 218-E-2 Burial Ground, across the railroad tracks, north of the B Plant. The drawings conflict in their depictions of trench location. The trench is about 14 m (46 ft) wide. No records or burial inventories are available to indicate that this burial ground ever was used as a disposal facility. On February 21, 1978, an inspection of the burial trench disclosed a number of sink holes along the center line of the trench, indicating the trench had been dug and used for dry waste burials. In the summer of 1979, at least 0.3 m (1 ft) dirt was used to fill the burial trench to ground level (WHC-EP-0912).

Reference drawings for this site are H-2-2479, *218-E-2, 218-E-5, E-5A+3-9 200E.Area Insustrial* [sic] *Burial Site*; and H-2-34761. Figure 2-20 illustrates the general configuration of this burial ground.

2.2.6.2.4 218-E-5 Burial Ground

The 218-E-5 Burial Ground originally was called the Industrial Burial Garden #5. This burial ground received miscellaneous contaminated equipment from the tank farm uranium recovery program and PUREX. The burial ground was used from 1954 to 1957 and is now inactive. It is contiguous with the western boundary of the 218-E-2 Burial Ground, north of the B Plant.

Hanford Site drawings that describe this site include H-2-31269, H-2-55534, *218-E2, E2A, E4, E5, E5A, & E9 Industrial Burial Ground Plan & Details*; H-2-34761, and H-2-2479. The drawings conflict in their depictions of trench locations. Figure 2-20 illustrates the general configuration of this burial ground.

Extensive research work was conducted during 1979 to determine the location of all the burial trenches within the bounds of the 218-E-2, 218-E-5, 218-E-5A, and 218-E-9 Burial Grounds. The work included viewing aerial photographs and construction drawings, analyzing plant growth patterns, and load testing the ground surface. Four previously unrecorded sites were identified. Multiple trenches were found running north and south in an area 40 to 104 m (131 to 341 ft). The multiple trenches were stabilized as a single trench with the addition of 0.3 m (1 ft) of soil (WHC-EP-0912).

2.2.6.2.5 218-E-5A Burial Ground

The 218-E-5A Burial Ground is an inactive burial ground that originally was called the Industrial Burial Garden #5A. This burial ground received failed equipment and industrial waste, including a PUREX L-Cell package in 1958, which consisted of four very large burial boxes and the D-2 column from the PUREX K-Cell (WHC-EP-0912). This burial ground was used from 1956 to 1959 and is now inactive. It is located contiguous with the western boundary of the 218-E-5 Burial Ground, north of the B Plant. Site reference drawings are H-2-55534 and H-2-34761. Exact trench locations are not known. Extensive research work was conducted during 1979 to determine the location of all burial trenches (see Section 2.2.3.2.4) and identified four previously unrecorded sites. In 1979, the burial ground was stabilized with 0.3 m (1 ft) of dirt and load tested with 40 tons. The burial location is a 30 by 37 m (100 by 120 ft) rectangular area. Figure 2-20 illustrates the general configuration of this burial ground.

2.2.6.2.6 218-E-8 Burial Ground

The 218-E-8 Burial Ground is an inactive burial ground originally known as the Construction Burial Garden (originally there was no number assigned to it). This burial ground received contaminated equipment and material generated during construction of the new crane addition on PUREX. The burial ground was used from 1958 to 1959 and is now inactive. It is located at the northwest edge of the 200 East Area burn pit, north of PUREX. The location and number of trenches in this burial ground are not known. On February 21, 1979, residue from broken tumbleweeds blown in along the west boundary line of this burial ground was found to be reading greater than 100,000 c/min beta-gamma activity (WHC-EP-0912). In 1979, the burial ground was stabilized with at least 0.5 m (1.5 ft) of backfill.

2.2.6.2.7 218-E-12A Burial Ground

The 218-E-12A Burial Ground is an inactive burial ground originally known as Dry Waste Burial Garden #12. This burial ground was active from 1953 to 1967. This burial ground received packaged solid waste material from all operational complexes located in the 200 East Area. It is located north of the B Plant, approximately 30 m (100 ft) northwest of the C Tank Farm. Figure 2-21 illustrates the general configuration of this burial ground. In 1979-1980 and again in 1994, the burial ground was stabilized with 0.5 to 0.6 m (1.5 to 2.0 ft) of backfill.

Hanford Site drawings that describe this site include H-2-32560, *As-Built Dry Waste Burial Site #218-E-12A*; and H-2-34761.

2.2.6.2.8 218-W-1 Burial Ground

The 218-W-1 Burial Ground is an inactive burial ground containing pre-1970 suspect transuranic and mixed solid wastes. It is located on the east side of Dayton Avenue, approximately west of the TX Tank Farm. It is about 460 m (1500 ft) northwest of the 234-5Z Building and lies between the 218-W-2 and 218-W-11 Burial Grounds. Inactive, in the case of solid waste burial grounds, means that each burial ground excavation has been backfilled and no opportunity for further waste burial exists (BHI-00175).

The 218-W-1 Burial Ground operated from 1944 until 1953 to receive more than 7,000 m^3 (9,200 yd^3) of miscellaneous dry wastes. It is 159 by 140 m (521 by 458 ft) and consists of 15 trenches that run east to west. Twelve of these are 2.4 m (8 ft) deep and 73 m (240 ft) long. The other three are 2.7 m (9 ft) deep and 149 m (488 ft) long. Trench arrangement and dimensions are shown in detail on Hanford Site drawing H-2-75149, *Dry Waste Burial Ground 218-W-1* (BHI-00175).

The site appears as a fenced field with an apparently undisturbed flat surface. It has been seeded with field grass. EPA notes that a small area near the center of the site contains contaminated mulch with a maximum reading of 12,000 d/min. Evidence exists that waste boxes have been buried less than 1.2 m (4 ft) from the surface. The site is fully fenced with chain-link fencing and is marked with permanent concrete posts with brass name plates (BHI-00175). Figure 2-22 illustrates the general configuration of this burial ground.

The burial ground was surface stabilized in 1983.

Hanford Site drawings that describe the site include H-2-75149; H-2-00123, *218-W-1 Dry Waste Burial Site*; and H-2-44511, *200 West T Plant Facilities*, Sheets 112 and 120.

2.2.6.2.9 218-W-1A Burial Ground

The 218-W-1A Burial Ground is an inactive burial ground originally called the Industrial Burial Garden #1 and Industrial Waste No. 1. This burial ground received contaminated process equipment and process waste. In addition to the ten trenches, there were pieces of equipment stored above ground that were later removed. This burial ground was active from 1944 to March 1954. It is located 600 m (2,000 ft) northwest of T Plant. A railroad spur passed through the central portion of this burial ground. This burial ground was the first large equipment burial site that was used in the 200 West Area. Most of the equipment was buried in wooden boxes, which eventually rotted and caused settling of the ground surface. Most of the sink holes were filled with dirt in 1975, but there still remained a number of deep sink holes north of the railroad tracks. The ground surface is free of contamination. A large number of 2 m (6 ft) thick concrete cell blocks were stored above ground south of the railroad tracks but were eventually disposed. Nearly all of the surface radioactive contamination that was on the blocks when they were stored in the burial ground has since decayed (WHC-EP-0912). Figure 2-23 illustrates the general configuration of this burial ground.

Hanford Site drawings that describe this site include H-2-02516, *Industrial Burial Ground 218-W-1A*; and H-2-34762.

2.2.6.2.10 218-W-2 Burial Ground

The 218-W-2 Burial Ground is an inactive burial ground originally called the Dry Waste Burial Garden #2. This burial ground received packaged waste materials from the 200 West Area. No material was stored above ground. This burial ground was active from January 1953 to December 1956. It is located northwest of T Plant, contiguous with the south boundary of the 218-W-1 Burial Ground. Some of the trenches at this site did not receive the required 1.2 m (4 ft) of overfill. Waste boxes were observed to be within a half meter (18 in.) of the ground surface. Routine radiation surveys of the surface of the trenches have found contaminated Russian thistle grows mostly along the edges of the trenches. Sink holes were filled in 1974 (WHC-EP-0912). Figure 2-24 illustrates the general configuration of this burial ground.

Hanford Site drawings that describe this site include H-2-02503, *218-W-2 Dry Waste Burial Ground*; H-2-31268; and H-2-34762.

2.2.6.2.11 218-W-2A Burial Ground

The 218-W-2A Burial Ground is an inactive burial ground originally called the Industrial Burial Garden #2. This burial ground received contaminated process equipment from 200 West Area. Trench 27 contains the contaminated soil scraped from the bottom of the 216-T-4-1 Pond. Trench 22 was a 7.6 m (25 ft) deep trench. No material was stored above ground. This burial ground was active from March 1957 to 1985. It is located northeast of the corner of 23rd Street and Dayton Avenue. Cell cover blocks, 2 m (6 ft) thick, were buried in this location along the west side of the railroad tracks. The block lifting bales were within inches of the ground surface. Interim stabilization activities were initiated in the burial ground during summer and fall of 1979 and completed in 1980. The purpose of the work was to eliminate the hazards of subterranean voids, reduce wind surface erosion, remove ground surface contamination, and establish deterrents against the growth of undesirable vegetation. Figure 2-25 illustrates the general configuration of this burial ground.

Hanford Site drawings that describe this site include H-2-32095, *218-W-2A Industrial Burial Ground & 218-W-3 Dry Waste Burial Ground*; H-2-36841, *218-W-2A Industrial Burial Ground & 218-W-3 Dry Waste Burial Ground*; and H-2-34762.

2.2.6.2.12 218-W-3 Burial Ground

The 218-W-3 Burial Ground is an inactive burial ground originally called the Dry Waste Burial Garden #3. This burial ground received packaged waste materials from 200 West Area. This burial ground was active from January 1957 to July 1961. It is located northeast of the corner of 23rd Street and Dayton Avenue. It is west of the 218-W-2A Burial Ground. The burial ground is composed of 20 trenches running east to west. Trenches 1 through 3 are 120 m (400 ft) in length. Trenches 4 through 20 are approximately 145 m (475 ft) in length. This burial ground did not show evidence of radioactivity by plant root penetration (WHC-EP-0912).

The burial ground was stabilized in 1983; the north end was restabilized with fill and gravel in 2001.

Hanford Site drawings that describe this site include H-2-3398, *218-W-3 Dry Waste Burial Ground*; and H-2-32095, Sheet 1. Figure 2-26 illustrates the general configuration of this burial ground.

2.2.6.2.13 218-W-4A Burial Ground

The 218-W-4A Burial Ground is located southeast of the intersection of 23rd Street and Dayton Avenue. Its dimensions are approximately 274 m (900 ft) by 268 m (879 ft). Source facilities include uranium drums from offsite sources; equipment from 231-Z, 234-5Z, the facility for Recovery of Uranium and Plutonium by Extraction (RECUPLEX), REDOX, 222-U, and 300 Area Laboratories; and Boeing Company missile parts. The burial ground contains miscellaneous waste, including 500 drums of depleted uranium, failed equipment, and plutonium-contaminated laboratory waste. It received waste from 1961 to 1968 (WIDS).

The site is a burial ground that contains 21 miscellaneous dry waste trenches oriented east to west and 6 vertical pipe units or drywells. All trenches are 9 m (30 ft) wide and range in length from 149 m (490 ft) to 295 m (696 ft). The vertical pipe units were installed near the east end of Trench 16 and consist of five 55-gal drums welded together with the lids and bottoms removed. They were placed 4.6 m (15 ft) below ground surface. Two larger caissons may be located between Trenches 17, 18, and 19. Trenches 16 and 20 received high-level plutonium wastes from PFP. Trench 19 is marked as RECUPLEX on Drawing H-2-32487, *218-W-4A Dry Waste Burial Site*. In July 1952, a fire in the burial ground spread contamination and is recorded as UPR-200-W-16. Spotty contamination was released during operations in November 1953 (UPR-200-W-26). In January 1959, a box containing REDOX cell jumpers collapsed (UPR-200-W-53) and in October 1975, a release of previously buried waste occurred (UPR-200-W-72). The site was stabilized in 1983 (WIDS).

Hanford Site drawing H-2-32487 describes this site and lists trench contents in detail. Figure 2-27 illustrates the general configuration of this burial ground.

2.2.6.2.14 218-W-11 Burial Ground

The 218-W-11 Burial Ground is an inactive burial ground originally known as a Regulated Storage Area. It received contaminated equipment from 200 West Area operations. The stored materials have been removed from the burial grounds. This burial ground was active in 1960. It is located between the 218-W-1 and 218-W-4A Burial Grounds. The burial ground was used as an aboveground storage site for low-level contaminated equipment storage. The one burial trench within the burial ground runs 45 m (150 ft) east and west. The trench was used for burial of low-level contaminated sluicing equipment that had been used in the uranium recovery program. Some of the equipment later was removed from the trench and was used in the strontium-cesium recovery program (WHC-EP-0912).

Hanford Site drawings that describe this site include H-2-34762; H-2-94250, *Dry Waste Burial Ground 218-W-11*; and H-2-44511, Sheet 20 (WHC-EP-0912). Figure 2-28 illustrates the general configuration of this burial ground.

2.2.6.2.15 UPR-200-E-95 Unplanned Release Site

The UPR-200-E-95 UPR site is a railroad spur located south of the 218-E-2 and 218-E-5 Burial Grounds and north of the 218-E-2A Burial Ground, north of the B Plant. The contaminated area was established as a UPR site in September of 1980. It became contaminated over time as a result of contaminated equipment (mainly from the B Plant and PUREX) being stored on railroad flat cars on the spur. The contamination is likely the accumulation of many small releases over time. In 1998, the tracks were covered with gravel and posted as an Underground Radioactive Material Area. The site is approximately 250 by 5 m (820 by 16 ft). A 1996 perimeter survey report reported less than detectable levels of contamination. A 1991 survey reported general rail contamination of 3,000 to 6,000 d/min beta with a maximum of 350,000 d/min beta in one spot (WIDS).

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Figure 2-1. Topographic Map of the Hanford Site.

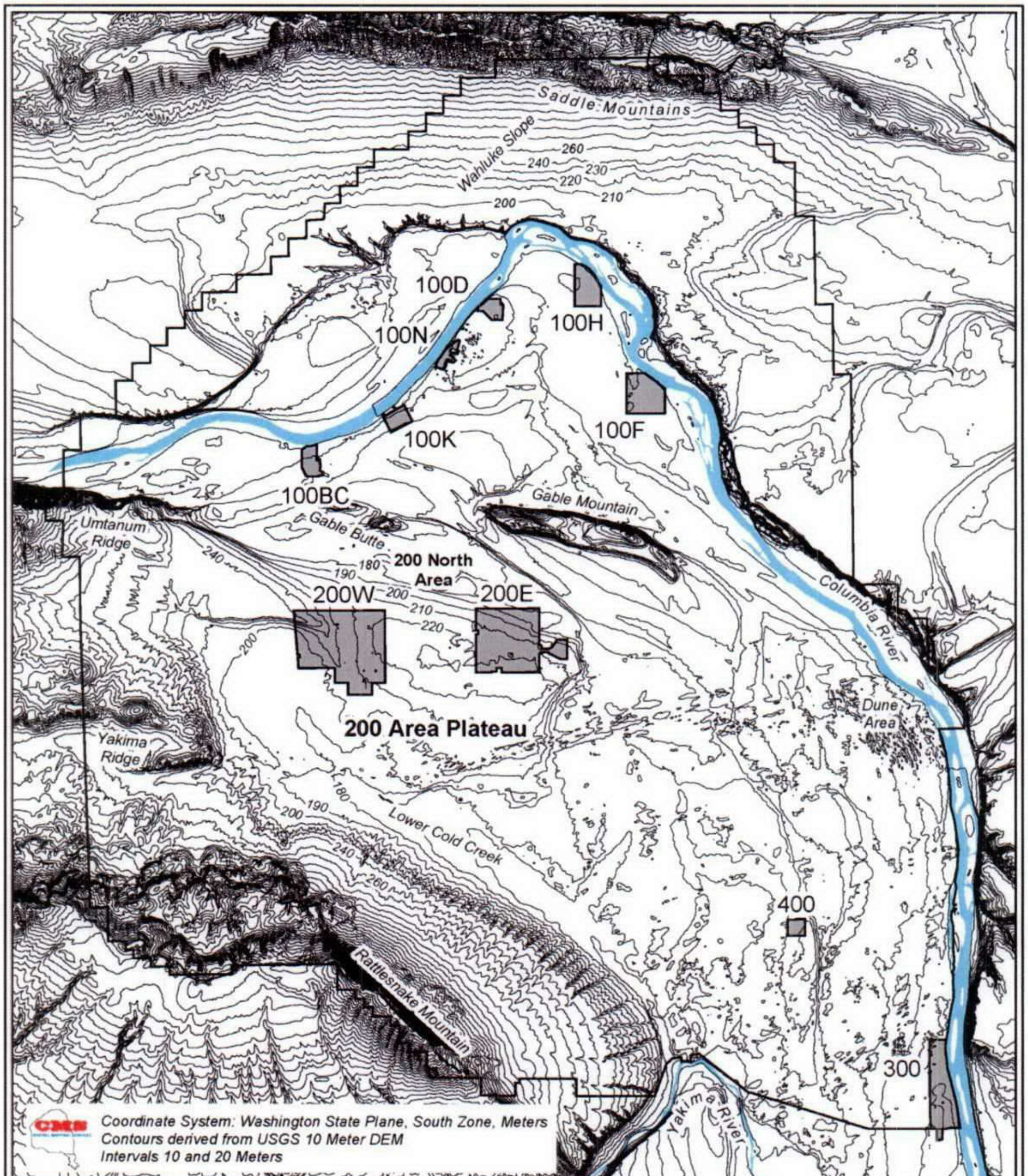

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Figure 2-2. Generalized Stratigraphic Column for the Hanford Site.

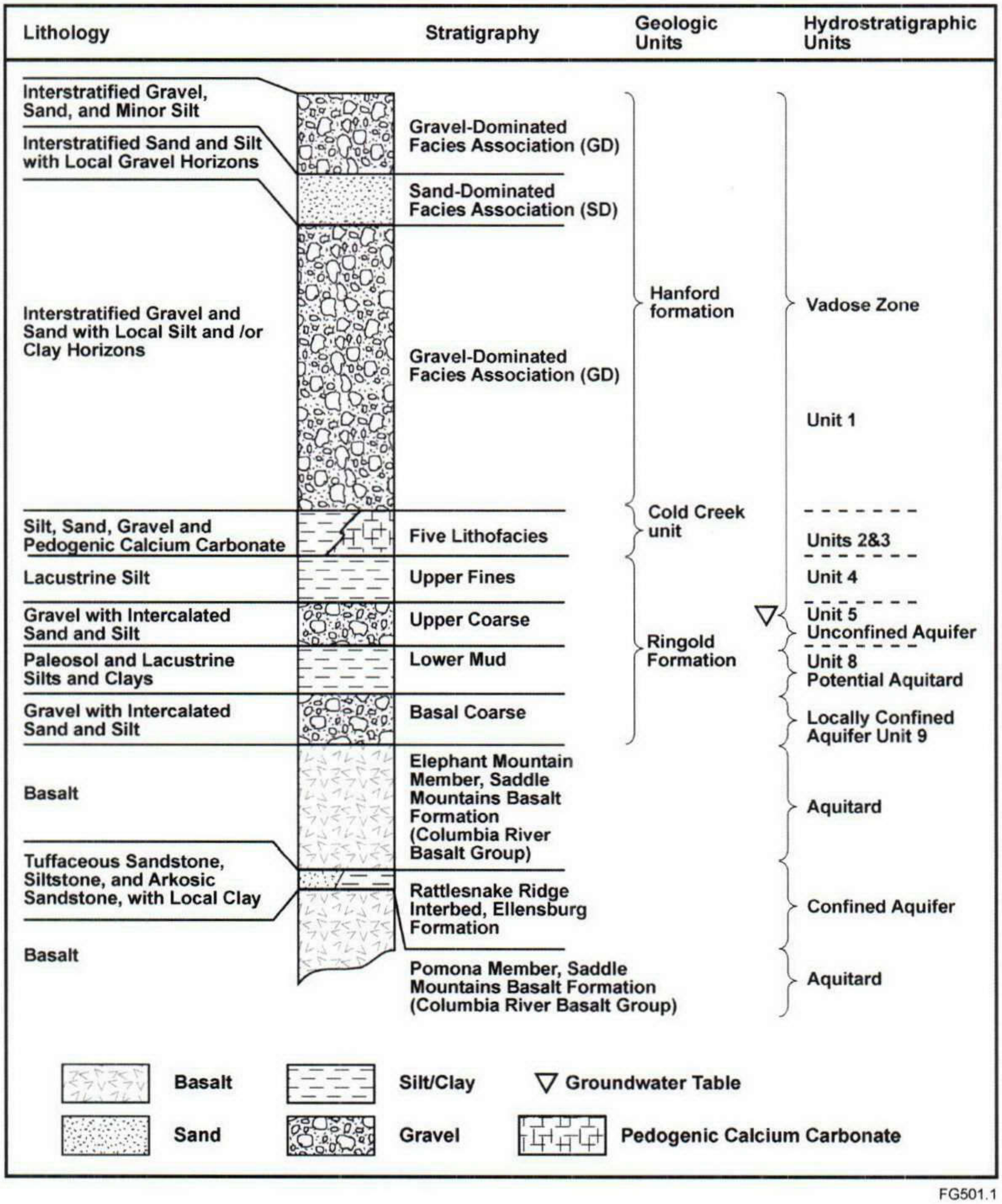
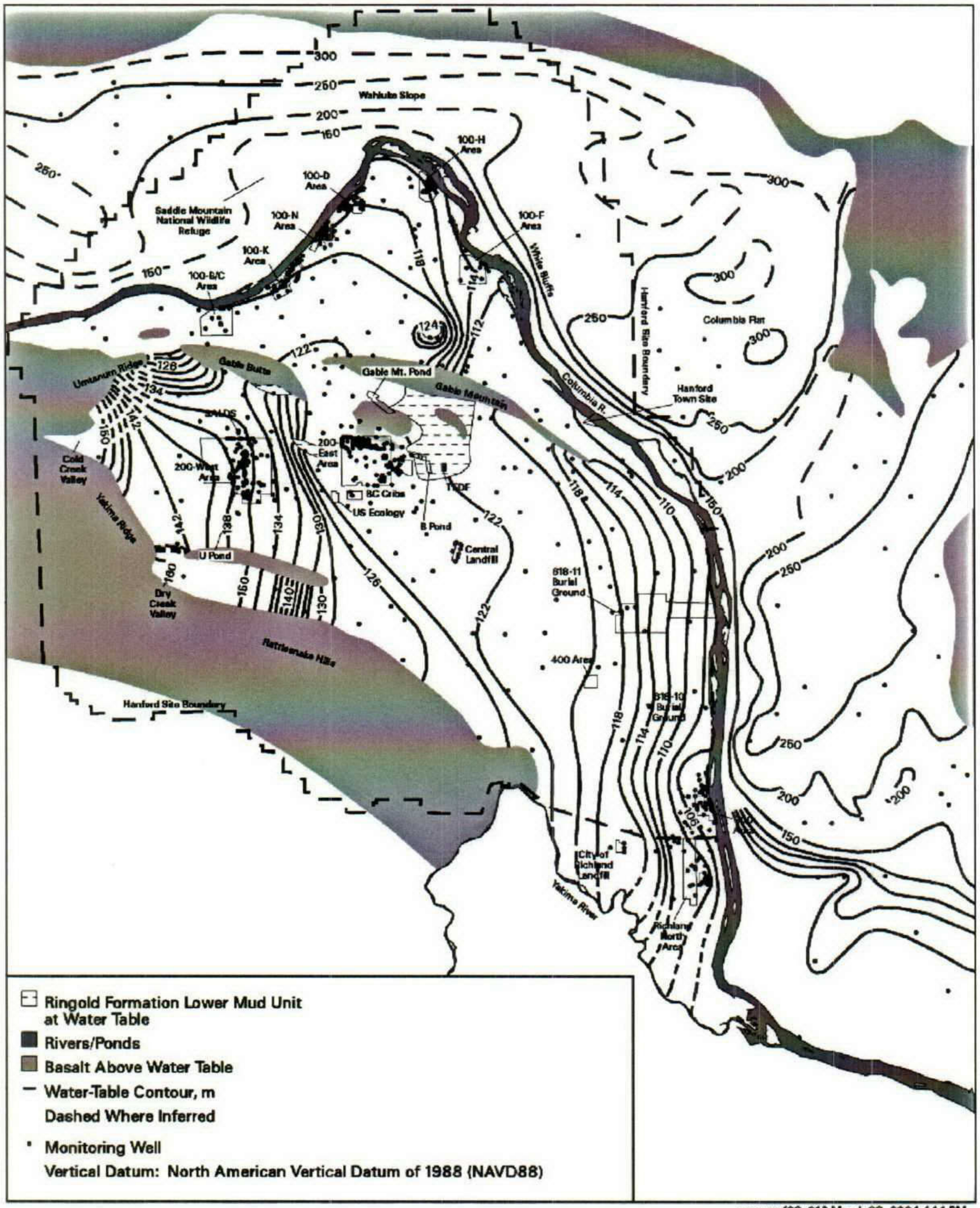


Figure 2-3. Hanford Site Water-Table Map, March 2003.



can_gwf03_012 March 03, 2004 4:14 PM

Source: PNNL-14548, *Hanford Site Groundwater Monitoring for Fiscal Year 2003.*

Figure 2-4. Stratigraphy at Representative Boreholes Near the Bin 3 Sites in the 200 West Area, 200 East Area, and 600 Area.

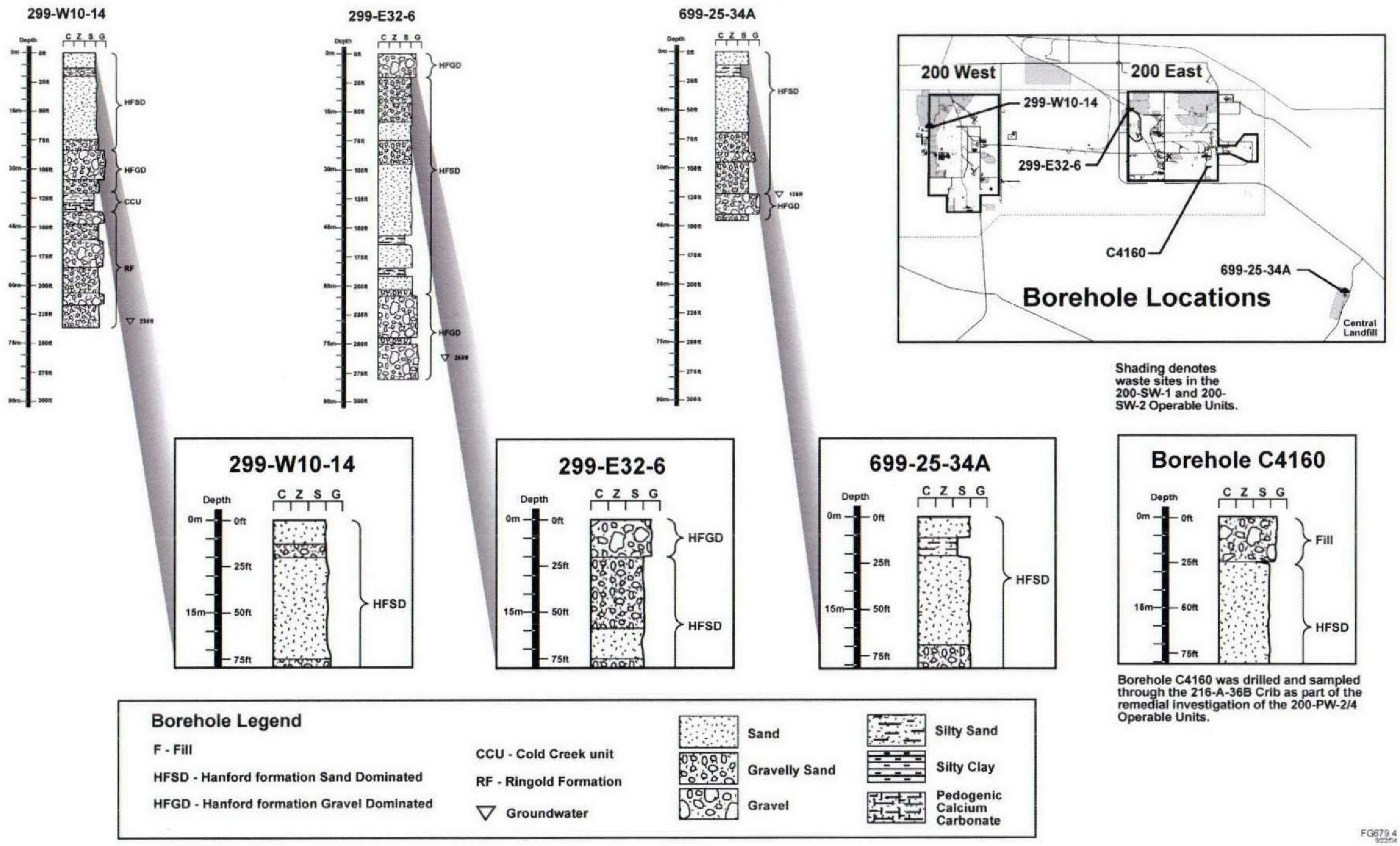


Figure 2-5. Timeline Illustrating Operations Periods for Burial Grounds, with Key Milestones. (2 Pages)

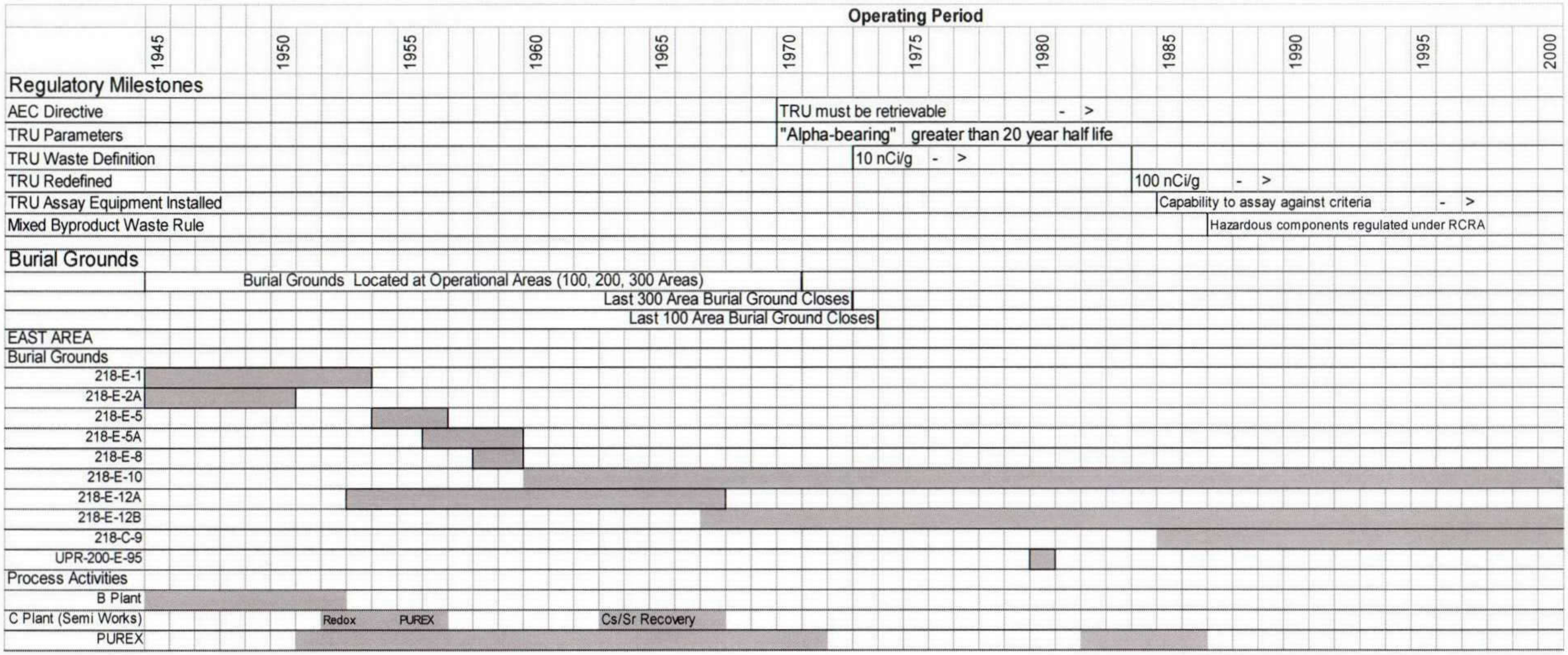


Figure 2-5. Timeline Illustrating Operations Periods for Burial Grounds, with Key Milestones. (2 Pages)

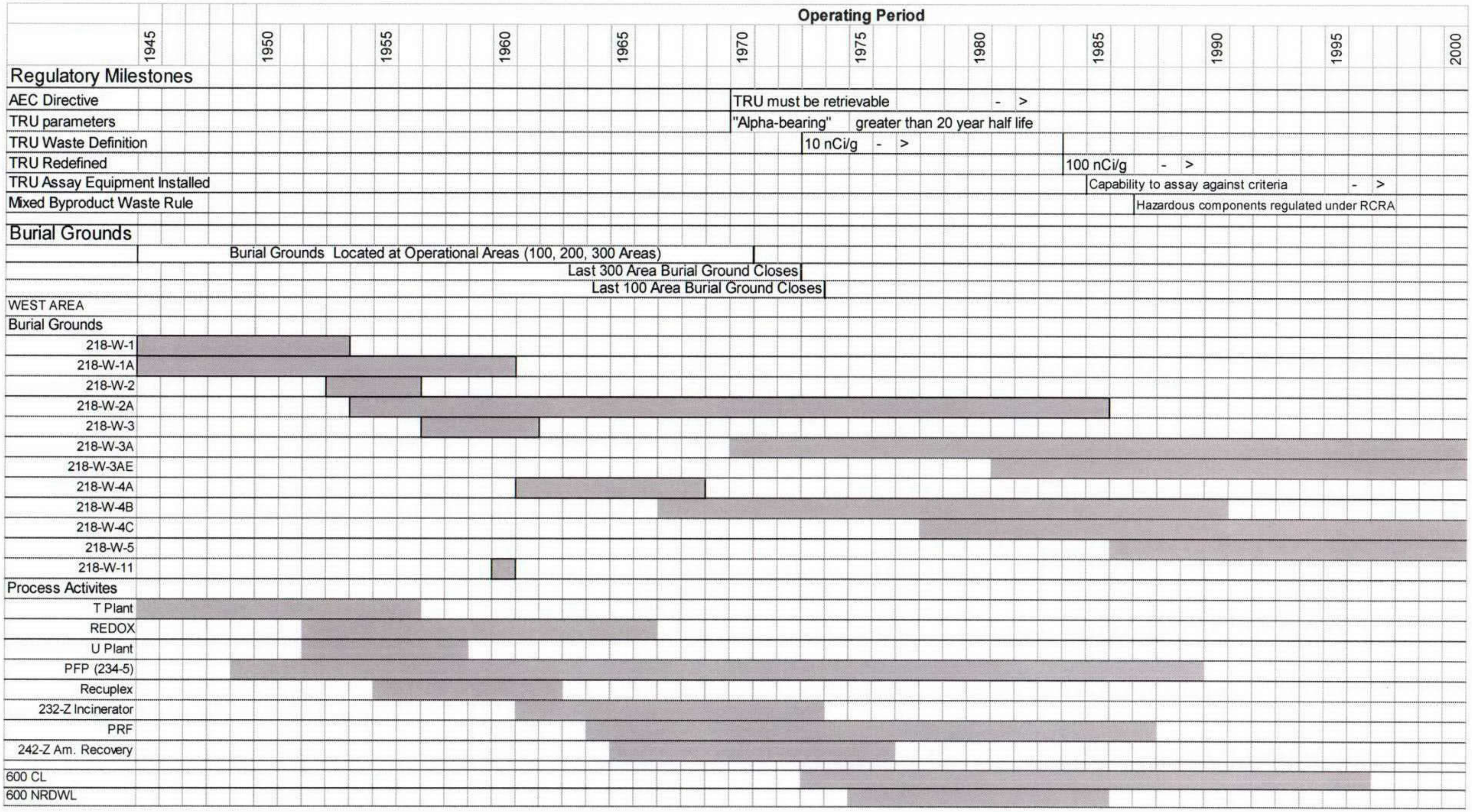


Figure 2-6. Diagram of Solid Waste Burial Trench.

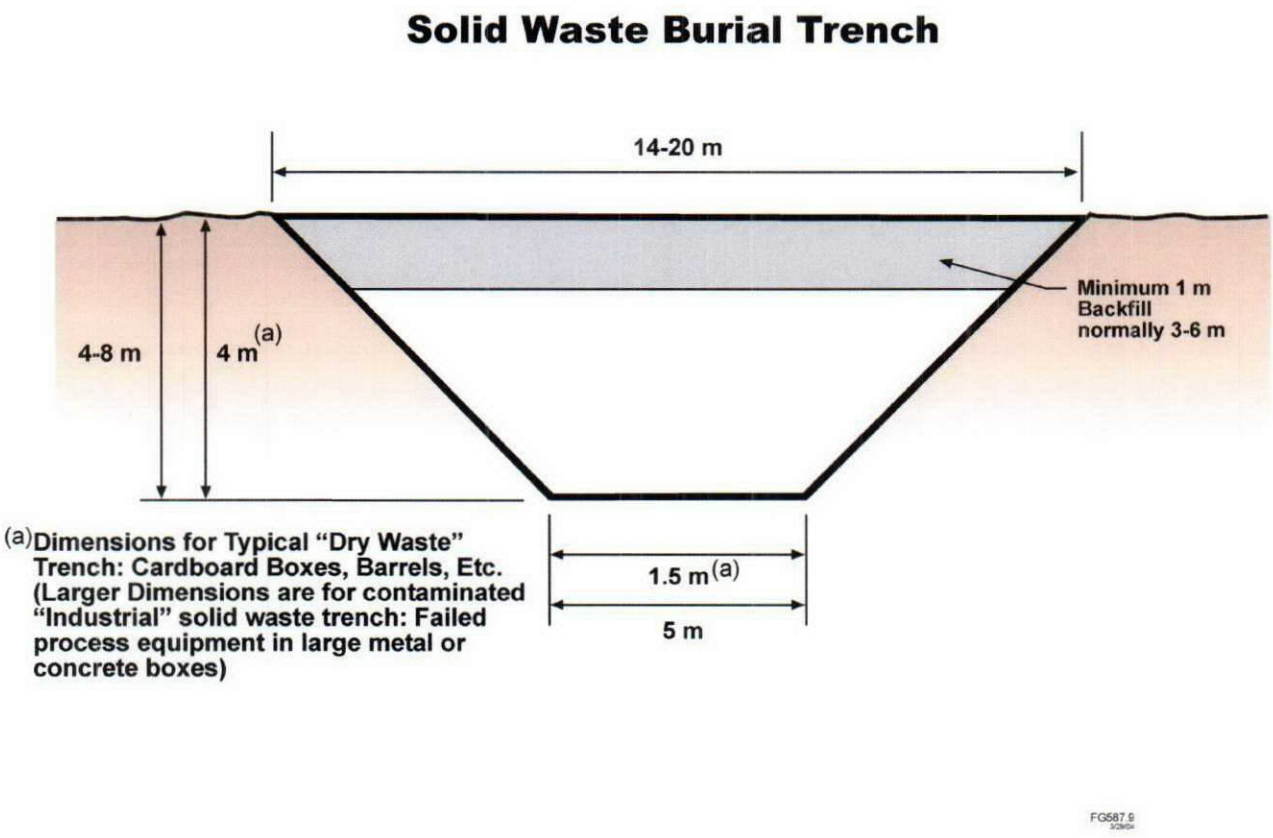


Figure 2-7. Diagram of Caisson with Blower.

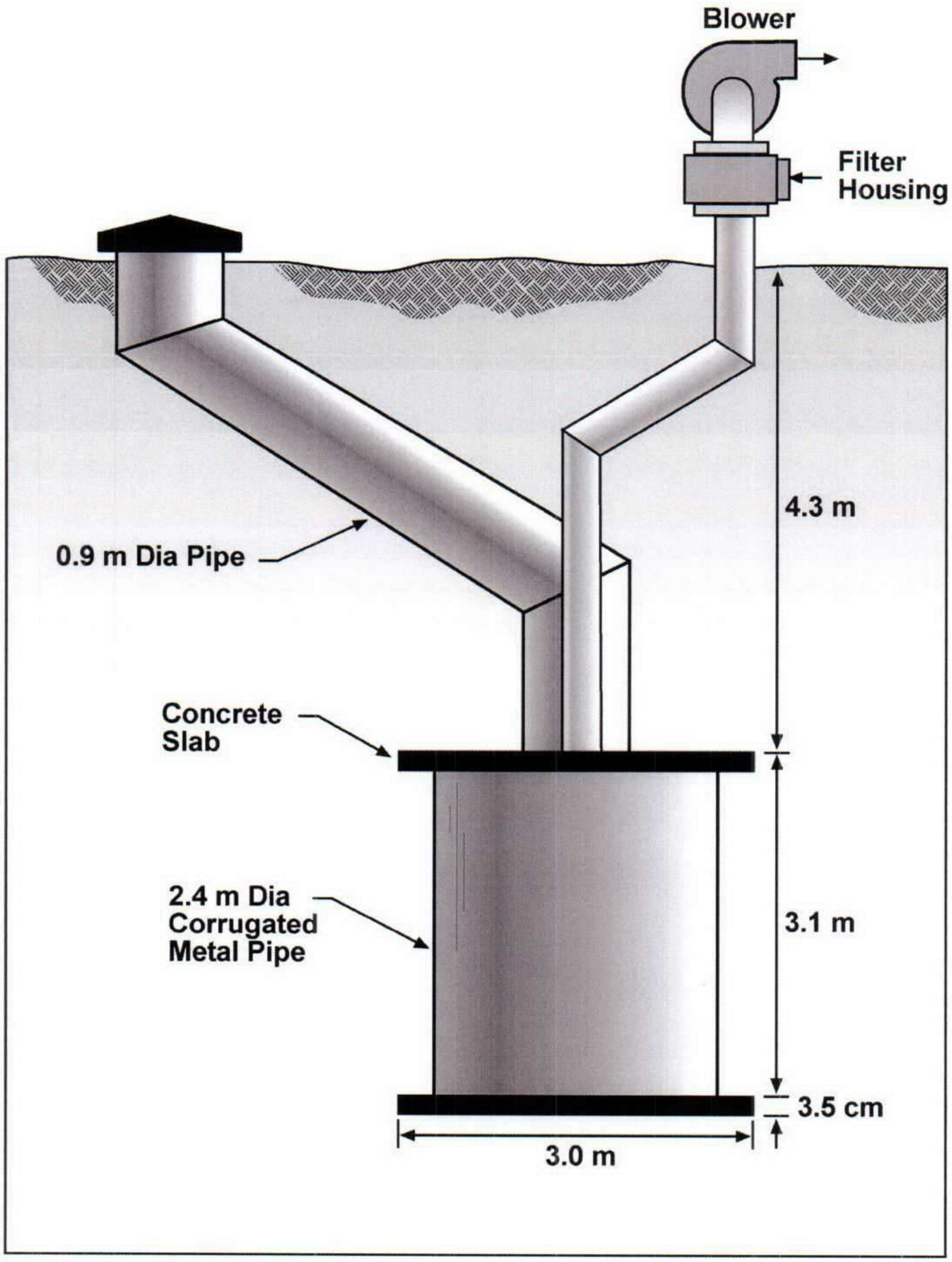


Figure 2-8. Diagram of Caisson.

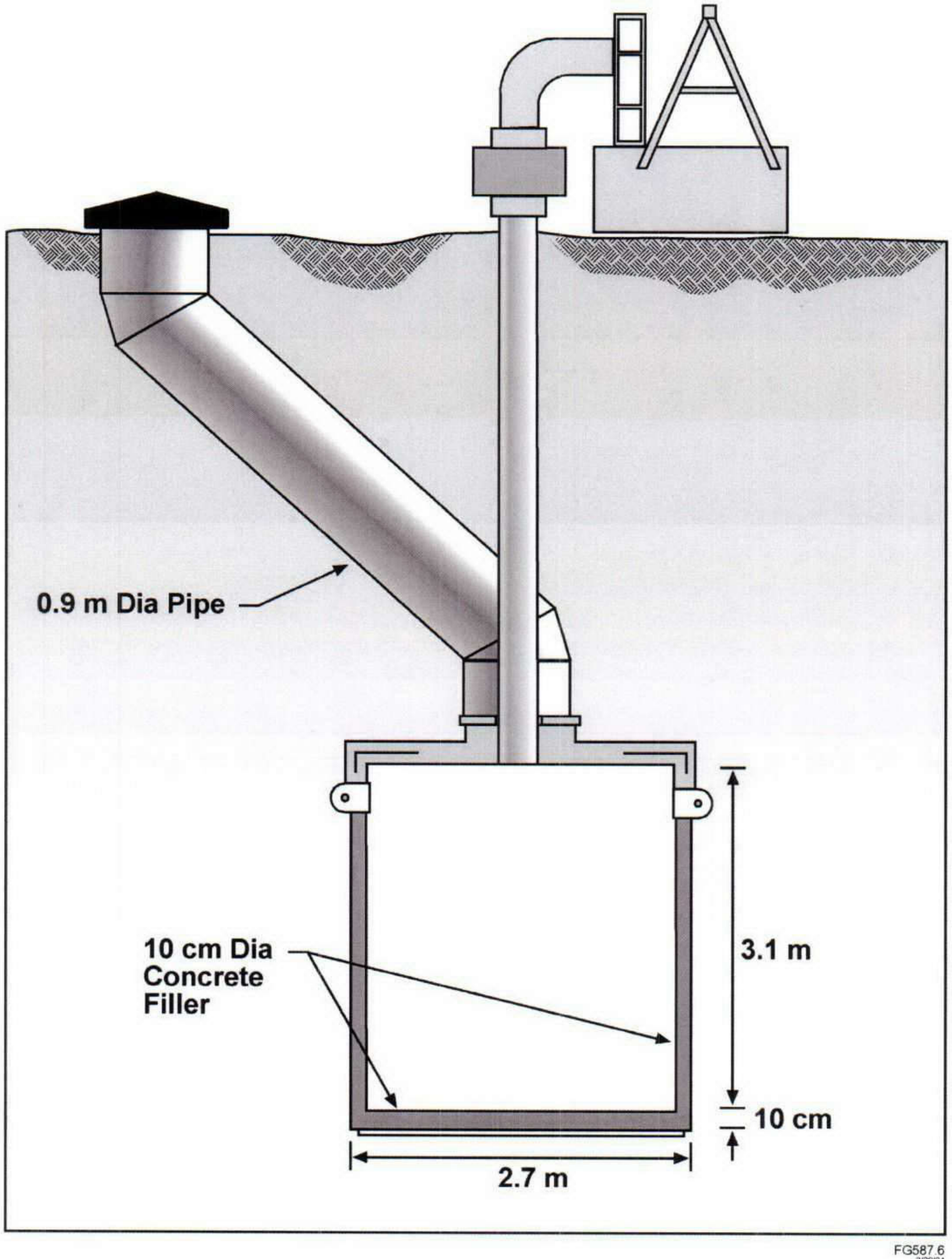


Figure 2-9. Diagram of Vertical Pipe Unit.

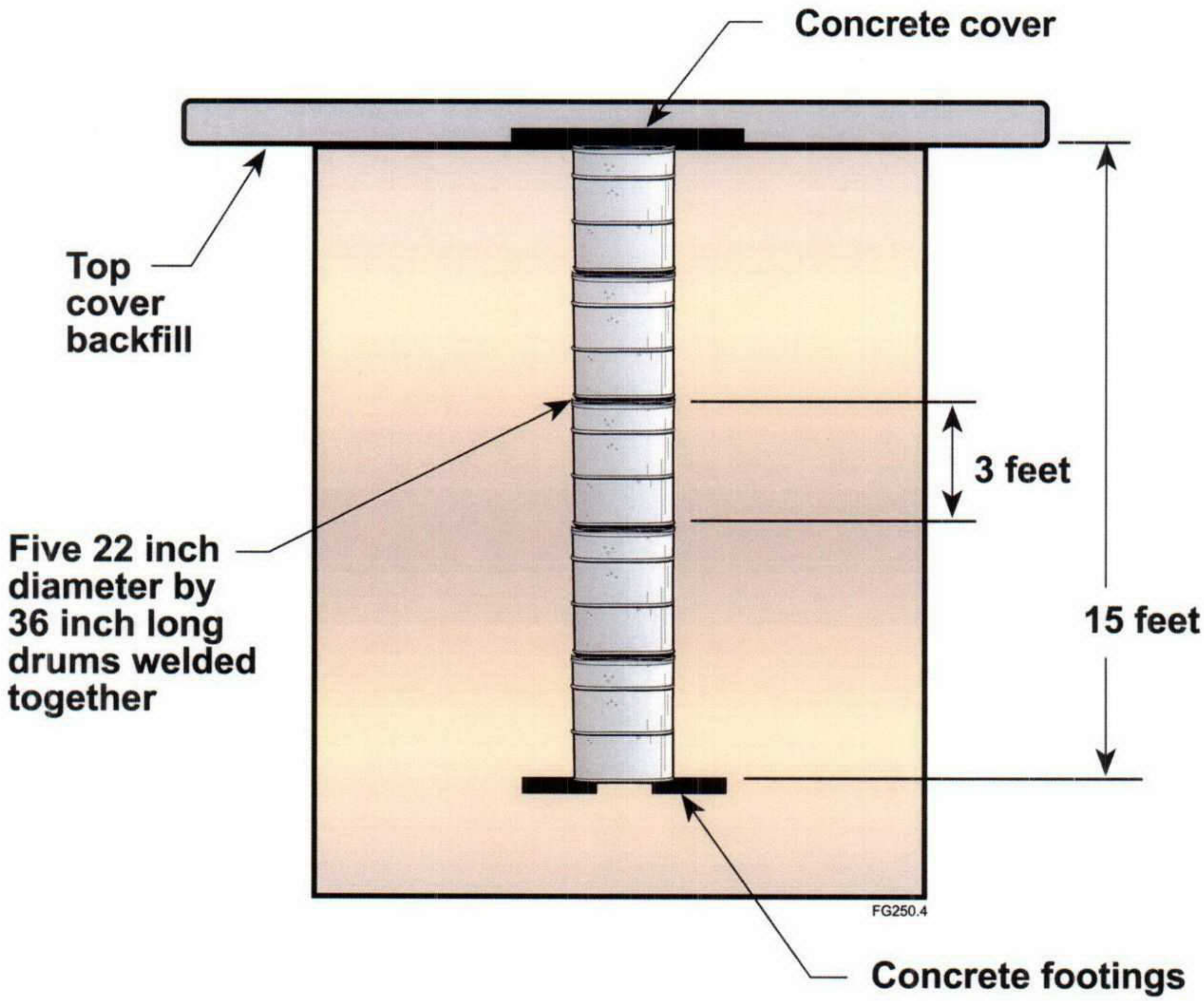
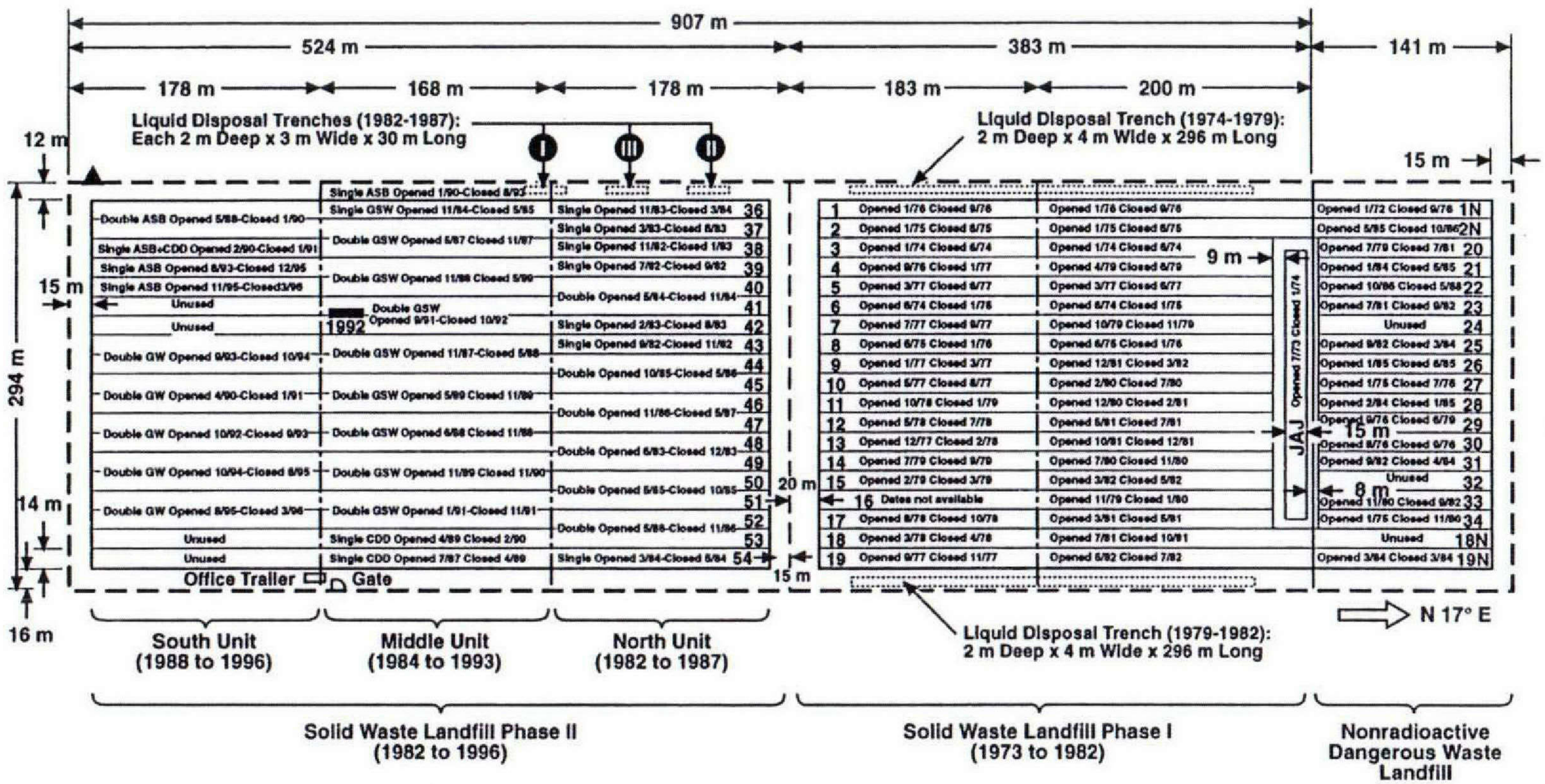


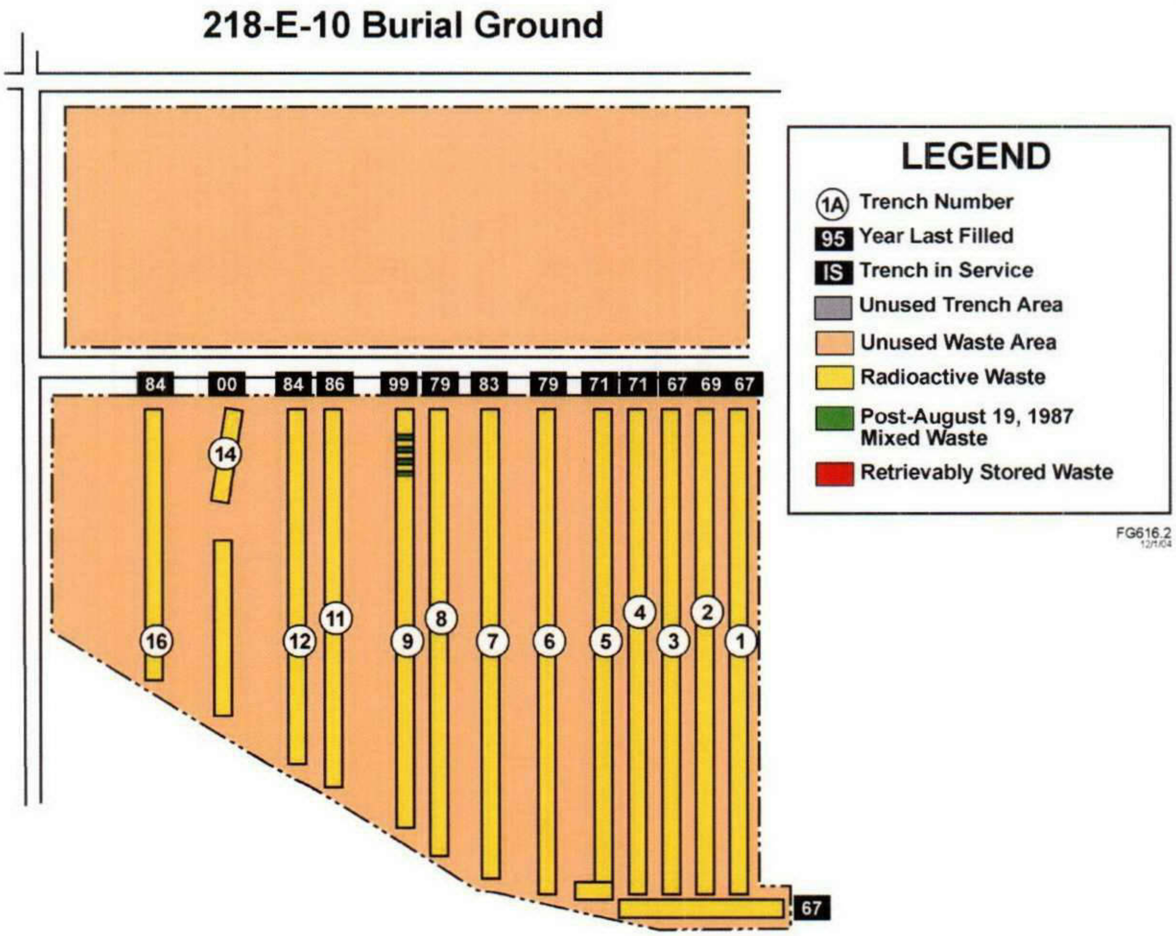
Figure 2-10. Nonradioactive Dangerous Waste Landfill and Solid Waste Landfill.



Legend

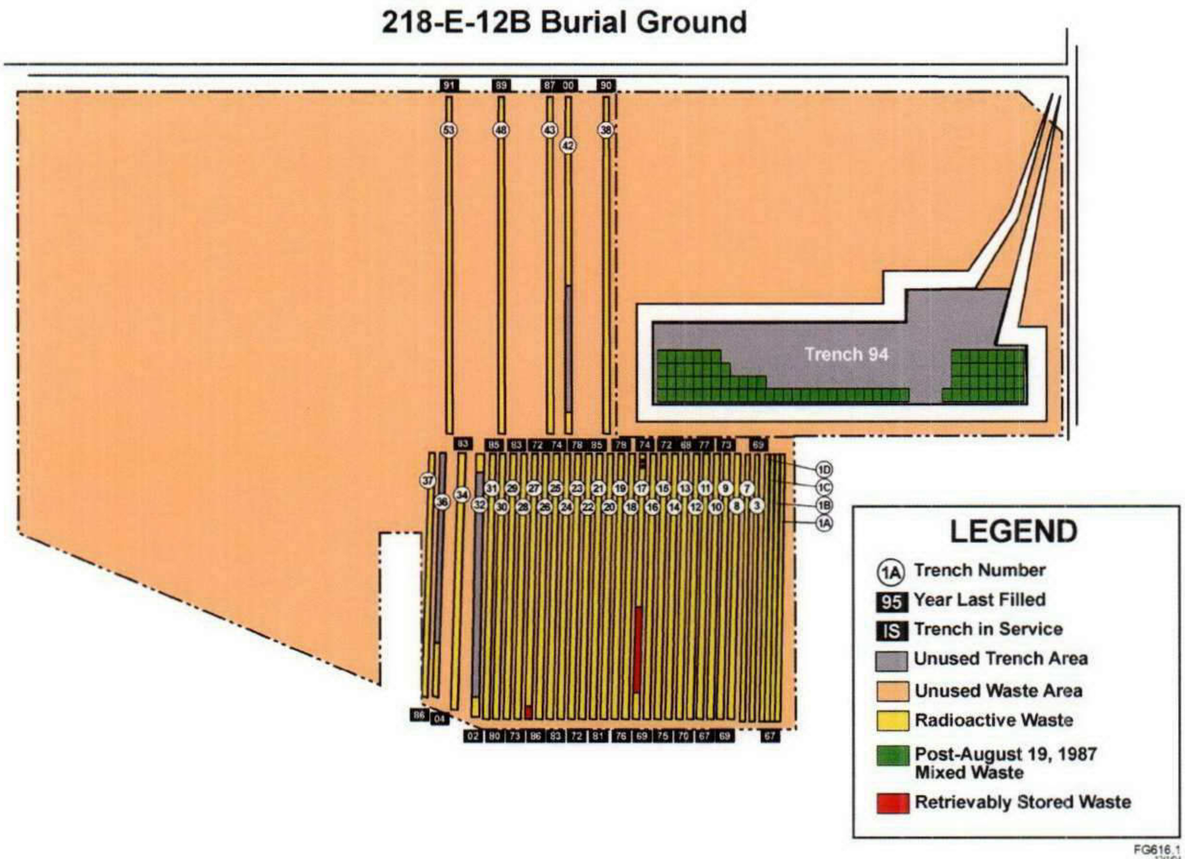
– – –	Fence	ASB	Asbestos Waste
—·—	Panel Boundary	GSW	General Solid Waste
········	Trench Boundary	CDD	Construction/Demolition Debris
▲	Survey Marker (N22618.14 W35398.87)	GW	General Solid Waste and Construction/Demolition Debris
▬ 1992	Basin Lysimeter with Date of Completion		

Figure 2-11. 218-E-10 Burial Ground.



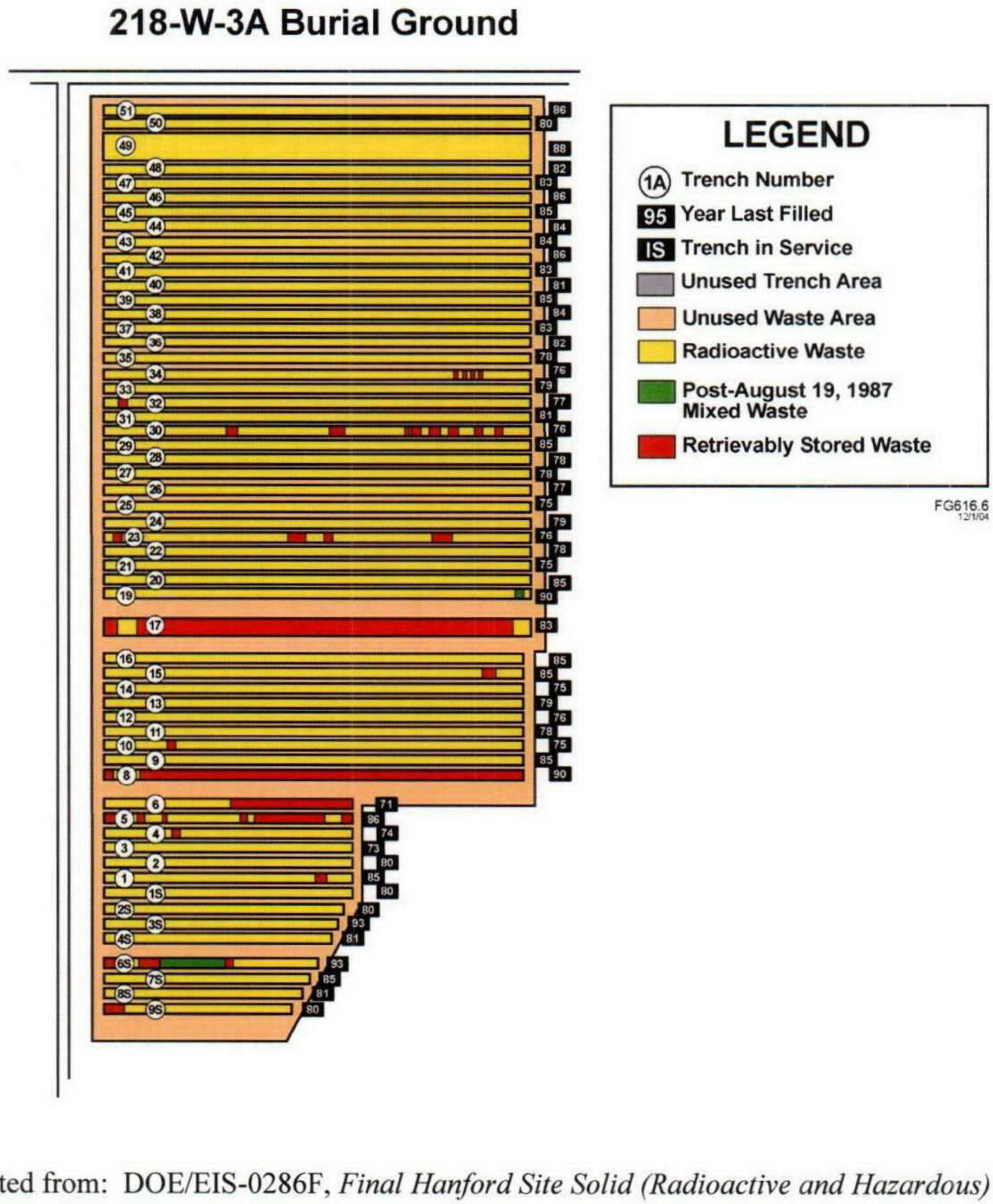
Updated from: DOE/EIS-0286F, *Final Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement, Richland, Washington*, Drawing MO212-0286.56.

Figure 2-12. 218-E-12B Burial Ground.



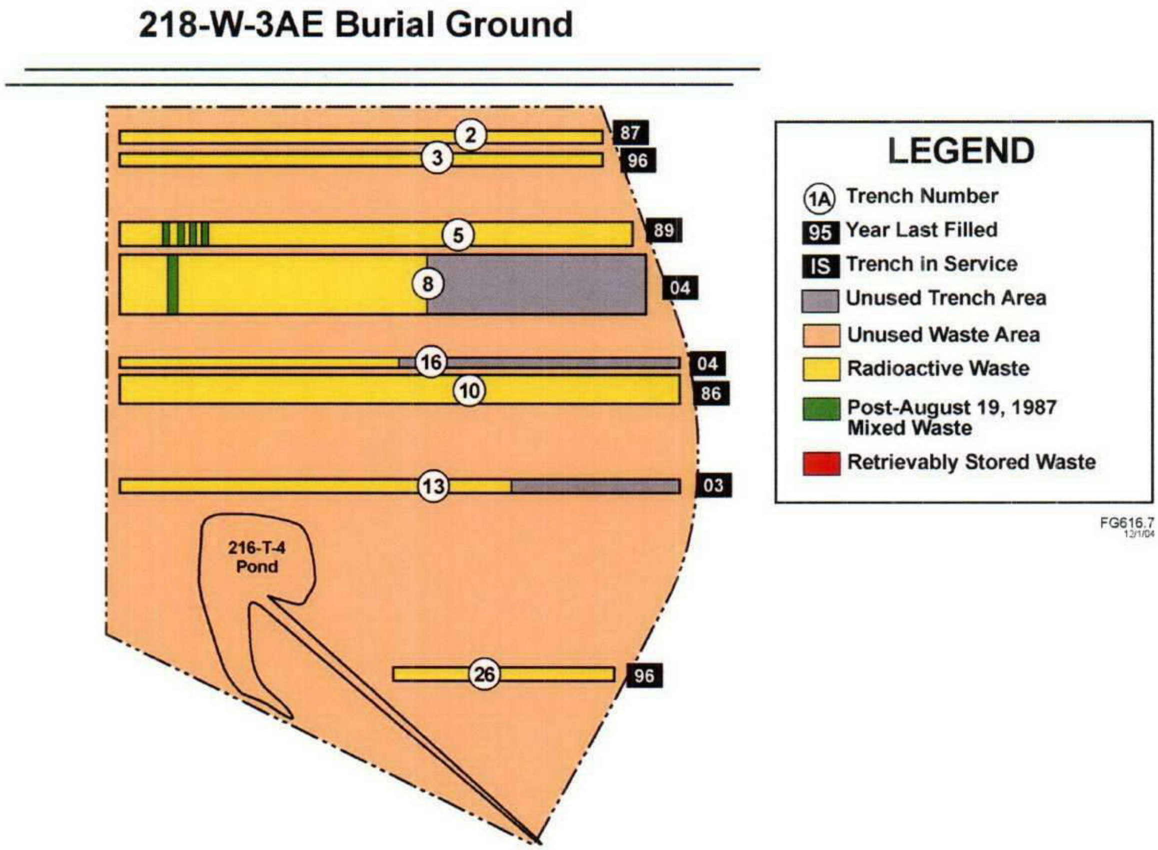
Updated from: DOE/EIS-0286F, *Final Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement, Richland, Washington.*

Figure 2-13. 218-W-3A Burial Ground.



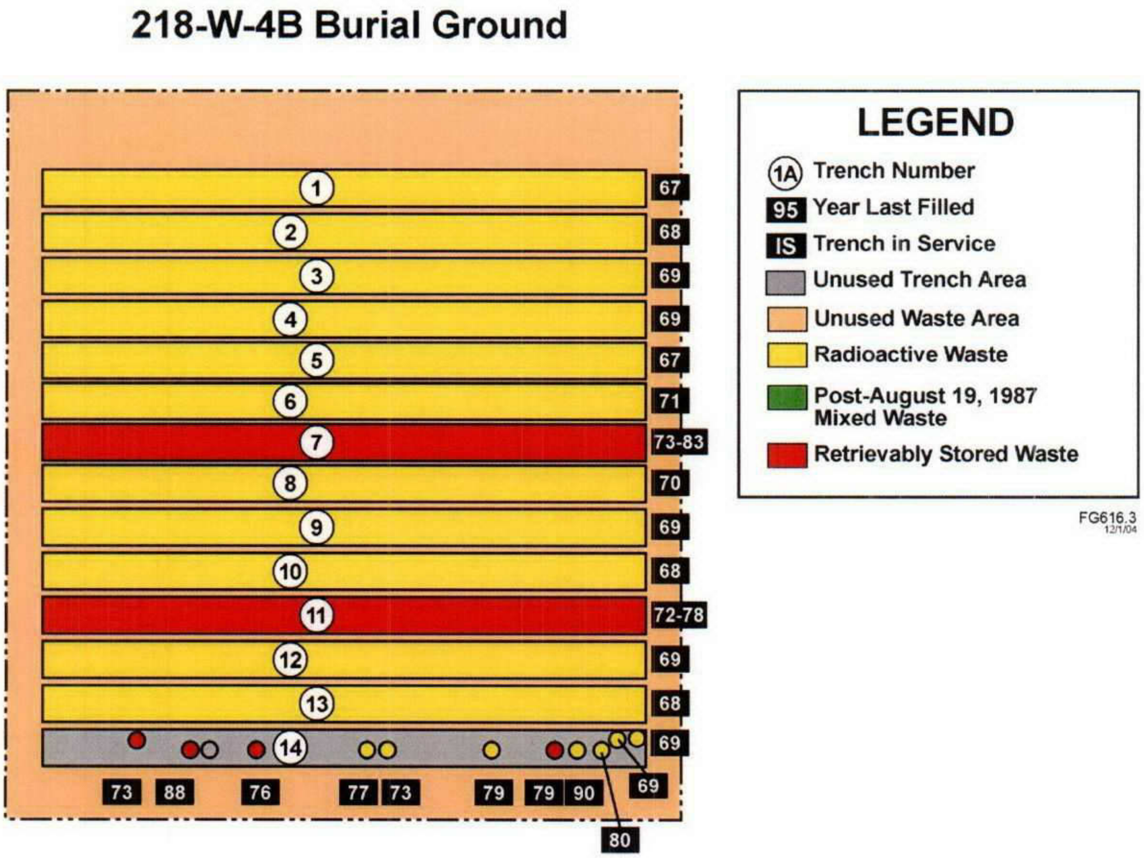
Updated from: DOE/EIS-0286F, *Final Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement, Richland, Washington.*

Figure 2-14. 218-W-3AE Burial Ground.



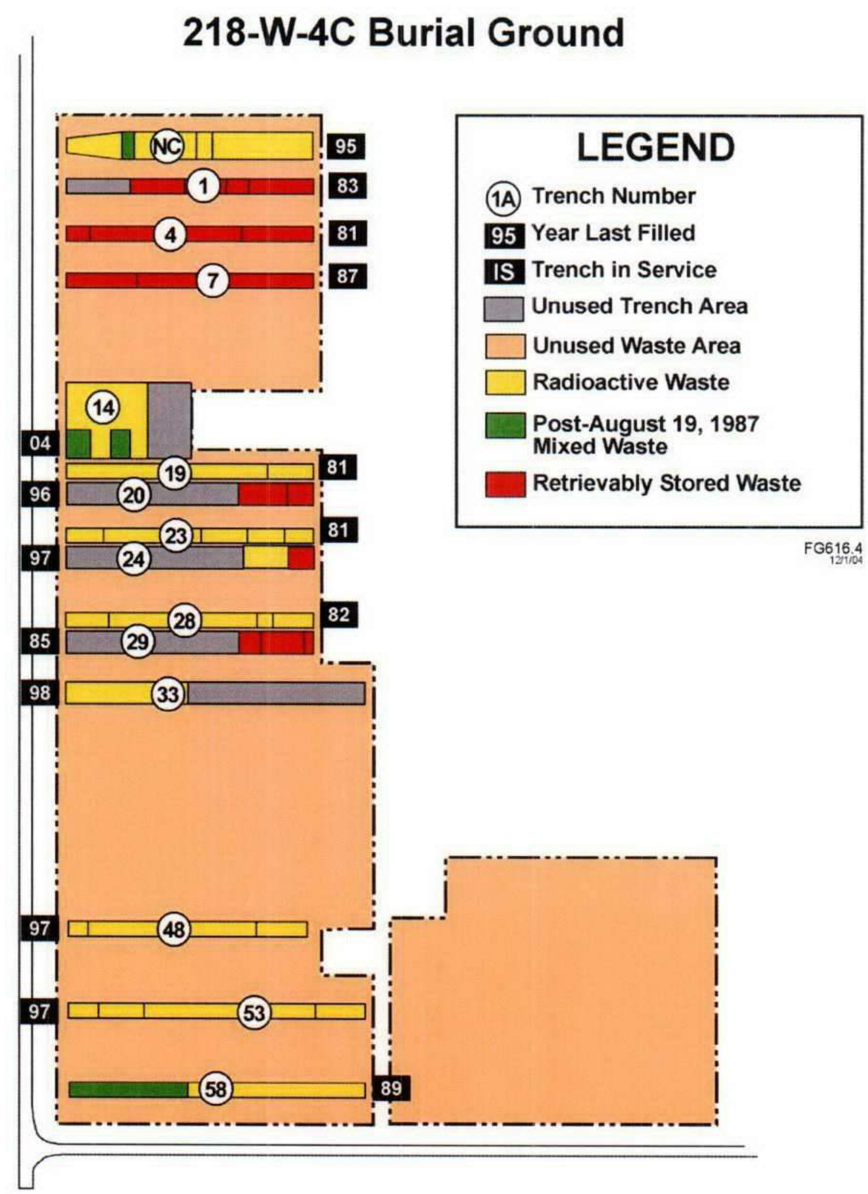
Updated from: DOE/EIS-0286F, *Final Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement, Richland, Washington.*

Figure 2-15. 218-W-4B Burial Ground.



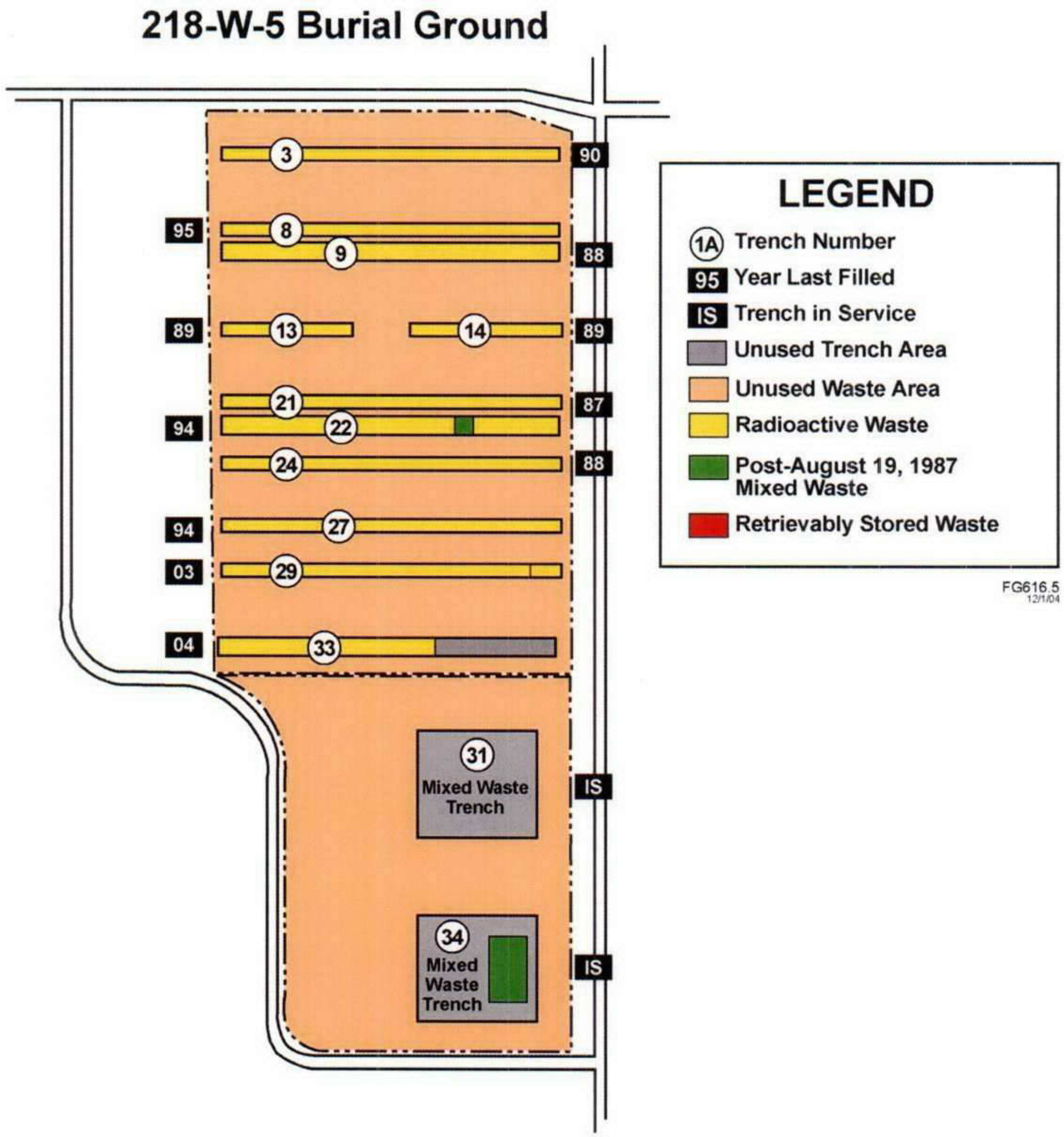
Updated from: DOE/EIS-0286F, *Final Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement, Richland, Washington.*

Figure 2-16. 218-W-4C Burial Ground.



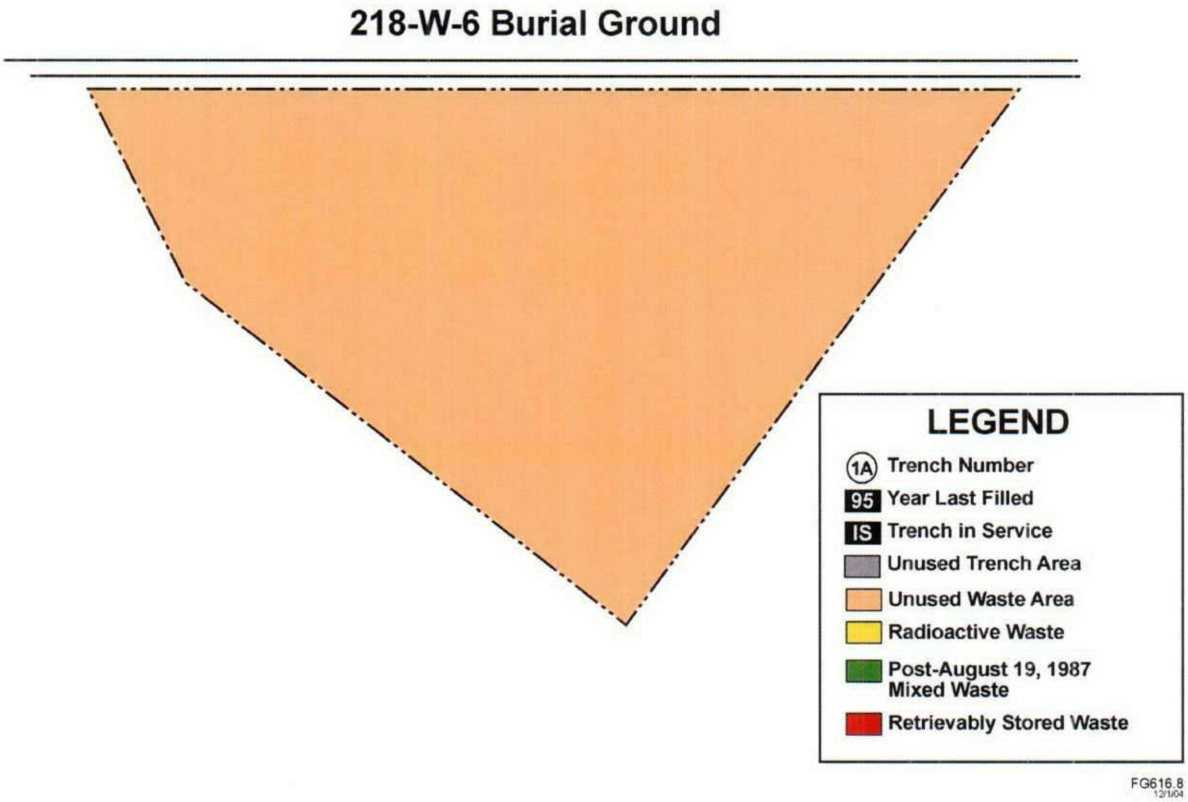
Updated from: DOE/EIS-0286F, *Final Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement, Richland, Washington.*

Figure 2-17. 218-W-5 Burial Ground.



Updated from: DOE/EIS-0286F, *Final Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement, Richland, Washington.*

Figure 2-18. 218-W-6 Burial Ground.



Updated from: DOE/EIS-0286F, *Final Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement, Richland, Washington.*

Figure 2-19. 218-E-1 Burial Ground.

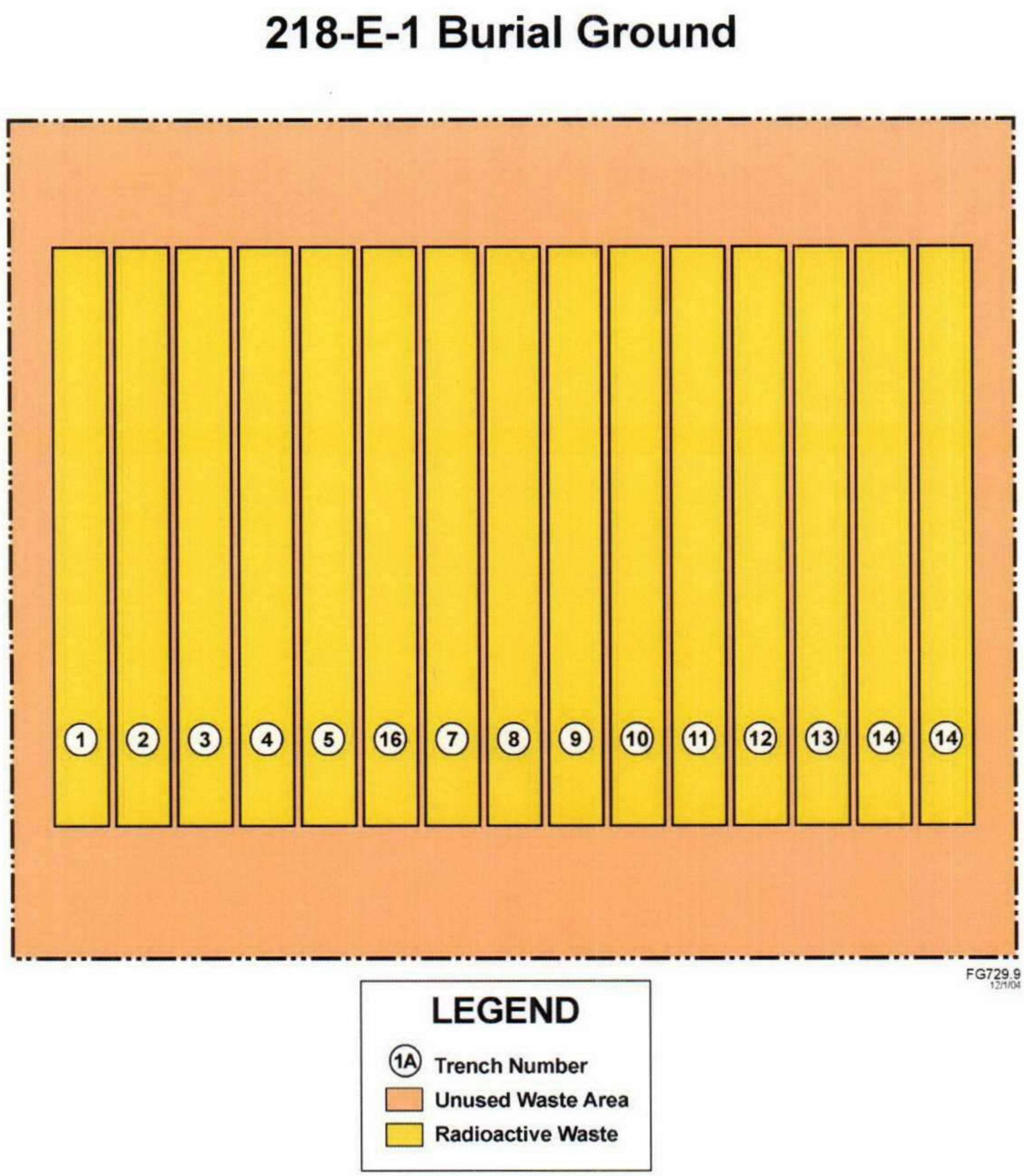


Figure 2-20. 218-E-2, 218-E-2A, 218-E-4, 218-E-5, 218-E-5A and 218-E-9 Burial Grounds.

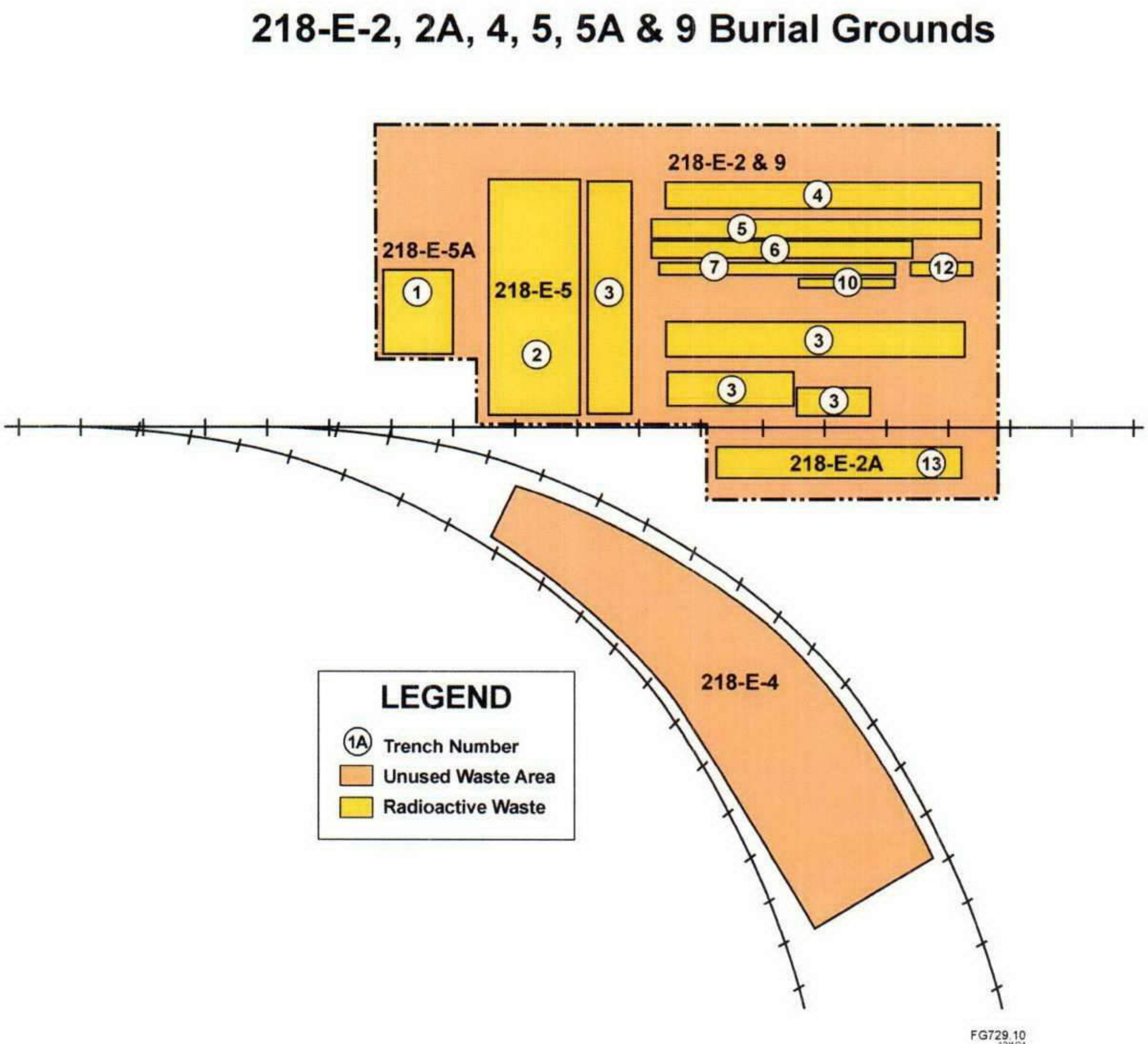


Figure 2-21. 218-E-12A Burial Ground.

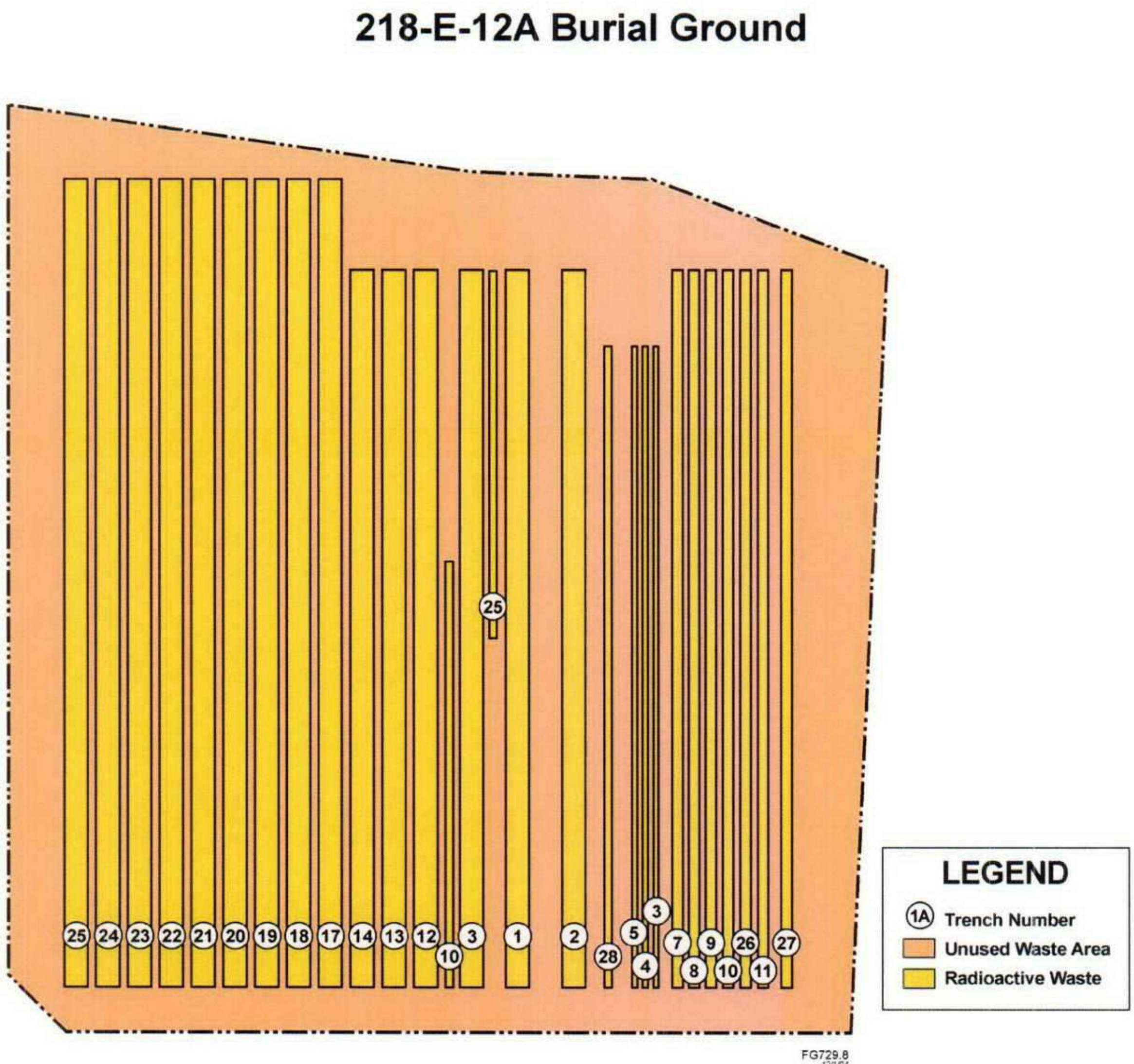


Figure 2-22. 218-W-1 Burial Ground.

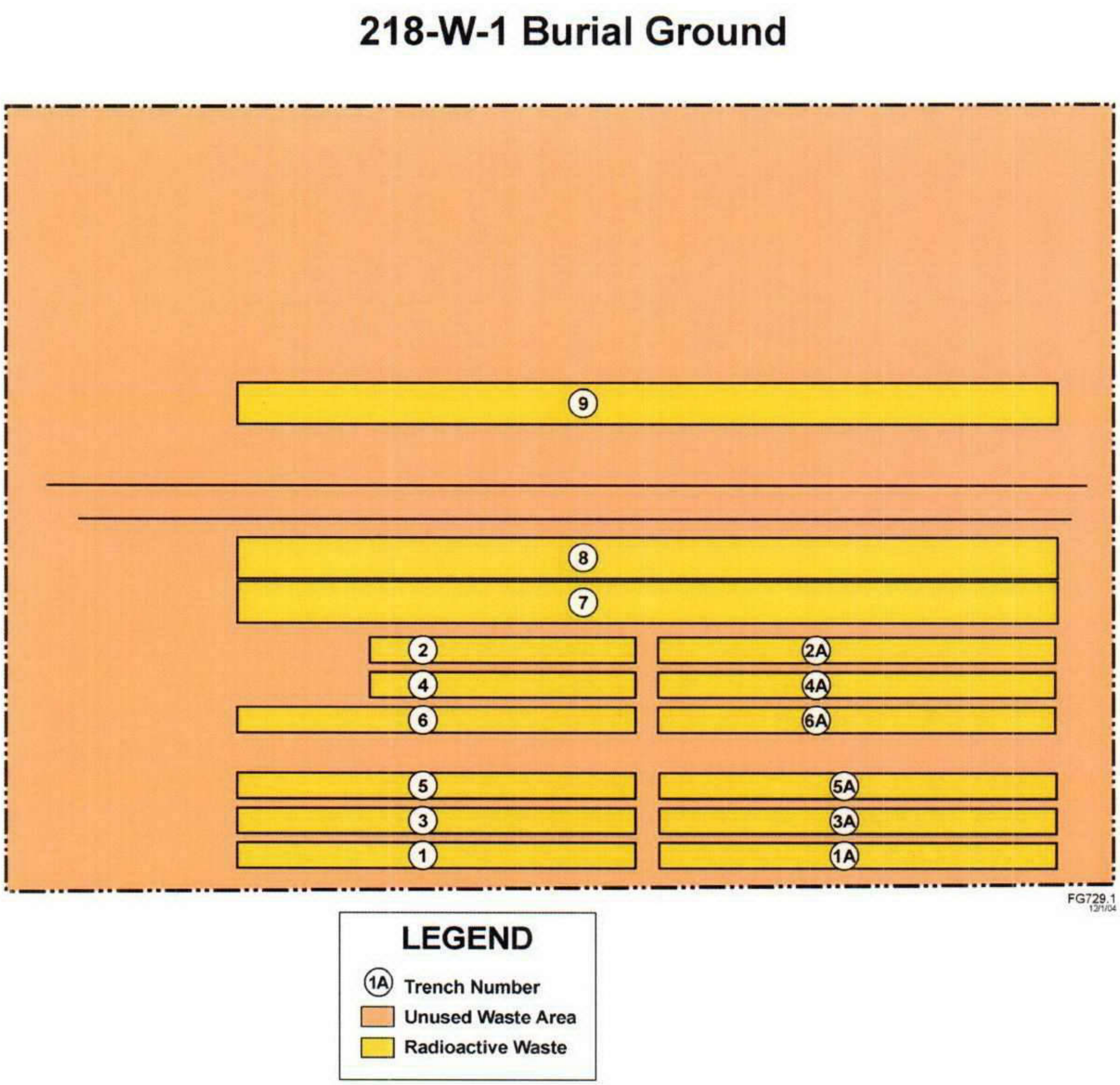


Figure 2-23. 218-W-1A Burial Ground.

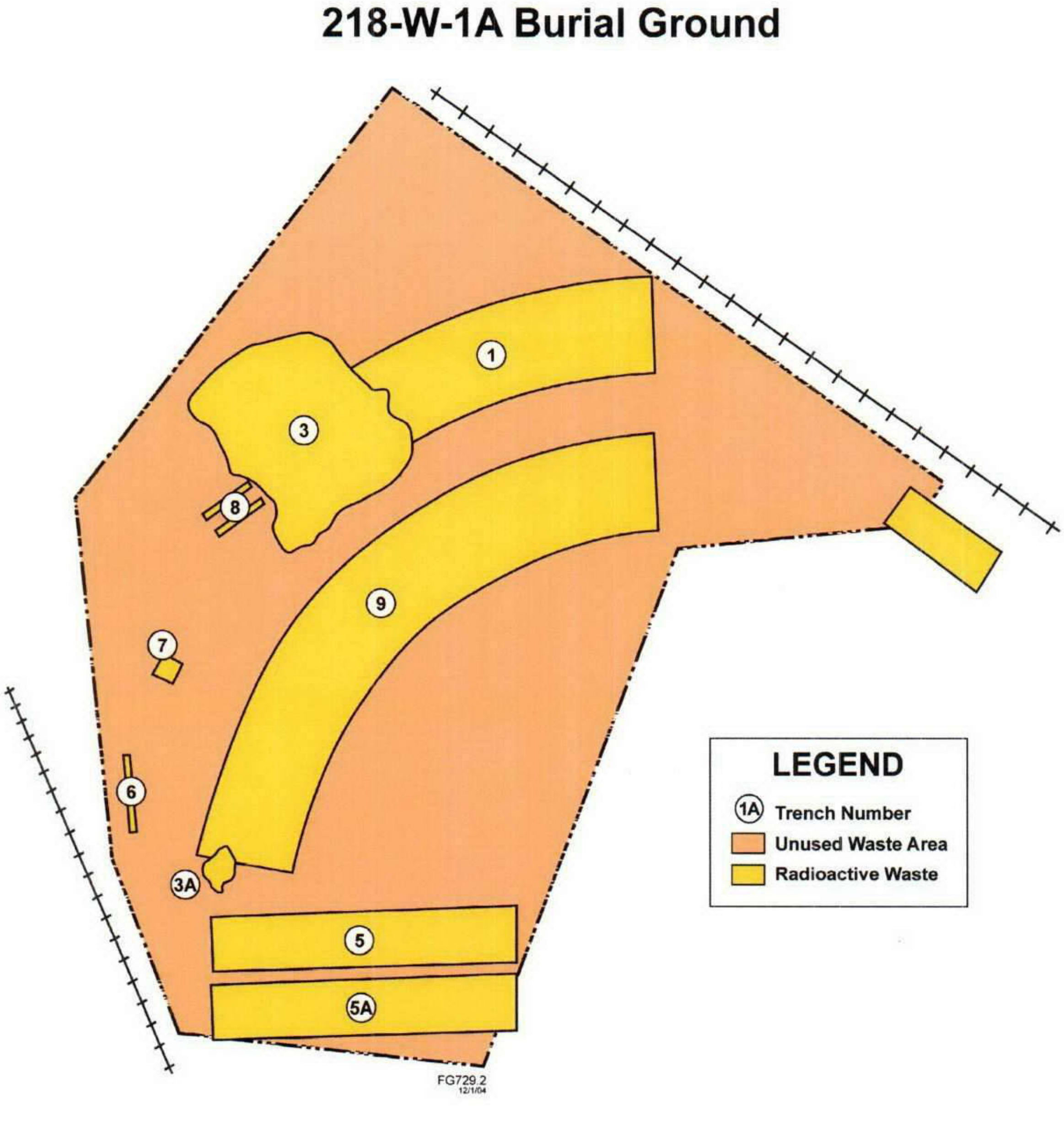


Figure 2-24. 218-W-2 Burial Ground.

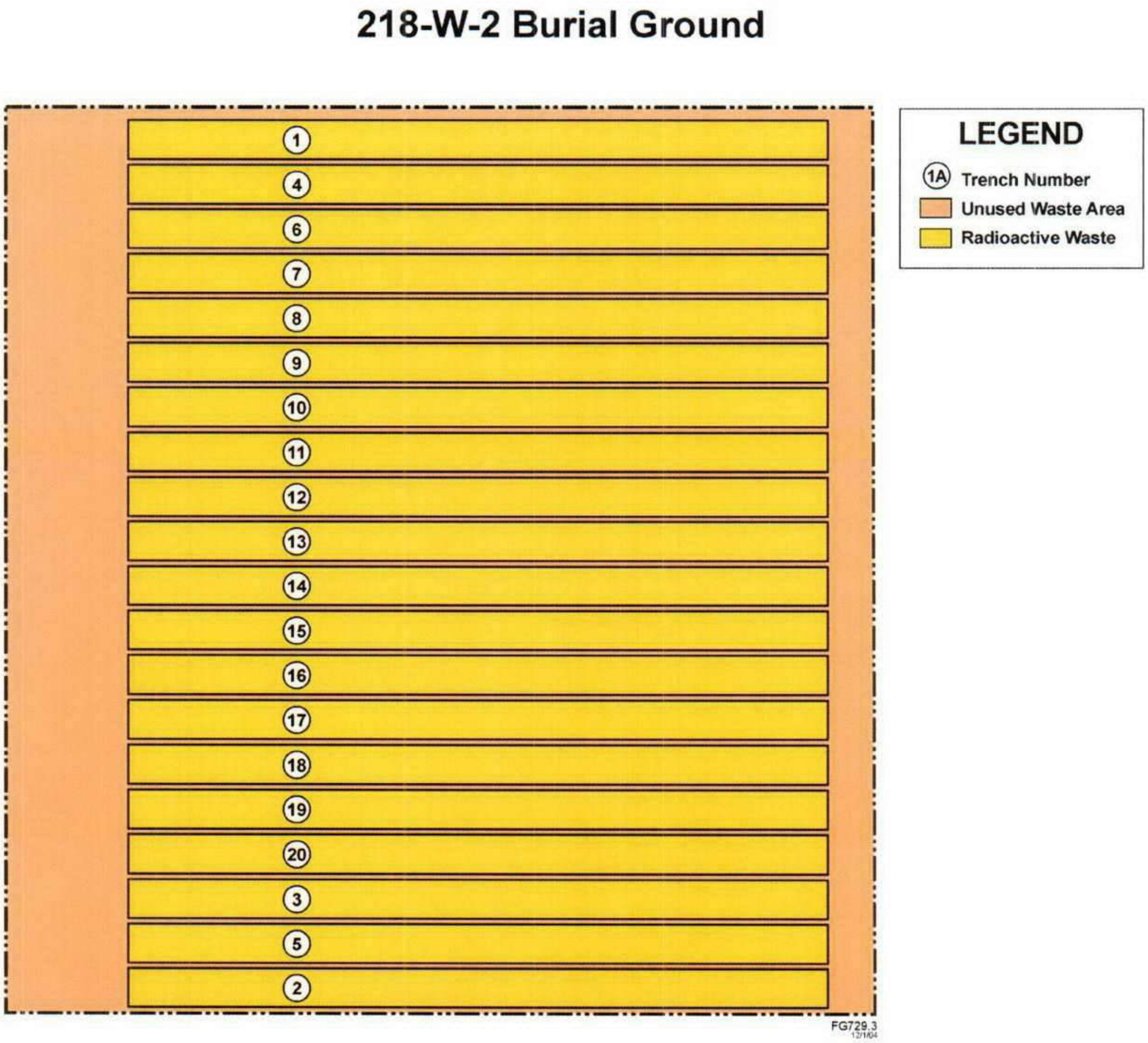


Figure 2-25. 218-W-2A Burial Ground.

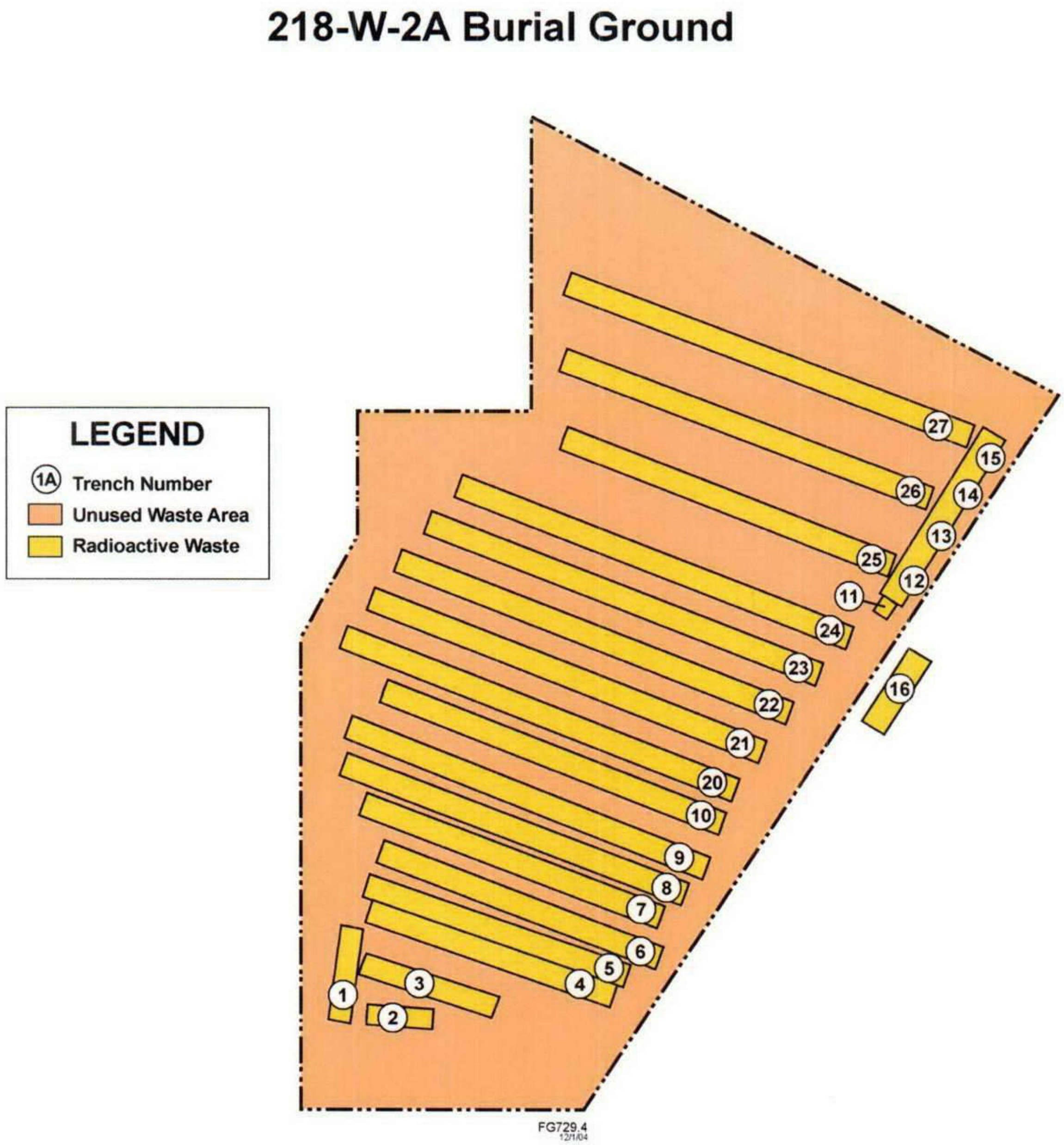


Figure 2-26. 218-W-3 Burial Ground.

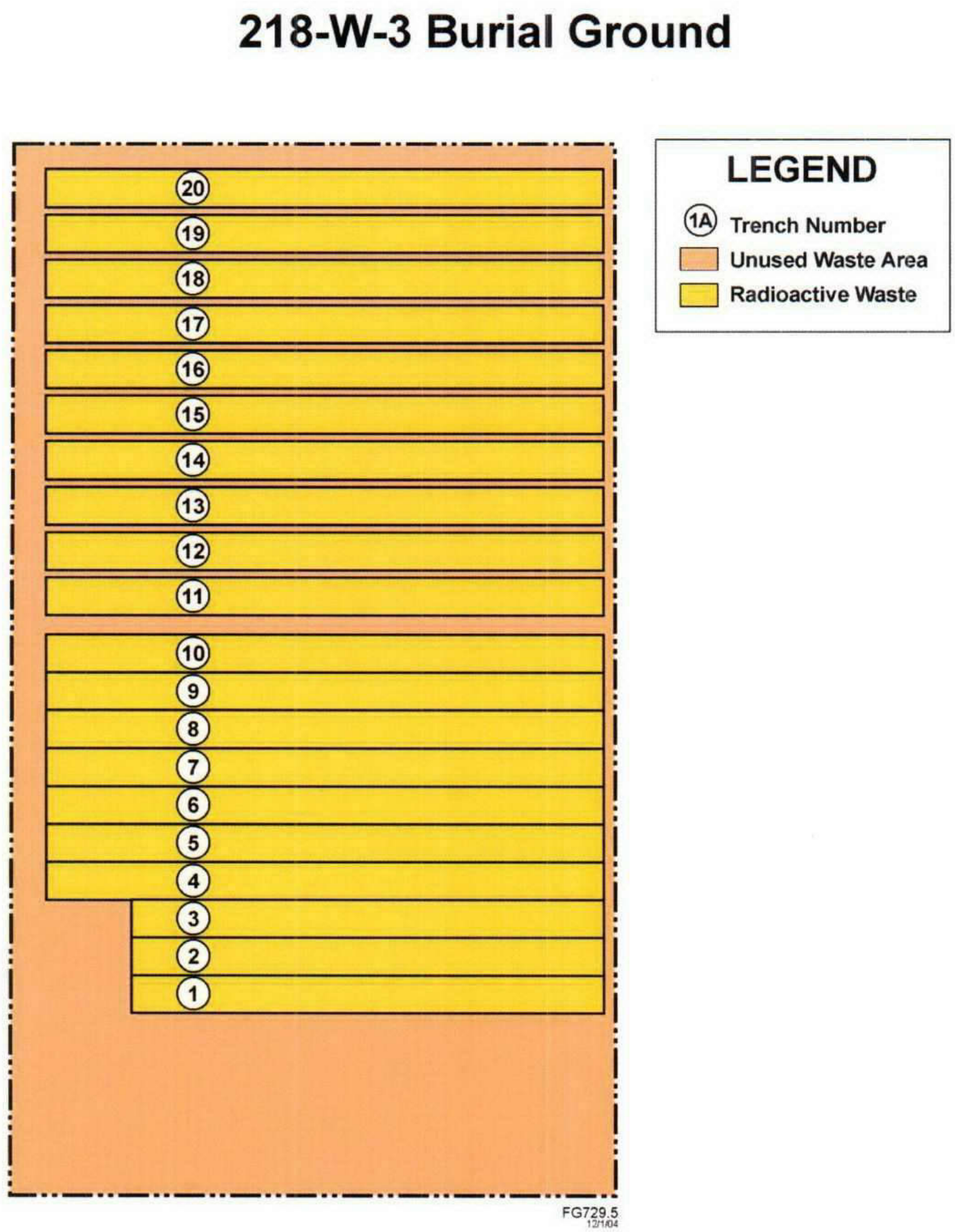


Figure 2-27. 218-W-4A Burial Ground.

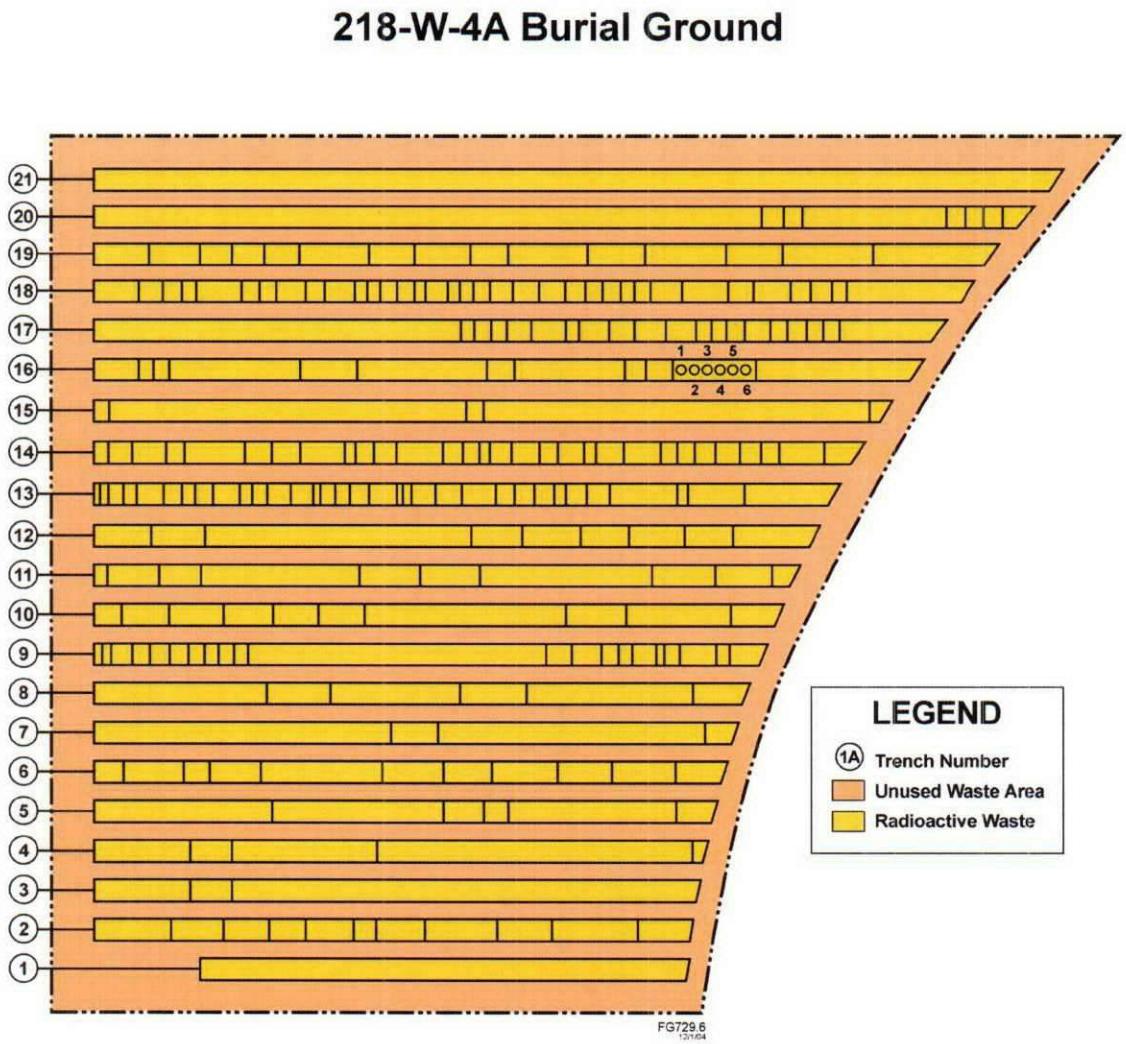


Figure 2-28. 218-W-11 Burial Ground.

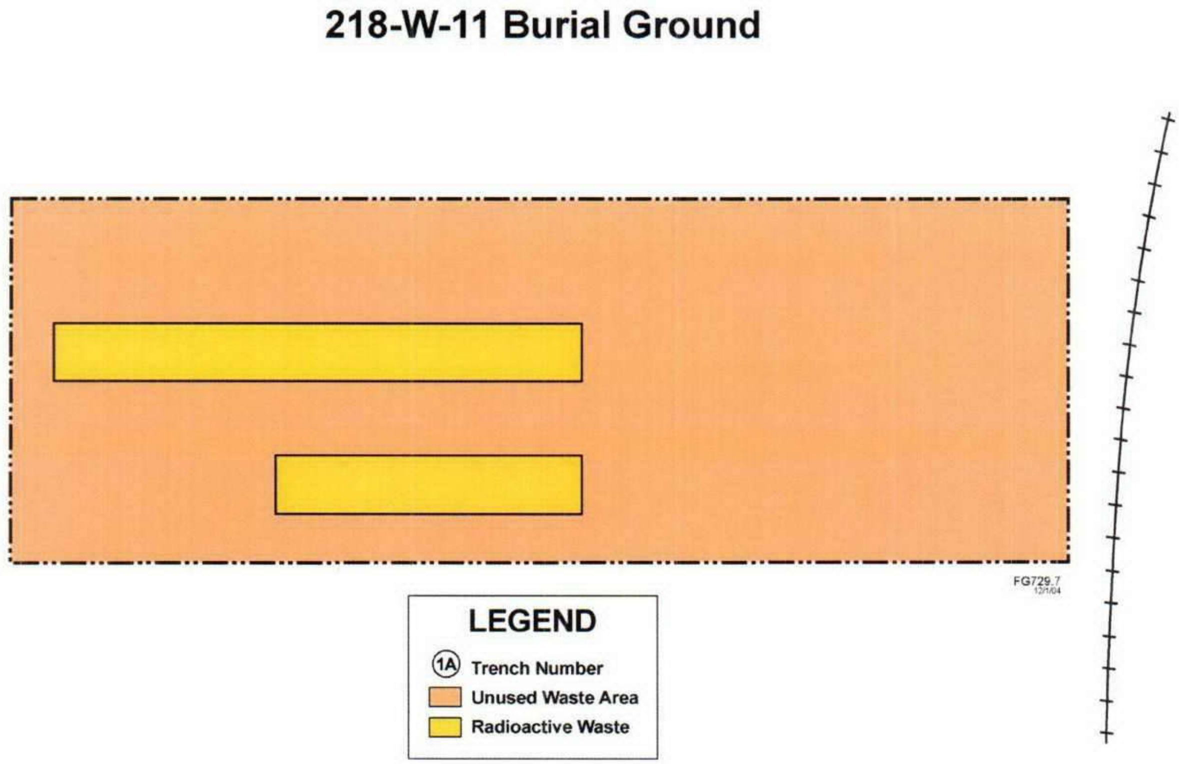


Table 2-1. Burial Ground Management Practices.

Operations Period	Management Practices
1944-1954	• No intensive waste segregation program. Radioactive wastes, including those containing hazardous and/or transuranic constituents, were commingled for disposal. • Combustibles and noncombustibles buried in the same trench. • Burial records contain minimal information. • Decentralized disposal; virtually all waste buried near point of origin.
1955-1965	• Alternate disposal methods and sites studied, documented, and, in some cases, implemented. • Intentional burning of combustible low-level radioactive solid waste in burial trenches began and ended in 1955. • Records improved.
1966-1973	• Burial grounds centralized. Central Landfill (Nonradioactive Dangerous Waste Landfill and Solid Waste Landfill) constructed for nonradioactive solid waste. • Measurement of burial materials volumes and inventories improved. • Burial records much more complete. • Some segregation of waste by category. • Beginning in 1968, increasing amounts of low-level radioactive solid waste transported to 200 Areas for disposal. • Retrievable storage of TRU wastes in backfilled trenches beginning 1970. • Radioactive waste burial stopped in the 300 Area in 1972 and in the 100 Areas in 1973.
Post-1973	• Low-level radioactive solid waste from all major Hanford Site areas (100, 200, 300, 400, and 600) disposed of in the 200 Areas burial grounds beginning about 1973. • Nonradioactive Dangerous Waste Landfill accepted dangerous waste 1975-1985. • About 1981, low-level liquid organic waste banned from land disposal. • Tracking system in place for MLLW trench burials 1985-1987. • In 1987, the U.S. Department of Energy issued a byproduct waste rule stating that the hazardous components of mixed waste are regulated by RCRA. • Central Waste Complex placed in service 1988, from which time MLLW and TRU are stored aboveground in the complex. • Environmental Restoration Disposal Facility constructed in 1995 for CERCLA waste. • Sanitary solid waste disposed of at the Solid Waste Landfill until the facility closed in 1996; sanitary waste currently sent to Roosevelt Landfill in Klickitat County, Washington for disposal. • TRU waste sent to Waste Receiving and Processing Facility beginning in 1998 for packaging and shipment to Waste Isolation Pilot Plant. • MLLW disposed in a RCRA-compliant TSD unit (218-W-5 lined MLLW trenches) beginning in 1999.

From DOE/RL-98-48, Vol. II, Rev. 0, *Groundwater/Vadose Zone Integration Project Background Information and State of Knowledge*; WHC-EP-0912, *The History of the 200 Area Burial Ground Facilities*; TRAC-0151-VA, *Historical Perspective of Radioactively Contaminated Liquid and Solid Wastes Discharged or Buried in the Ground at Hanford*; HNF-4755, *Hanford Site Solid Waste Management Environmental Impact Statement (EIS) Technical Information Document;* and McDonald et al., 2001, "Hanford Site Mixed Waste Disposal."

CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980.*
MLLW = mixed low-level waste.
RCRA = *Resource Conservation and Recovery Act of 1976.*
TRU = transuranic.

3.0 INITIAL EVALUATION OF WASTE SITES

The purpose of this chapter is to present a summary of existing knowledge and the results of previous characterization efforts at the waste sites in the 200-SW-1 and 200-SW-2 OUs, and to provide an understanding of conditions at the waste sites. The contaminant inventories, waste volumes, and current understanding of the distribution of contamination are discussed for the various types of waste sites and each of the RI/FS and TSD unit waste sites.

3.1 KNOWN AND SUSPECTED CONTAMINATION

As discussed in Chapter 2.0, waste sites in these OUs received solid waste (bulk quantities of trash, construction debris, soiled clothing, failed equipment, and laboratory and process waste) placed on the surface, or in designated shallow burial trenches and covered with soil. Wastes in burial trenches were either placed directly in the waste sites or packaged in cardboard, wooden, or fiber-reinforced polyester boxes, steel drums, concrete burial vaults, or other containers. Some wastes were contaminated with radionuclides, organics, and/or inorganic chemicals from various facilities, mainly from the Hanford Site 200 Areas. Relatively small amounts of wastes from the 100 and 300 Areas and from offsite sources also were placed in some of the waste sites, particularly the LLBG TSD unit sites. The estimated inventory of the main radionuclides and chemicals that were discharged to waste sites in the 200-SW-1 and 200-SW-2 OUs was obtained primarily from the following sources:

- *Hanford Environmental Information System* (HEIS)
- *Waste Information Data System*
- *Solid Waste Information Tracking System*
- BHI-01115, *Evaluation of the Soil-Gas Survey at the Nonradioactive Dangerous Waste Landfill*
- DOE/RL-96-81, *Waste Site Grouping for 200 Areas Soil Investigations*
- RHO-CD-673, *Handbook 200 Areas Waste Sites*
- RHO-CD-78, *Assessment of Hanford Burial Grounds and Interim TRU Storage*
- WHC-EP-0125-1, *Summary of Radioactive Solid Waste Received in the 200 Areas During Calendar Year 1988*
- WHC-EP-0912, *The History of the 200 Area Burial Ground Facilities*
- ARH-2762, *Input and Decayed Values of Radioactive Solid Wastes Buried in the 200 Areas Through 1971.*

The following sections provide an overview of the potential contaminants.

3.1.1 Nonradioactive Landfills and Dumps (200-SW-1 Operable Unit)

Most of the sites in this OU were accumulation points for materials not believed at the time to be potentially hazardous. There are recorded incidents of UPRs at some of the burn pits from the accidental burning of radioactive materials. Contamination from these releases was removed or stabilized at the time of discovery. Burn pits also were used for detonating shock-sensitive and potentially explosive chemicals. These sites were cleaned in 1995 to meet RCRA standards. In addition, the following reported waste disposal practices have the potential for contamination at 200-SW-1 OU sites:

- The Original Central Landfill consists of a single trench that was used for 9 months in 1973. A small amount of low-level radioactive contamination was found on the site surface in 1986 and the trench was posted as an Underground Radioactive Material Area.
- The SWL, which was active until 1996, has an estimated inventory of approximately 382,500 m^3 (500,000 yd^3) of solid waste. In addition, up to 5,000,000 L (1,320,000 gal) of sewage and an estimated 380,000 L (100,000 gal) of wastewater from 1100 Area vehicle maintenance catch tanks were disposed to liquid waste trenches.
- The NRDWL is adjacent to the SWL and received primarily dangerous waste materials from laboratories and asbestos. Records indicate that the site received liquid wastes packed in 55-gal drums and laboratory packs filled with absorbents.

3.1.2 Radioactive Landfills and Dumps (200-SW-2 Operable Unit)

Detailed inventory records of waste were not maintained before 1960 and only limited information was recorded regarding radioactive and nonradioactive waste content at the time of placement. Based on available knowledge, radioactive contaminants expected in the 200-SW-2 Burial Grounds include uranium, Cs-137, Sr-90, Pu-239/240, Am-241, Co-60, Tc-99, and Ru-106. Only those contaminants with a half-life of more than 20 yr (i.e., all those listed except Co-60 and Ru-106) are expected to pose a significant risk. WHC-EP-0645, *Performance Assessment for the Disposal of Low-Level Waste in the 200 West Area Burial Grounds*, also looked at C-14 and I-129. Although a variety of chemical wastes may have been disposed to these burial grounds, chemical inventories were not maintained until the mid-1980s.

Before 1970, wastes were designated as either routine or industrial wastes; there generally was no segregation of materials within either of these major categories. Industrial waste trenches received large items, often packaged in drag-off boxes. Drag-off boxes routinely had a dose associated with their waste of up to 200 mrem/h at 61 m (200 ft). Records indicate a box was disposed with a reading of 250 mrem/h at 152 m (500 ft) on October 21, 1953; another box in 1975 read 4 R/h at about 21 m (70 ft); and a third showed 2.8 R/h at 15 m (50 ft). Routine wastes have been disposed in trenches in containers (e.g., cardboard boxes, drums) and unpackaged. Many of these trenches contain wastes that could result in as low as reasonably achievable (ALARA) concerns; wastes with dose rates at 200 R/h have been disposed to these trenches (WHC-EP-0912).

Cover requirements for burial ground wastes varied over the years. Because of shallow burial, some wastes were exposed by wind erosion. There are a number of recorded incidents of burial boxes collapsing and dispersing radioactive contamination across wide areas of the site. In addition, shallow burial resulted in uptake from plants whose roots penetrated into the waste packages. Most of these issues have been resolved through compaction of soils at waste sites and the addition of soil with vegetation cover to stabilize existing soils.

3.1.3 Remediation Bins

As noted in Chapter 1.0, the DQO for these OUs established a binning procedure to group the sites into categories for remediation, based on the current state of knowledge for these sites. The following section provides a summary of the known or anticipated contaminant inventory for sites within these bins.

3.1.3.1 Bin 1 Sites – No Remediation Planned

The Bin 1 sites are not anticipated to contain contamination at levels that will require remedial action. The sites include, for example, burn pits, mud pits, gravel pits, and other solid waste disposal sites. Investigations at other, similar sites have shown little or no contamination present at these locations. The majority of the sites are from the 200-SW-1 OU. Any contamination that is present at the Bin 1 sites is expected to be minor. No contaminant inventory that will require remedial action is anticipated for sites in Bin 1.

3.1.3.2 Bin 2 Sites – Remediate Using Remove/Treat/Dispose Approach

The Bin 2 sites are anticipated to be contaminated with radioactive and/or hazardous/dangerous wastes. Based on available knowledge, contamination is expected to be at low levels and primarily near the surface, or in a form that is amenable to readily available remediation techniques. The remediation techniques for some of these sites may require additional refinement elsewhere on the Hanford Site before using them at these locations. These would include, for example, retrieval of wastes from caissons or vaults containing high dose materials. Because efforts are currently under way at the Hanford Site to address similar wastes, these sites are included in Bin 2 with the anticipation that remedial options will be available by the time they are needed for these 200-SW-2 OU sites.

Many of the Bin 2 sites are rubble piles or construction burial grounds. These sites contain primarily construction debris and are not anticipated to pose a significant contamination threat. The bin contains a number of former artillery and anti-aircraft gun sites, which are also expected to contain little in the way of contaminated materials. A contaminant inventory was not developed for these sites.

The most significant potential inventory of contamination at Bin 2 sites is anticipated at the 222-B, -S, and -T Vaults, which received packaged laboratory samples and wastes. These wastes are likely to contain significant amounts of radioactive constituents, but are not anticipated to be highly mobile. The 218-E-2 Burial Ground also received significant amounts of radioactive constituents.

A conceptual contaminant distribution model for these sites is presented in Section 3.2.

3.1.3.3 Bin 3 – Sites Requiring Characterization

Inventory information for the waste sites in Bins 3A and 3B is more complete for sites receiving waste after 1970. Obtaining inventory information becomes more difficult with increasing age of the operating period of the waste site. In some cases, although records are kept of the burial ground contents, a detailed inventory of contaminants is unavailable. In other cases, even the burial ground contents are not known with certainty. Radionuclide inventory for the older burial grounds was estimated based on historical records. Table 3-1 contains estimated areas and radionuclide inventories for Bin 3 waste sites. Data were taken from SWITS and supplemented with information from WIDS.

Site-specific inventories were developed for the Bin 3 sites, based on records found in SWITS and WIDS (Table 3-1). Records in SWITS and WIDS may or may not reflect the complete record of wastes at a given site. When it was possible to verify the original inventory information source (as cited in WIDS, and often on file in the WIDS library), it has been referenced in this work plan.

Chemical inventories are presented in Table 3-2 for Bin 3 waste sites for which this information could be located.

The summaries provided below (Section 3.1.4) reflect the information that is readily available for the Bin 3 waste sites. Inventories are given for some Bin 3B sites for which good information exists, and all Bin 3A sites, because they have the most complete records. As noted in Section 2.2.2 and as shown in the timeline bar diagram (Figure 2-5), only limited records were maintained for wastes placed in the older burial grounds. Therefore, although wastes containing nonradioactive contaminants would have been placed at these sites, there are no records documenting the nonradionuclide inventories. The inventories presented are for the waste sites only; monitoring data for the groundwater beneath the sites are presented in Section 3.4.

Sources of information on contaminant inventory vary widely among the different waste sites. The number of available reference sources containing inventory information, and the amount and type of information in each source, vary. The amount of inventory contained at each site is not consistent among sources, the sizes of the waste sites are not consistent among sources, and the locations of some structures (such as caissons) within the waste sites are inconsistent. However, even given the large variation in source data, the basic conclusions drawn by different sources do not typically vary widely. Contaminant inventories and waste site sizes are nearly always well within an order of magnitude (or there is a good reason for the inconsistency, such as a very old inventory of a still-active burial ground compared with a more recent inventory). Different renditions of location are limited to a few structures, which the sources agree are within close range of each other even though exact locations vary. Given other uncertainties relevant to the total inventories in burial grounds, these differences are inconsequential for purposes of this analysis. For example, RHO-CD-194 reported that the plutonium inventory for burial grounds could be as much as 275 kg (605 lb) over the values reported.

3.1.4 Nature and Extent of Contamination

The following discussion provides a summary of known contamination at the Bin 3 sites, based on existing records. The Bin 3A sites (TSD units), which have been characterized to a greater extent than the Bin 3B burial grounds, are discussed in this section. Because no investigations have been conducted for the Bin 3B sites, there are few or no data available to describe existing contamination for these sites.

Groundwater well monitoring results are discussed in Section 3.4. Groundwater wells installed at burial grounds after approximately 1990 generally are not sampled for specific contaminants, but are sampled for contaminant indicators such as conductivity and total organic carbon. There also is little information from gamma logging or soil samples available for these sites. Monitoring wells installed since about 1990 were typically sampled during installation only for moisture content and particle size, not contaminants. Most of the more recent well installations were for monitoring conditions under tank farms, not burial grounds.

A few reference sources present information on geophysical results or sediments obtained during installation of wells, and are briefly summarized as follows:

- PNL-6820 presents groundwater and geophysical results from samples collected during the installation of some monitoring wells in the 200 Areas. This information is suitable for the records review process in conjunction with site characterization as discussed in Section 4.2.
- WHC-MR-0204, *200-East and 200-West Areas Low-Level Burial Grounds Borehole Summary Report*, summarizes the results of 11 wells drilled in the 200 East and 200 West Areas in FY 1989. Selected sediment samples from the installation of these 11 wells were tested for physical and hydrogeologic properties. The sediment samples also were analyzed for contaminant indicator parameters (total organic carbon, anions, low-energy alpha emission, and beta emission). In addition, the sediment samples were analyzed for volatile organic constituents. Samples were collected from each location from surface to groundwater, which was at about 75 m (240 ft); the samples were collected at roughly 6 m (20 ft) intervals. Of the anions analyzed, the highest concentration detected was sulfate at 130 mg/kg in Well 299-W7-7 (at the north border of the 218-W-3AE Burial Ground) at a depth of 12.2 m (40 ft). All other anions either were not detected or were detected at values below 130 mg/kg. The most significant beta count was 29.1 pCi/g at Well 299-W7-8 (at the northeast corner of the 218-W-3AE Burial Ground), at a depth of 9.3 m (30.5 ft). Alpha readings were all below 15.4 pCi/g. Total organic carbon analyses detected a concentration of 85 mg/kg at well 299-W7-7 at a depth of 24.4 m (80 ft). Other concentrations of total organic carbon were below this value in all samples collected. The volatile organic constituent concentrations were similarly low in all samples collected. Carbon tetrachloride was detected in well 299-W15-19 (at the north border of the 218-W-4B Burial Ground) at a concentration of 8.1 μg/kg at a depth of 75 m (240 ft). Details of the physical and hydrogeologic properties of the samples collected can be found in Appendix C of WHC-MR-0204.
- WHC-MR-0205, *Borehole Completion Data Package for Low-Level Burial Grounds – 1990*, summarizes the installation of six new monitoring wells in the 200 East and 200 West Areas in FY 1990. Selected sediment samples were collected during installation of each well and analyzed for volatile organics, anions, total organic carbon, and gross alpha and gross beta. Physical properties analysis results also were obtained. Chemical and radionuclide data can be found in Appendix B of WHC-MR-0205. Samples were collected from each well in zones that had one or more of the following: (1) higher than background photo-ionizer readings during drilling, (2) higher than background radiation readings during drilling, (3) zones of higher moisture content, (4) within 12.2 m (40 ft) of the water table (3 from each well), and (5) high silt and clay content. The results from analysis of these samples were substantially similar to those results presented in WHC-MR-0204. All results for all constituents were at least two orders of magnitude below the potential preliminary remediation goals (PRG) established in the SAP of this document (Appendix A).

3.1.4.1 218-E-10 Burial Ground

Groundwater monitoring wells for Burial Ground 218-E-10 are discussed in Section 3.4.1. No gamma logging or soil sample data could be located for any of the wells associated with this site. No other data were found to characterize soil conditions in the vicinity of this site.

3.1.4.2 218-E-12B Burial Ground

Groundwater monitoring wells for Burial Ground 218-E-12B are discussed in Section 3.4.2. No gamma logging or soil sample data could be located for any of the wells associated with this site. No other data were found to characterize soil conditions in the vicinity of this site.

In January 2000, contaminated tumbleweeds were found on the waste site with readings of 29,000 to 59,000 d/min per 100 cm^2 beta-gamma, less than 20 d/min alpha (WIDS).

3.1.4.3 218-W-3A Burial Ground

Groundwater monitoring wells for Burial Ground 218-W-3A are discussed in Section 3.4.3. No gamma logging or soil sample data could be located for any of the wells associated with this site. No other data were found to characterize soil conditions in the vicinity of this site.

3.1.4.4 218-W-3AE Burial Ground

Groundwater monitoring wells for Burial Ground 218-W-3AE are discussed in Section 3.4.3. No gamma logging or soil sample data could be located for any of the wells associated with this site. No other data were found to characterize soil conditions in the vicinity of this site.

3.1.4.5 218-W-4B Burial Ground

Groundwater monitoring wells for Burial Ground 218-W-4B are discussed in Section 3.4.4. No gamma logging or soil sample data could be located for any of the wells associated with this site. No other data were found to characterize soil conditions in the vicinity of this site.

3.1.4.6 218-W-4C Burial Ground

Groundwater monitoring wells for Burial Ground 218-W-4C are discussed in Section 3.4.4. No gamma logging data could be located for any of the wells associated with this site.

Information on contamination in the 218-W-4C Burial Ground is summarized below from CP-16886, *Data Quality Objectives Summary Report for the 218-W-4C Burial Ground Contaminant Release Investigation*, written to determine whether contaminants have been released to the vadose zone from retrievably stored waste in the unit.

Vent risers in Trenches 1, 4, 7, and 20 were sampled in 1997 for concentrations of volatile organic compounds. Vent risers in Trenches 1, 4, and 7 also were sampled in 2002 for concentrations of carbon tetrachloride. All of the vent risers sampled in 1997 showed elevated amounts of several chlorinated volatile organic vapors including carbon tetrachloride and degradation products, trichloroethylene and degradation products, and chlorofluorocarbons. Alcohols, ketones, and aromatic compounds also were detected, but at much lower concentrations (HNF-SD-WM-RPT-309, *Report on Sampling and Analysis of Air at Trenches 218-W-4C and 218-W-5 #31 of the Low-Level Burial Grounds*; CP-13514, *200-PW-1 Operable Unit Report on Step I Sampling and Analysis of the Dispersed Carbon Tetrachloride Vadose Zone Plume*).

Soil-vapor samples were collected from the vadose zone adjacent to Trenches 1, 4, and 7 and analyzed for carbon tetrachloride in 2002. Carbon tetrachloride was detected in soil-vapor samples collected along the east end of Trench 4, near the location of vent risers at which elevated concentrations of carbon tetrachloride were detected in 2002 (CP-13514).

Groundwater monitoring wells have been installed on the eastern and western perimeters of the 218-W-4C Burial Ground to comply with RCRA groundwater monitoring requirements. During drilling of wells along the western perimeter in 1990, carbon tetrachloride was detected in soil and soil-vapor samples (DOE/RL-91-32, *Expedited Response Action Proposal (EE/CA & EA) for 200 West Area Carbon Tetrachloride Plume*, Draft B).

The presence of volatile organic compounds in vapor samples collected inside the trenches through vent risers suggests that organic contaminants, in either a liquid and/or vapor phase, are able to migrate outside of the waste containers. The carbon tetrachloride in soil-vapor samples collected adjacent to Trench 4 appears to have resulted from release of carbon tetrachloride from the engineered structure. However, the remedial investigation of potential carbon tetrachloride releases to the vadose zone has not been completed.

Soil-gas survey data indicate contaminants in parts per million by volume. The full range of all detected soil gas and groundwater data for this burial ground from samples reported in HEIS for August 2002 is shown in Table 3-3.

3.1.4.7 218-W-5 Burial Ground

Groundwater monitoring wells for Burial Ground 218-W-5 are discussed in Section 3.4.3. No gamma logging or soil sample data could be located for any of the wells associated with this site. No other data were found to characterize soil conditions in the vicinity of this site.

3.1.4.8 Nonradioactive Dangerous Waste Landfill

Groundwater monitoring wells for the NRDWL are discussed in Section 3.4.5. No gamma logging or soil sample data could be located for any of the wells associated with this site.

BHI-01115 reports volatile organics in low concentrations in soil-gas samples collected in 1997 and 1993. Concentrations reported in Table 3-4 are the maxima reported at shallow and deep concentrations for each sampling event, and are reported in parts per million by volume.

WHC-SD-EN-DP-064, *Data Package for Geophysical Investigation of Nonradioactive Solid Waste Landfill (NRDWL)*, contains survey data obtained with electromagnetic induction instruments and ground penetrating radar.

FS0419, *Data Package Summary, Analytical Laboratory Solid Waste Landfill Soil Gas and Methane Monitoring Round 1 Sampling, June 25, 2001*, summarizes quarterly volatile organic analyses from samples collected at the SWL, adjacent to the NRDWL. All reported values are at or below 1.0 p/M.

FS0438, *Data Package Summary, Analytical Laboratory Solid Waste Landfill Soil Gas and Methane Monitoring Round 1 Sampling, October 18, 2001*, and FS0473, *Data Package Summary Analytical Laboratory Solid Waste Landfill Soil Gas and Methane Monitoring Round 1 Sampling, March 4, 2002*, summarize quarterly soil gas and methane monitoring conducted at the SWL. All values reported in this survey are at or below 1.02 p/M for all constituents monitored.

FS0529, *Data Package Summary, Analytical Laboratory Solid Waste Landfill Soil Gas and Methane Monitoring Round 1 Sampling, July 10, 2002*, and FS0508, *Data Package Summary Analytical Laboratory Solid Waste Landfill Soil Gas and Methane Monitoring Round 1 Sampling, July 8, 2002*, summarize quarterly soil gas and methane monitoring conducted at the SWL. All values reported in this survey are at or below 1.0 p/M for all constituents monitored.

FP0015, *Data Package Summary, Analytical Laboratory Solid Waste Landfill Soil Gas and Methane Monitoring Sampling, September 17, 2002*, summarizes quarterly soil gas and methane monitoring conducted at the SWL. All values reported in this survey are at or below 1.09 p/M for all constituents monitored. The various references differ on their interpretation of contaminant sources. DOE/RL-96-81 indicates that volatile organic contamination primarily is attributed to the 1100 Area vehicle maintenance catch tank liquids disposed to liquid trenches in the SWL. BHI-01115 associates contaminants with the chemical trenches in the eastern half of NRDWL.

The NRDWL is a nonradioactive (200-SW-1 OU) site in the 600 Area.

3.2 CONCEPTUAL CONTAMINANT DISTRIBUTION MODELS

Preliminary conceptual contaminant distribution models first were developed for the 200-SW-1 and 200-SW-2 OUs in DOE/RL-96-81, which provided generalized models at the OU scale. Using waste site-specific information (Sections 2.1.5, 2.2.6, 3.1.4 and 3.4) and the OU models as a baseline, conceptual contaminant distribution models were developed that provide a basis for each of the three bins established in the DQO process. Conceptual contaminant distribution models are shown in Figures 3-1 through 3-3.

Information pertaining to contaminant sources, release mechanisms, transport media, exposure route, and receptors has been incorporated into the discussion of the conceptual contaminant distribution models in this section. The conceptual exposure model is included to develop an understanding of potential risks and exposure pathways associated with the waste sites. This information forms the basis for an evaluation of potential human health and environmental risk.

Many of the 200-SW-1 and 200-SW-2 OU sites are associated with landfills and planned disposal areas. Inadvertent spills, as well as container collapse and leakage, may have contributed to UPRs at some of these sites. In addition, some sites are included in the OUs that were the location of poorly defined waste disposal practices. Based on their characteristics and available knowledge of the waste forms and quantities, the sites within these OUs were separated into the three bins summarized in Chapter 1.0. Contamination expected in each bin is described in more detail in Section 3.1.3.

The Bin 1 sites include ash pits, burn pits, and solid waste sites that are not anticipated to include any significant contaminants of concern. Figure 3-1 illustrates the conceptual model for these sites. For the Bin 1 sites, there is no contamination present that is anticipated to pose a threat to human health or the environment.

Some of the sites in Bin 2 consist of surface debris that could potentially be either radioactively or chemically contaminated (Figure 3-2). In most cases, this debris is scattered over the site surface or near the surface; it is not uniformly distributed. Bin 2 also includes some burial grounds, vaults, and other above- or below-grade disposal sites with limited extent (or size). Radioactive, hazardous, and mixed waste and media potentially could be discovered at sites within Bin 2. Contamination present in these areas would be expected to be found primarily in shallow zone soils less than 4.6 m (15 ft) below ground surface.

Most of the sites in Bin 3 are burial grounds; there is only one conceptual model for Bin 3 sites. The burial grounds consist primarily of shallow, mostly unlined trenches generally 3 to 10 m (9.8 to 33 ft) wide, 50 to 100 m (154 to 328 ft) long, and 5 to 10 m (16.5 to 33 ft) deep. The size of some trenches exceeds these general dimensions and the two MLLW trenches in the 218-W-5 Burial Ground are lined. Waste in containers (boxes, drums, etc.) was placed in the trenches 2 to 3 m (6.5 to 9.8 ft) below the surface and then covered with soil. Wastes were placed in the trenches through a variety of methods. The boundaries and extent of the wastes within many of the early trenches cannot be exactly defined. More recent trenches are delineated with surface markers.

Types of LLW disposed of in these areas include paper, plastics, wood, protective clothing, concrete rubble, activated metal, contaminated equipment, and sludges. Bin 3B sites include both industrial waste and dry waste burial grounds. Industrial waste sites typically contain equipment and other large items such as vehicles. Dry waste sites contain many types of wastes such as rags, cans, clothing, filters, and small items such as tools.

Radionuclides listed in Table 3-5 are potentially found at these burial grounds. Some TRU wastes were retrievably stored at these sites in addition to the LLW. Nonradionuclide hazardous chemicals listed in Table 3-5, including metals, other inorganic constituents, volatile organics, semivolatile organics, and petroleum compounds, also potentially were disposed of in some of the trenches. The LLW consisted primarily of containerized materials; bulk disposal of liquid waste was not a significant contributor to the waste loading at these sites. There is a potential for contaminants to migrate into soil surrounding the trenches and possibly to groundwater. Therefore, soil is expected to be the primary contaminated media of concern at these sites. Infiltration of water (e.g., precipitation) into the trenches, particularly after surface-flooding events, may have facilitated migration of contamination into the surrounding soil although there is no evidence contamination has migrated to groundwater.

Contamination in the trenches is expected to remain within or in proximity to the waste forms. Minor penetration of contaminants into the trench subsurface is expected generally to extend to a depth of 1 m (3 ft), below the trench bottom. In some instances, driven by instances of snowmelt (for example, at 218-W-3A, 218-W-4B and 218-W-4C) or rainwater above or at the bottom of the trench, penetration of contaminants may be up to 3 m (10 ft) into the subsurface. However, most of the contaminants likely are held within the first 15 cm (6 in.) of native soil below the burial grounds. Contaminant penetration will be localized and irregular within the described parameters. Surface contamination is not anticipated to be present at shallow depths below and at the top of stabilizing soil covers from plants, animals, or insects bringing the material to the surface because of the application of herbicides and pesticides throughout burial ground operations, although such contamination spread may have occurred before stabilization. Contamination of the trench backfill may be encountered because of disposal packages that have failed and because of historical biointrusion and/or subsidence. Infiltration of rainfall and snowmelt is expected to concentrate this material in the lower portions of the trench. Ejection of contaminants from surface collapses will have produced a localized concentration around the subsequently backfilled voids. Records indicate that most burial grounds have received a stabilized soil cover; therefore, contamination in the first foot of soils should be minimal.

Surface and subsurface contamination also may be taken up by plants and migrate from the site through windblown dispersion of plant material or through consumption and dispersal in the fecal material of animals. Subsurface contamination also may be brought to the surface by burrowing animals and thereby become accessible to surface terrestrial receptors.

Contamination is assumed to have not spread vertically. This assumption is based on disposal of extremely limited volumes of liquid wastes to the burial grounds. However, volatile organics, if present, may migrate laterally and/or vertically in the vapor phase. The groundwater in the LLBG TSD unit monitoring network does not show the presence of any radionuclides or contaminants except nitrates (see Section 3.4). Conservative performance assessments for the LLBG sites show no exposure to concentrations in groundwater above drinking water standards (WHC-EP-0645; WHC-SD-WM-TI-730, *Performance Assessment for the Disposal of Low-Level Waste in the 200 East Area Burial Grounds*). Of the burial grounds covered by this work plan, only the SWL and NRDWL show data indicating that the groundwater in the aquifer below them is contaminated with volatile organics. The source of these contaminants may be the SWL and/or NRDWL. The SWL received bulk liquids, and the NRDWL received chemical waste, as discussed in Sections 2.2.3.6 and 2.2.6.1.1.

3.3 ENVIRONMENTAL MONITORING

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

Environmental monitoring at the Hanford Site consists of effluent monitoring, environmental surveillance, groundwater monitoring, investigative sampling, and select characterization within the vadose zone. Investigative sampling of air, external radiation, soil, vegetation, and biota is conducted in the 200 Areas as part of the Hanford Site near-facility and environmental monitoring programs. Its purpose is to confirm the absence or presence of radioactive and/or hazardous contaminants where known or suspected contaminants are present or to verify radiological conditions at specific project sites. Media sampled include air, surface water and sediment, drinking water, food and farm products, external radiation, soil, vegetation, nests (bird, wasp, ant), mammal feces (rabbit, coyote), mammals (mice, bats), and insects (fruit flies). Investigative wildlife samples are used to monitor and track the effectiveness of measures designed to deter animal intrusion. Wildlife-related materials, including nests, carcasses, and feces, are collected as part of the integrated pest management program, or when encountered during a radiological survey. Samples are analyzed for radionuclides and/or other hazardous substances, with disposal contingent on the level of contamination present. Results of investigative sampling are reported in the annual Hanford Site Environmental Surveillance Data Report. The most recent of these annual reports is PNNL-14295, Appendix 1, *Hanford Site Environmental Surveillance Data Report for Calendar Year 2002*. PNNL-14295 covers the entire Hanford Site, including those areas not associated with operations (such as the 600 Area).

Groundwater also is routinely monitored sitewide. More than 600 monitoring wells are sampled annually to characterize groundwater flow, groundwater contamination by metals, radionuclides and chemical constituents, and the area of contamination. Groundwater remediation, ingestion risk, and dose also are assessed. Results of groundwater monitoring and remediation are presented in an annual report, the most recent of which is PNNL-14548, *Hanford Site Groundwater Monitoring for Fiscal Year 2003.*

3.3.1 Central Plateau Ecological Evaluation Report

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

DOE/RL-2001-54 contains a compilation and evaluation of ecological sampling data that have been collected over many years from undisturbed and disturbed habitats in the Central Plateau. The ecological evaluation document helps answer questions about the ecological resources in the Central Plateau that are important to preserve and protect habitats. The document also identifies ecological data needs that can be addressed in future ecological sampling activities on the Central Plateau.

DOE/RL-2001-54 includes descriptions of the habitats in the Central Plateau, including sensitive habitats, and the plants and animals that inhabit them. The document identifies potential species of concern, including threatened and endangered species and new-to-science species. The Ecological Compliance Assessment Project conducted a detailed survey of the Central Plateau in 2000 and 2001, and it is incorporated into the ecological evaluation documentation. The evaluation provides a detailed description of the ecological setting of the Central Plateau and augments the ecological information presented in this work plan.

3.3.2 200-SW-1 and 200-SW-2 Operable Unit-Specific Environmental Information

A summary of ecological resources for the 200 Areas is provided in Section 8.0 of Appendix F of the Implementation Plan (DOE/RL-98-28). Available information pertaining to sampling of vegetation and biota within the 200-SW-1 and 200-SW-2 OU waste sites is presented in this section to summarize existing ecological data and as input to Section 3.5 on potential impacts to human health and the environment.

Eighty-five environmental monitoring records of wildlife and vegetation at the 200 East and 200 West Areas collected since 1965 were reviewed and summarized in WHC-MR-0418, *Historical Records of Radioactive Contamination in Biota at the 200 Areas of the Hanford Site.* The report indicates that areas in the vicinity of the LLBG sites were sampled between 1965 and 1993. About 4,500 individual cases of monitoring for radionuclide uptake or transport in biota in the 200 Areas environs were included in the documents reviewed in WHC-MR-0418. Approximately 2,400 samples were collected from near the operations areas, and only about 120 samples (i.e., approximately 5 percent) exceeded radionuclide concentrations of 10 pCi/g. Roughly 2,100 biotic samples were collected during special investigations at known or suspected contaminated sites and about 1,800 (i.e., approximately 86 percent) exceeded concentrations of 10 pCi/g, indicating that radionuclide contamination has remained relatively localized even though it has spread beyond the intended waste site boundaries. WHC-MR-0418 further states that the routine monitoring is targeted to detect potential radioactive contamination at nuclear facilities and waste sites, and the special investigative samples usually are targeted at known incidents of biotic uptake and transport. Therefore, both results are biased toward detection of radioactivity. These radionuclide transport or uptake cases were distributed among 45 species of animals (mostly small mammals), feces, and 30 species of vegetation.

Wildlife species most commonly associated with uptake of radioactive contamination in the 200 Areas historically have been house mice and deer mice, but other animals such as birds (including waterfowl), coyotes, cottontail rabbits, mule deer, and elk have been sampled (WHC-MR-0418; PNNL-14295, Appendix 2, *Hanford Site Near-Facility Environmental Monitoring Data Report for Calendar Year 2002*). Deer or elk and rabbits are routinely monitored outside the fence in the vicinity of the 200 East and 200 West Areas as part of the Surface Environmental Surveillance program identified in DOE/RL-91-50, *Environmental Monitoring Plan United States Department of Energy Richland Operations Office*.

Plant species potentially may be exposed to contaminated soils and/or groundwater present in the vadose zone soil. Plants live in direct contact with the soil and can take up contaminants through physical and biological processes. Exposure is a function of the plant species, root depth, physical nature of the contamination, and the contaminant concentrations and distributions in the soil. Plants generally are tolerant of ionizing radiation (IAEA 332, *Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards*), but potentially present a contaminant pathway to wildlife through the consumption of contaminated seeds, leaves, roots, or stalks. Radionuclide uptake by plants within the 200 Areas was demonstrated in WHC-MR-0418. The vegetative species most commonly associated with the contamination was the Russian thistle.

In a 2001 sampling effort described in PNNL-13910, *Hanford Site Environmental Report for Calendar Year 2001*, 57 soil samples and 49 vegetation samples were collected in the 200/600 Areas. Soil samples consisted of a composite of five plugs of soil, each 2.5 cm (1 in.) deep, and 10 cm (4 in.) in diameter, from each sampling location. Two sites in the 200-SW-1 and 200-SW-2 OUs were sampled for soil contamination in 2000 and 2001. Perennial vegetation samples consisted of the current year's growth of leaves, stems, and new branches collected from sagebrush and rabbitbrush. Vegetation from two locations in the 200-SW-1 and 200-SW-2 OUs were sampled in 2000 and 2001. Surveillance of perennial vegetation in 1998 generally confirmed observations of past sampling efforts. Radionuclide analysis indicated that Sr-90, Cs-134, Cs-137, and uranium were detectable in soil; Sr-90 and uranium were detectable in vegetation. Fission products were most common in the 200 Areas. Thirty-one site-wide investigative vegetation samples were analyzed for radionuclides in 2001. Of the samples analyzed, 27 showed measurable levels of activity. Eight tumbleweed fragments showed elevated field readings, with 5 of these 8 samples originating from the 218-E-12B Burial Ground (part of the 200-SW-2 OU) in the 200 East Area (PNNL-13910).

Investigative wildlife sampling was used to monitor and track the effectiveness of measures designed to deter animal intrusion. Wildlife-related materials, including nests, carcasses, and feces, were collected as part of the integrated pest management program or when encountered during a radiological survey. Samples were analyzed for radionuclides and/or other hazardous substances, with disposal contingent on the level of contamination present. In 2001, five wildlife samples were submitted for analysis. The maximum radionuclide activities in 2001 were in mouse feces collected near the 241-TX-155 Diversion Box (part of the 200-IS-1 OU) in the

200 East Area. Contaminants included Sr-89/90, Cs-137, Eu-154, Pu-238, and Pu-239/240 (PNNL-13910). The number of animals found to be contaminated with radioactivity, their radioactivity levels, and the range of radionuclide activities were within historical levels (PNNL-13910).

As described in WHC-MR-0418, a sample of mouse feces collected at the 218-E-12A Burial Ground (part of the 200-SW-2 OU) in 1985 had a Sr-90 concentration of 400 million pCi/g; the 218-E-12A Burial Ground was interim stabilized in 1994. Noticeable improvements in reducing the uptake and transport of radionuclide contaminants by biota have been observed in areas where interim stabilization activities have taken place (WHC-MR-0418).

Biological transport of contamination by ants is a source of concern on the Hanford Site. Harvester ants, which are present on the disturbed soils associated with waste sites, have shown extreme resistance to radioactive sources (Gano 1980, "Mortality of the Harvester Ant (Pogonomyrmex owyheei) After Exposure to ^{137}Cs Gamma Radiation"). In a contamination area, ants are capable of bringing radioactive materials to the surface, where they potentially could become available to other means of transport by wind, plant uptake, birds, or mammals. The biological transport of contamination by harvester ants was noted during an annual radiological survey at the UPR-200-E-64 site in 1985. The source of contamination was assumed to be a small-diameter pipe visible on the west side of the 216-B-64 Basin, near the 270-E-1 Tank. In 1985, the pipe had a dose rate of 30 mrad/h. Surrounding contamination was transported to the surface by harvester ants and further spread by wind. The size of the area of contamination in 1995 was approximately 8,100 m^2 (2 acres), and it currently is posted as a soil contamination area. Additional contaminated soil and ant hills were identified both north and south of 7th Street and around the 241-ER-151 Diversion Box in September 1998.

3.4 RCRA TREATMENT, STORAGE, AND/OR DISPOSAL UNIT GROUNDWATER MONITORING

This section presents descriptions and results of the existing groundwater monitoring at the RCRA TSD units within the 200-SW-1 and 200-SW-2 OUs. The purpose of this section is to present current groundwater monitoring information that can be referenced or included in a FS/closure/postclosure plans developed for each of the TSD units.

The current groundwater monitoring plans (as required by *Washington Administrative Code* (WAC) 173-303-400, "Interim Status Facility Standards," and 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Subpart F, "Ground-Water Monitoring") are contained in two separate documents: PNNL-12227 and WHC-SD-EN-AP-015, *Revised Ground-Water Monitoring Plan for the 200 Areas Low-Level Burial Grounds,* and subsequent revisions. These documents contain details regarding the geology, hydrology, and current groundwater monitoring programs for the RCRA TSD unit sites. Excerpts from the most recent annual groundwater monitoring reports for the Hanford Site (PNNL-14187; PNNL-14548) are presented below for the current monitoring network and groundwater conditions.

The LLBG TSD unit Part B Permit Application was first submitted to Ecology in December 1989 (DOE/RL-88-20, *Hanford Facility Dangerous Waste Permit Application, Low-Level Burial Grounds*) to meet Tri-Party Agreement Milestone M-020-06. The most recent version of the

Part B Permit Application for the LLBG TSD unit was submitted to Ecology in June 2002. Chapter 5 of the Part B Permit Application contains groundwater monitoring requirements for the LLBG sites. Notice of Deficiency workshops pursuant to the Tri-Party Agreement (Action Plan, Section 9.2.2, "Part B Permit Applications and Closure/Postclosure Plans," Figure 9-2, "Part B Permit Application and Closure/Postclosure Plan Process Flowchart") are continuing to refine the groundwater information needs. Results of the Notice of Deficiency workshops will be appropriately considered and used to determine remedial actions under this work plan.

The NRDWL closure/postclosure plan was submitted in August 1990 (DOE/RL-90-17) to meet Tri-Party Agreement Milestone M-020-07. The Notice of Deficiency process was not completed for this closure/postclosure plan. Activities under the 200-SW-1 OU CERCLA process will be used to develop groundwater information data to support the NRDWL closure/postclosure plan.

Quarterly RCRA groundwater compliance monitoring reports first were published in 1986 on the Hanford Site. In addition to quarterly reports, annual reports commenced in 1988. The RCRA-compliant monitoring networks were implemented at different times for the various facilities, as defined under Tri-Party Agreement (Ecology et al. 1989) Milestone M-24-00. Annual reports for the RCRA groundwater monitoring program have been included in the Hanford Site groundwater monitoring report since 1997 (e.g., PNNL-14548).

3.4.1 218-E-10 Burial Ground Groundwater Monitoring

3.4.1.1 History of RCRA Groundwater Monitoring

The 218-E-10 Burial Ground is located in the northwestern corner of the 200 East Area. The monitoring wells have been sampled since September 1988 for contaminant indicator parameters, groundwater quality parameters, drinking water parameters, and site-specific parameters as required by WAC 173-303-400(3), "Interim Status Facility Standards," "Standards," which incorporates by reference 40 CFR 265, Subpart F. Semiannual statistical evaluations have shown that groundwater quality has not been impacted by the 218-E-10 Burial Ground (PNNL-14187; PNNL-14548).

3.4.1.2 Aquifer Identification

The 218-E-10 Burial Ground is underlain by the Hanford formation (DOE/RL-2000-72). The depth to the water table ranges between 71 and 87 m (233 and 285 ft) below ground surface and the aquifer is ~3 to ~8 m (~10 to ~26 ft) thick. The unconfined aquifer is contained in sand and gravel of the Hanford formation. Determining the direction of groundwater flow in this area, using only water-level data from the monitoring wells, is unreliable because the gradient in this area is extremely low. A better estimate of the flow direction can be inferred from contaminant plume maps, which suggest that the general direction of flow is to the northwest (PNNL-13080). The mean of the calculated gradients using different sets of wells in the monitoring network was 0.00006. The estimated flow rate at this burial ground is ~0.01 to 0.5 m/day (~0.03 to 1.6 ft/day) (PNNL-14187).

3.4.1.3 Well Location and Design

The historic monitoring plan for the 218-E-10 Burial Ground (WHC-SD-EN-AP-015) included four upgradient wells and nine downgradient wells. The wells were designed to monitor the top portion of the unconfined aquifer and were completed with 6.1 m (20-ft) screens that extended approximately 4.6 m (15 ft) below and 1.5 m (5 ft) above the water table. The monitoring network since has been expanded to include seven upgradient wells and ten downgradient wells; no additional wells are planned for this site (PNNL-14548). The groundwater monitoring well network at this burial ground is shown in Figure 3-4.

3.4.1.4 Results of Groundwater Monitoring Data

Specific conductance increased through December 2001 in monitoring wells in the northeast corner of the 218-E-10 Burial Ground, but declined in the June 2002 samples. Downgradient monitoring wells 299-E33-34 and 299-E32-10 continued to exceed the critical mean for specific conductance in samples taken in FY 2002. This exceedance is related to the nitrate plume from the vicinity of the BY Cribs and not the 218-E-10 Burial Ground. The DOE first notified Ecology about this issue in 1999. Because no waste has been placed in the north portion of this site and there is a known nitrate plume from an upgradient source, no further action is necessary (PNNL-14187).

3.4.2 218-E-12B Burial Ground Groundwater Monitoring

3.4.2.1 History of RCRA Groundwater Monitoring

Burial Ground 218-E-12B is located in the northeastern corner of the 200 East Area. The monitoring wells have been sampled since September 1988 for contaminant indicator parameters, groundwater quality parameters, drinking water parameters, and site-specific parameters as required by WAC 173-303-400(3), which incorporates by reference 40 CFR 265. Semiannual statistical evaluations have shown that groundwater quality has not been impacted by the 218-E-12B Burial Ground (PNNL-14187; PNNL-14548).

3.4.2.2 Aquifer Identification

The 218-E-12B Burial Ground is underlain by the Hanford formation. The depth to the water table is 57 to 74 m (187 to 243 ft) below ground surface and the aquifer thickness ranges from 0 to ~2 m (0 to ~6.6 ft) thick. The unconfined aquifer is contained in the sand and gravel of the Hanford formation, which directly overlie the basalt. In this area, the groundwater flows primarily from east to west based on water-table contours of the regional flow system. The flow regime in this area is influenced by the basalt subcrop to the north and east, and because of the extremely flat gradient and network configuration, it is difficult to use water level data to determine flow direction. The gradient calculated from wells along the south boundary of the site is 0.00003. Using this gradient, the estimated flow rate at this burial ground is ~0.04 to 0.5 m/day (~0.13 to 1.6 ft/day) (PNNL-14187).

3.4.2.3 Well Location and Design

The historical monitoring plan for the 218-E-12B Burial Ground (WHC-SD-EN-AP-015) included four upgradient wells and eight downgradient wells. The wells were designed to monitor the top portion of the unconfined aquifer and were completed with 6.1 m (20-ft) screens that extended approximately 4.6 m (15 ft) below and 1.5 m (5 ft) above the water table, unless the aquifer was less than 4.6 m (15-ft) thick. The monitoring network was subsequently expanded to include 16 wells, but as of FY 2003 five of these wells have gone dry. The current monitoring network (three upgradient wells and eight downgradient wells) appears to effectively monitor this site. No new wells are proposed at this site, in spite of wells going dry, because the water-table elevation is declining below the top of basalt. Where basalt is present above the water table, it is impossible to monitor the unconfined aquifer. Deeper aquifers are isolated from this burial ground by the low-permeability basalts. The groundwater monitoring well network at this burial ground is shown in Figure 3-5.

3.4.2.4 Results of Groundwater Monitoring Data

Statistical evaluations for this burial ground determined that upgradient well 299-E34-7 exceeded the critical mean for specific conductance, total organic carbon, and total organic halides in FY 2002 and FY 2003 (PNNL-14187; PNNL-14548). The major contributors to the increase in specific conductance are sulfate, chloride, and calcium. The source of these constituents is not clear, but may be caused by leaching or infiltration processes within the vadose zone. The cause of an observed increase in total organic carbon and total organic halides is also not known. The average total organic carbon concentration for FY 2002 samples was 6,500 µg/L and the average total organic halide concentration was 19.2 µg/L. No organic hazardous constituents were identified in the FY 2002 sampling. Samples collected in April 2001 were analyzed for oil and grease and total petroleum hydrocarbons (diesel). These results were consistent with the total organic carbon values. However, total petroleum hydrocarbons were not detected during sampling for an extensive list of 40 CFR 264, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Appendix IX constituents early in FY 2003 (October). The only organic constituent detected from that FY 2003 sample was 0.076 µg/L of Endrin aldehyde. This is an impurity or breakdown product of the pesticide Endrin that has not been sold in the United States since the 1980s. There is no drinking water maximum contaminant level for Endrin aldehyde, but the drinking water standard for Endrin is 2 µg/L. The level of Endrin aldehyde is far lower than the total organic halides, indicating the main sources of the elevated total organic halide readings are substances that are not on the 40 CFR 264, Appendix IX hazardous substances list. Because of the anomalous chemistry in this upgradient well, it is not used in the statistical upgradient: downgradient comparisons (PNNL-14187).

3.4.3 218-W-3A, 218-W-3AE, and 218-W-5 Burial Grounds Groundwater Monitoring

3.4.3.1 History of RCRA Groundwater Monitoring

Burial Grounds 218-W-3A, 218-W-3AE, and 218-W-5 are located in the north-central part of the 200 West Area. The monitoring wells have been sampled since October 1988 for contaminant indicator parameters, groundwater quality parameters, drinking water parameters, and site-specific parameters as required by WAC 173-303-400(3), which incorporates by reference 40 CFR 265. Semiannual statistical evaluations have shown that groundwater quality has not been impacted by these burial grounds (PNNL-14187; PNNL-14548).

3.4.3.2 Aquifer Identification

The 218-W-3A, 218-W-3AE, and 218-W-5 Burial Grounds are underlain by the Hanford formation, the CCU, and the Ringold Formation. The depth to the water table is ~64 to 74 m (~210 to 243 ft) below ground surface and the aquifer thickness ranges from ~62 to ~75 m (~203 to ~246 ft) thick. The unconfined aquifer is entirely within Ringold Formation Unit 5. The aquifer is locally semiconfined beneath fine-grained sediment in the northern portions of these burial grounds (PNNL-13080). The base of the aquifer is the Ringold Formation lower mud unit, except where this unit is not present in the northern portions of these burial grounds;

there the aquifer base is the top of basalt. The groundwater flow in this portion of the 200 West Area is to the east-northeast (66 degrees) with a calculated gradient of 0.0012. The flow direction is returning to the pre-Hanford conditions and will continue to change until the direction is predominately west to east. Groundwater velocity is in the range of 0.0001 to 0.12 m/day (0.0003 to 0.39 ft/day) (PNNL-14187).

3.4.3.3 Well Location and Design

The historical monitoring plan for the 218-W-3A, 218-W-3AE, and 218-W-5 Burial Grounds (WHC-SD-EN-AP-015) included 2 shallow upgradient wells and 11 shallow downgradient wells, and 2 deep monitoring wells (one upgradient and one downgradient). The shallow wells were designed to monitor the top portion of the unconfined aquifer and were completed with 6.1 m (20-ft) screens that extended approximately 4.6 m (15 ft) below and 1.5 m (5 ft) above the water table. The deep wells were installed with 6 m (20-ft) screened intervals. The monitoring network subsequently was expanded to include 20 wells, but as of FY 2003, nine of the shallow wells have gone dry. The current shallow monitoring network (three upgradient wells and six downgradient wells) only marginally monitors these burial grounds. New groundwater monitoring wells for this area are part of the application submitted to Ecology in June 2002 to incorporate the LLBG TSD unit sites into the Hanford Part B RCRA permit. The groundwater monitoring well network at these burial grounds is shown in Figure 3-6.

3.4.3.4 Results of Groundwater Monitoring Data

There are no indications that the 218-W-3A, 218-W-3AE, and 218-W-5 Burial Grounds have contributed to groundwater contamination. Indicator parameter data from upgradient wells were statistically evaluated, and values from downgradient wells were compared to values established from the upgradient wells. Contamination indicator parameters were not exceeded in any wells monitoring this waste management area during FY 2003. Nitrate and carbon tetrachloride routinely exceed the allowed maximum contaminant levels at these burial grounds. This contamination is related to widespread plumes originating to the south and is not believed to be a result of waste disposal practices at these sites (PNNL-14187; PNNL-14548).

3.4.4 218-W-4B and 218-W-4C Burial Grounds Groundwater Monitoring

3.4.4.1 History of RCRA Groundwater Monitoring

The 218-W-4B and 218-W-4C Burial Grounds are located in the south-central part of the 200 West Area. The monitoring wells have been sampled since October 1988 for contaminant indicator parameters, groundwater quality parameters, drinking water parameters, and site-specific parameters as required by WAC 173-303-400(3), which incorporates by reference 40 CFR 265. Semiannual statistical evaluations have shown that groundwater quality has not been impacted by the 218-W-4B and 218-W-4C Burial Grounds (PNNL-14187; PNNL-14548).

3.4.4.2 Aquifer Identification

The 218-W-4B and 218-W-4C Burial Grounds are underlain by the Hanford formation, the CCU, and the Ringold Formation. The depth to the water table is ~64 to 74 m (~210 to 243 ft) below ground surface and the aquifer thickness ranges from ~62 to ~75 m (~203 to ~246 ft) thick. The unconfined aquifer is entirely within Ringold Formation Unit 5, and the base of the aquifer is the

Ringold Formation lower mud unit. The groundwater flow beneath these burial grounds is generally to the east (77 to 89 degrees) with a mean gradient of 0.0024. The groundwater flow is affected to a large degree by the 200-ZP-1 Pump-and-Treat System, which has extraction wells to the east and injection wells to the west of this RCRA site. The groundwater velocity is 0.2 to 0.6 m/day (0.66 to 1.97 ft/day) (PNNL-14187).

3.4.4.3 Well Location and Design

The historical monitoring plan for the 218-W-4B and 218-W-4C Burial Grounds (WHC-SD-EN-AP-015) included three shallow upgradient wells and nine shallow downgradient wells, and two deep monitoring wells (one upgradient and one downgradient). The shallow wells were designed to monitor the top portion of the unconfined aquifer and were completed with 9.1 m (30-ft) screens that extended approximately 7.6 m (25 ft) below and 1.5 m (5 ft) above the water table. The deep wells were installed with 3 to 9.1 m (10 to 30 ft) screened intervals. The monitoring network was subsequently expanded to include 17 wells, but as of FY 2003, 10 of the shallow wells have gone dry. The current shallow monitoring network (four upgradient wells and one downgradient well) requires upgrading to satisfy RCRA requirements. New groundwater monitoring wells for this area are part of the application submitted to Ecology in June 2002 to incorporate the LLBG sites into the Hanford Part B RCRA permit. The groundwater monitoring well network at these burial grounds is shown in Figure 3-7.

3.4.4.4 Results of Groundwater Monitoring Data

There is no evidence that the 218-W-4B and 218-W-4C Burial Grounds have contributed to contaminants found in the groundwater. Downgradient well 299-W15-16 exceeds the critical mean for total organic halides. This well is affected by contamination from other sources and was at one time an upgradient monitoring well. The DOE reported the exceedance to EPA and Ecology in August 1999. The elevated total organic halide concentrations are attributed to carbon tetrachloride from PFP operations. However, air sampling of vent risers from trenches in Low-Level Waste Management Area 4 indicated the presence of high levels of carbon tetrachloride. Subsequent soil-gas sampling was performed to determine if carbon tetrachloride contamination is present in the vadose zone (CP-13514). Nitrate exceeds the maximum contaminant level (45 mg/L) at many of these burial ground monitoring wells. This contamination is not believed to be related to waste disposal at these burial grounds. In the southwest corner of the 218-W-4C Burial Ground, upgradient well 299-W18-21 has increasing nitrate concentrations that have not been associated with the large contaminant plumes in the 200 West Area. The fiscal year average nitrate concentration in this well was 96 mg/L. Only a few trenches have received waste in this part of the burial ground, so it is unlikely that the contamination is related to the burial ground itself (PNNL-14187; PNNL-14548).

3.4.5 Nonradioactive Dangerous Waste Landfill Groundwater Monitoring

3.4.5.1 History of RCRA Groundwater Monitoring

The NRDWL is located in the central part of the Hanford Site about 5.5 km (3.4 mi) southeast of the 200 East Area. The monitoring wells have been sampled since October 1986 for contaminant indicator parameters, groundwater quality parameters, drinking water parameters, and site-specific parameters as required by WAC 173-303-400(3), which incorporates by reference

40 CFR 265. Semiannual statistical evaluations have shown that this site has not had a significant impact on groundwater quality (PNNL-14187; PNNL-14548).

3.4.5.2 Aquifer Identification

The NRDWL is underlain by the Ringold Formation and Hanford formation. The depth to the water table is ~38 to 41 m (~125 to 135 ft) below ground surface and the uppermost unconfined aquifer thickness ranges from ~16 to ~25 m (~52 to ~82 ft) thick. The uppermost unconfined aquifer is within the Hanford formation and the upper part of Ringold Formation Unit 4. The base of the uppermost unconfined aquifer is a 1 to 4 m (3 to 13 ft) thick clayey silt layer in Ringold Formation Unit 4 (PNNL-12227). The direction and rate of groundwater flow at this landfill are difficult to determine from water-table maps because of the extremely low hydraulic gradient (0.00005) (PNNL-12227). The best indicators of flow direction are the major plumes of I-129, nitrate, and tritium from the 200 Areas. These plumes flow to the southeast (~125 degrees east of north) in the vicinity of the landfill. The rate of groundwater flow is ~0.026 to 0.23 m/day (~0.08 to 0.75 ft/day) (PNNL-14187).

3.4.5.3 Well Location and Design

The revised monitoring plan for the NRDWL (PNNL-12227) included two shallow upgradient wells and five shallow downgradient wells, and two deeper monitoring wells (one upgradient and one downgradient) that are screened at the base of the uppermost unconfined aquifer. The shallow wells were designed to monitor the top portion of the unconfined aquifer and were completed with 6 to 14 m (20 to 47 ft) screened intervals with about ¾ of the interval below and about ¼ of the interval above the water table. The deeper wells were installed with 9.1 m (30 ft) screened intervals. The groundwater monitoring well network at the NRDWL is shown in Figure 3-8.

3.4.5.4 Results of Groundwater Monitoring Data

The values for RCRA indicator parameters at the NRDWL did not exceed their critical means (or critical range for pH) in FY 2002 for three of the indicator parameters: pH, total organic carbon, and total organic halides. However, the critical mean for specific conductance (564 µS/cm) was exceeded at three downgradient wells: 699-25-34A, 699-25-34D, and 699-26-33. The highest values reported were at well 699-25-34A, where the September 2002 quadruplicate samples averaged 625 µS/cm. This exceedance was first discovered and reported in FY 2000. An assessment plan and assessment report were submitted to the regulator (Ecology) at that time. The increased specific conductance is most likely caused by increases in the concentrations of nonhazardous constituents (bicarbonate, calcium, manganese, and sulfate) from the adjacent SWL (Figure 3-8). During FY 2002, seven volatile organic compounds were detected in wells at the NRDWL, but six of the seven were detected at levels considered "estimates" because the concentrations were too low for certainty. The volatile organic compound 1,1,1-trichloroethane was detected at high enough concentrations to provide certainty of detection. The highest concentration reported during the fiscal year was 1.3 µg/L at well 699-26-35A (an upgradient well) for a sample collected in March 2002; the drinking water standard for 1,1,1-trichloroethane is 200 µg/L. A duplicate sample collected at the same time had a reported result of 1.0 µg/L. The six volatile organic compounds with uncertain detections were 1,1-dichloroethane, acetone, chloroform, methylene chloride, tetrachloroethene, and trichloroethene. The source of the volatile organic compounds could be from either the SWL (to the south) or the NRDWL (bottom of trenches is ~35 m [115 ft] above the water table). For example, tetrachloroethene is present in vadose zone vapor beneath the SWL (PNL-7147, *Final Report: Soil Gas Survey at the Solid Waste Landfill*) and is the principal contaminant in vadose zone vapor around the chemical disposal trenches at the NRDWL. It is possible that both of these sources contribute to the contamination. Nitrate continued to be detected in wells at the NRDWL during FY 2002. Its source is upgradient in the 200 East Area. Nitrate concentrations continue to decrease with time (PNNL-14187).

3.5 POTENTIAL IMPACTS TO HUMAN HEALTH AND THE ENVIRONMENT

This section presents and discusses the conceptual exposure model developed to identify potential impacts to human health and the environment from waste sites in the 200-SW-1 and 200-SW-2 OUs. Existing information pertaining to contaminant sources, release mechanisms, transport media, exposure routes, and receptors is discussed to develop a preliminary conceptual understanding of potential risks and exposure pathways. This information will be used to support further evaluation of potential human health and environmental risk based on the RI results as part of the RI and FS documents for the 200-SW-1 and 200-SW-2 OUs.

3.5.1 Contaminant Sources and Release Mechanisms

As mentioned previously in Section 2.2.1, the primary sources of contaminants at the 200-SW-1 and 200-SW-2 OU waste sites were the major facilities (e.g., U Plant, REDOX, PUREX, B Plant, Hot Semiworks Plant) and support operations in the 200 East and 200 West Areas. Many of the pieces of equipment from these facilities have a high dose rate associated with them (see, e.g., HW-63703, *Disposition of Contaminated Processing Equipment at Hanford Atomic Products Information 1958 - 1959*). The packaged waste from operations also contains significant radionuclide activity from the cesium and strontium components of the waste (ARH-2762). Releases of contaminants from the 200-SW-1 and 200-SW-2 OU sites can occur through infiltration (movement of wastewater through the soil), resuspension of contaminated soil (erosion or mechanical disturbances), volatilization (movement of organic chemicals through the soil and into the air), biotic uptake (plant uptake or animal ingestion), leaching (contaminant release from rain or snowmelt exposure), and external radiation (gamma). The dominant mechanism of vertical contaminant transport in the 200-SW-1 and 200-SW-2 OUs is from infiltration and leaching, with rainwater or snowmelt as driving forces because the volumes of liquids discharged at the 200-SW-1 and 200-SW-2 OU sites were very small. It is not likely that groundwater was impacted.

3.5.2 Potential Human and Ecological Receptors

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

- Ingestion of contaminated soils, sediments, or biota
- Inhalation of contaminant dusts, vapors, or gases
- Dermal contact with contaminated soils or sediments
- Direct exposure to external gamma radiation in site soils and sediments or exposed waste.

Potential human receptors include site workers (current and future) and site visitors (occasional users). Site worker and visitor exposure pathways primarily would involve incidental soil/sediment ingestion, inhalation of contaminants, dermal contact with contaminated soils/sediments, and external gamma radiation. Potential ecological receptors include terrestrial plants and animals using the sites. More details on these specific receptors were presented in Section 3.3.2. Site biota exposures primarily would involve incidental soil/sediment ingestion, biota ingestion (e.g., coyotes eating prey that live on the site or deer consuming plants growing on the site), dermal contact with contaminated soils/sediments, and external gamma radiation. A summary of the contaminant types, exposure mechanisms, and principal receptors for the 200-SW-1 and 200-SW-2 OUs is provided in Table 3-6. Figure 3-9 shows the conceptual exposure pathway model.

3.5.3 Potential Impacts

This section discusses potential impacts to human and ecological receptors based on existing information. Potential contaminant exposures and health impacts to humans largely are dependent on land use.

The land use for the 200 Areas selected by the DOE through the *National Environmental Policy Act of 1969* (NEPA) process (DOE/EIS-0222-F, *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement*) and documented in 64 FR 61615, "Record of Decision: Hanford Comprehensive Land-Use Plan Environmental Impact Statement (HCP EIS)" is industrial (exclusive). Most of the 200-SW-1 and 200-SW-2 OU waste sites are located within the 200 Areas Central Plateau Core Zone boundary. Therefore, based on the land-use decision for the 200 Areas, potential impacts from the waste site contaminants within the 200 Areas would be to current and future site workers and to terrestrial biota using the sites. The land use for the sites outside the Core Zone boundary focuses on preservation, recreation, conservation, fill material, grazing, or industrial uses depending on the location (DOE/EIS-0222-F).

A remediation pathway at the historical burial grounds that involves excavation and repackaging of waste could result in significant worker impacts. The 200-SW-2 OU remedial investigation and feasibility study will explore the decision between the potentially high dose, short-term risk of removal and the potentially lower dose, longer term effects if the waste is remediated with other options.

A screening-level ecological risk assessment for the Central Plateau waste sites was developed in 2002. Based on the results of the screening-level ecological risk assessment, the full EPA eight-step ecological risk assessment process was initiated in 2003. The DOE expects to complete the ecological risk assessment in conjunction with the ongoing RI/FS processes for the 200 Areas. The ecological risk assessment process may identify additional characterization needs. Those needs could include soil sampling and analysis, biological studies (including sampling and analysis), or other studies. Any data needs may apply to one or more OUs. Ecological receptors have been identified and potential impacts to those receptors have been evaluated at waste sites in the 200 Areas (PNNL-13230, *Hanford Site Environmental Report for Calendar Year 1999 (Including Some Historical and Early 2000 Information)*; PNL-2253, *Ecology of the 200 Area Plateau Waste Management Environs: A Status Report*; and WHC-SD-EN-TI-216, *Vegetation Communities Associated with the 100-Area and the 200-Area Facilities on the Hanford Site*). The vegetation cover on the Central Plateau predominantly is a rabbitbrush-cheatgrass and sagebrush-cheatgrass association with the incidental presence of herbaceous and annual species. Many areas are disturbed and void of vegetation or sparsely populated with annuals and weedy species such as Russian thistle. The contamination pathways to ecological exposures for the waste sites are minimized by the stabilization activities that have been conducted.

3.6 DEVELOPMENT OF CONTAMINANTS OF CONCERN

The development of the list of contaminants of concern (COC) for the 200-SW-1 and 200-SW-2 OUs was one of the main objectives of the DQO process conducted to support this work plan. The COCs identified for the sites represent the complete set of radioactive, organic, and inorganic contaminants that were, or could have been, discharged to the 200-SW-1 and 200-SW-2 OU waste sites based on the 200 Areas plant operations, as identified in DQO documents for the 200 Areas OUs, including the following, and as outlined in the Implementation Plan (DOE/RL-98-28). The final list of COCs is presented in Table 3-5.

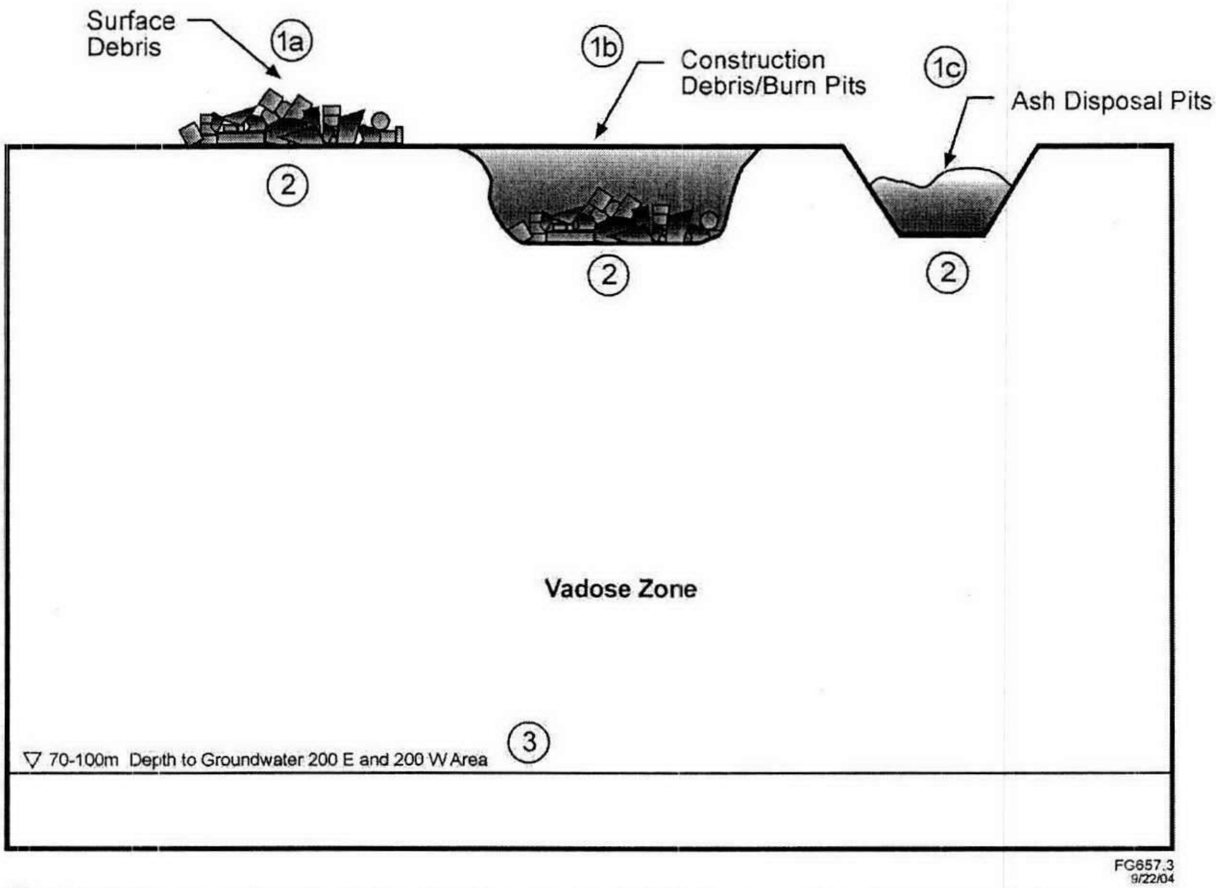
200-CW-1	BHI-01239	*200-CW-1 Gable/B-Pond and Ditches Cooling Water Waste Group Remedial Investigation DQO Summary Report*	1999
200-CS-1	CP-13196, Draft A	*Data Quality Objectives Summary Report for Designation of the 200-CS-1 Investigation Derived Wastes*	2001
200-CW-5	BHI-01591	*Data Quality Objectives Summary Report for Designation of the 200-CW-5 Investigation Derived Wastes*	2002
200-LW-1 and LW-2	WMP-18098	*Data Quality Objectives Summary Report for the Designation of the 200-LW-1 and 200-LW-2 Operable Unit Investigation-Derived Wastes*	2003
200-MW-1	WMP-20380	*Data Quality Objectives Summary Report for the Designation of the 200-MW-1 Operable Unit Investigation-Derived Wastes*	2004
200-PW-1	BHI-01608	*Data Quality Objectives Summary Report for Designation of 200-PW-1 Investigation-Derived Wastes*	2002
200-PW-2 and PW-4	CP-14682	*Data Quality Objectives Summary Report for the Designation of the 200-PW-2 and 200-PW-4 Investigation-Derived Wastes*	2003
200-TW-1 and TW-2	BHI-01492	*Data Quality Objectives Summary Report for 200-TW-1 and 200-TW-2 Waste Designation*	2001

The majority of the waste generated by Hanford Site and offsite plant and support operations (and contamination associated with the 200-SW-1 and 200-SW-2 OU waste sites) can be described as containing various constituents including radionuclides, metals, inorganic chemicals, and semivolatile and volatile organic chemicals. The analytical approach employed for this project generally targets the significant risk drivers that are representative of the waste constituents present. For laboratory analyses, the general suite-type analytical techniques yield results for many metals and organic compounds, providing a cost-effective approach for the known toxic materials that could be present. At 200-SW-2 OU waste sites, radioactive and chemical constituents are potential COCs. Radioactive constituents are not considered as COCs for 200-SW-1 OU (nonradioactive) sites.

The exclusion rationale used to eliminate contaminants of potential concern from the final list of COCs includes the following:

- Short-lived radionuclides with half-lives less than 3 yr
- Radionuclides that constitute less than 1 percent of the fission product inventory and for which historical sampling indicates non-detection
- Naturally occurring isotopes that were not created as a result of Hanford Site operations
- Constituents with atomic mass numbers greater than 242 that represent less than 1 percent of the actinide activities
- Progeny radionuclides that build insignificant activities within 50 yr and/or for which parent/progeny relationships exist that permit progeny estimation
- Constituents that would be neutralized and/or decomposed by facility processes
- Chemicals in a gaseous state that cannot accumulate in soil media
- Chemicals used in minor quantities relative to the bulk production chemicals consumed in the normal processes; these chemicals are not likely to be present in toxic or high concentrations
- Chemicals that are not persistent in the environment because of volatilization, biological degradation, or other natural mitigating features
- Chemicals that are not persistent in the vadose zone because of high mobility and previous confirmatory sampling/analysis activities
- Standards that could be applicable from Ecology 94-145, *Model Toxics Control Act Cleanup Levels & Risk Calculations (CLARC) Version 3.1*, tables (November 2001) do not apply to chemical substances if they are not identified in the tables.

Figure 3-1. Conceptual Contamination Distribution Model, Bin 1 Sites.



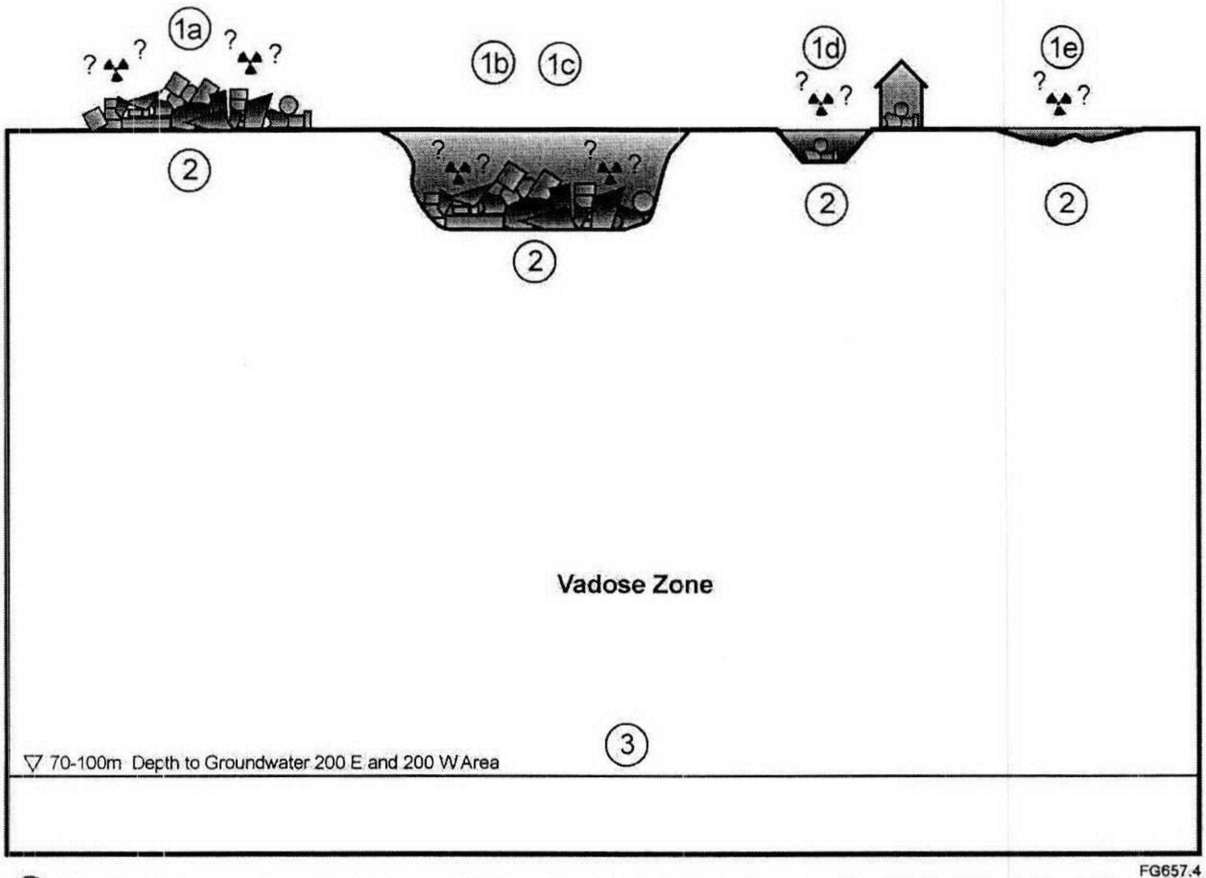
① Bin 1 sites are primarily shallow (<4.6 m deep), of limited area, and contain waste that was either uncontaminated or contained contaminants that have volatilized or decayed to innocuous levels. The sites include:

a. Surface debris sites that may include building rubble, equipment and miscellaneous trash
b. Shallow excavations filled with debris similar to above and/or used for burning combustibles.
c. Shallow pits excavated for disposal of fly ash

② The sites likely are minimally contaminated. Any contamination present is believed to be lower than action levels and will not require remediation.

③ Groundwater is not impacted by disposal practices

Figure 3-2. Conceptual Contamination Distribution Model, Bin 2 Sites.



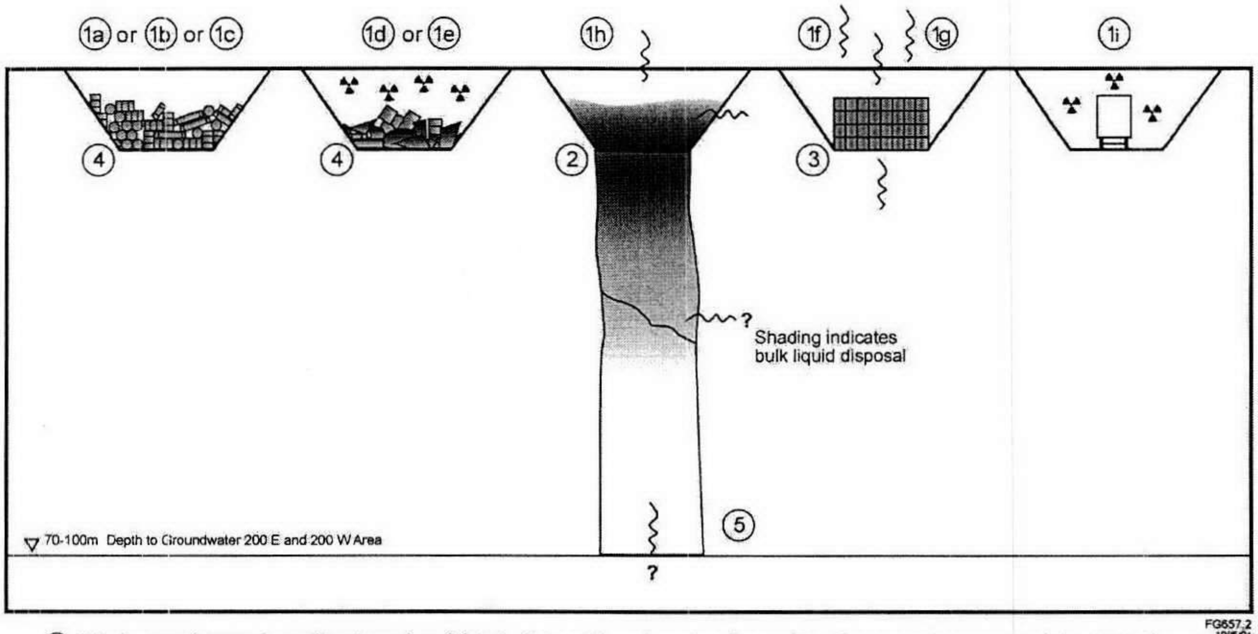
① Bin 2 sites are primarily shallow (<4.6 m deep), of limited area, and contain non-radioactive or radioactive wastes. Most of the sites consist of non-radioactive wastes disposed to the surface. The sites include:

a. Surface debris sites that may include building rubble, equipment, and miscellaneous trash. The debris is scattered at most sites.
b. Shallow excavations filled with debris similar to above and/or used for burning combustibles.
c. Up to 3.5 hectare (8.7 acre) burial grounds with fairly well-defined contents.
d. Small above or below ground structures (silos, vaults) and/or remnants of larger structures (railway lines, building foundations).
e. Small chemical dumps and spills.

② Potential contaminants may include hazardous chemicals and/or radionuclides. Contaminants are anticipated to be present at or near ground surface (<1 m below bottom of waste site).

③ Groundwater is not impacted by disposal practices.

Figure 3-3. Conceptual Contamination Distribution Model, Bin 3 Sites.



① Waste was disposed to unlined trenches (historically) and lined trenches (currently). Some wastes were containerized. Types of waste disposed include:

a. Pre-RCRA solid waste
b. RCRA permitted dangerous/hazardous solid waste
c. Sanitary solid waste
d. Low-level radioactive solid waste
e. Mixed solid waste (low-level radioactive waste contaminated with RCRA-regulated constituents)
f. Solid chemicals
g. Liquid wastes packed in drums and stabilized with porous materials or lab-packed
h. At the Solid Waste Landfill (SWL) only, records indicate a disposal of bulk liquids (sewage and 1100 Area catch tank waste water)
i. Radioactively contaminated large equipment

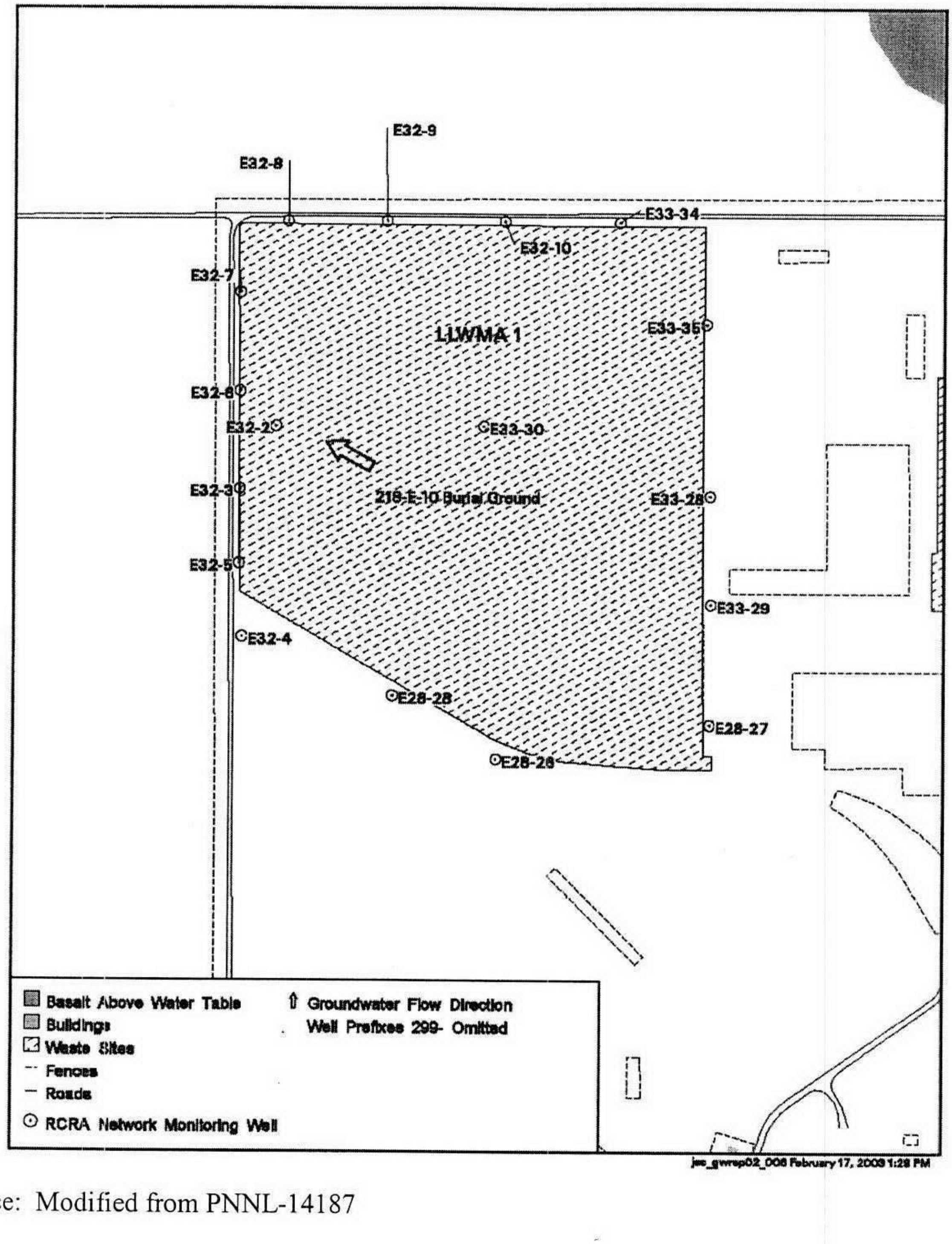
② Bulk liquids (SWL only) percolate into the soil. Associated contaminants have potential for migrating, especially volatile organic compounds (VOC). Particulates filter out in soil immediately beneath trench. Soil gas data (SWL) indicate presence of VOCs near surface.

③ Packed/absorbed liquids are present in small quantities. Associated contaminants have a low potential for migration since recharge and leachate generation is expected to be minor. VOCs may be an exception since they are mobile in the vapor phase even in relatively small quantities.

④ Contaminants in solid waste form (1a, 1b, 1c, 1d, 1e, 1f) have a low potential for migrating. Recharge and leachate generation is expected to be minor. Potential contaminants should be limited to a depth of <1 meter below bottom of waste site.

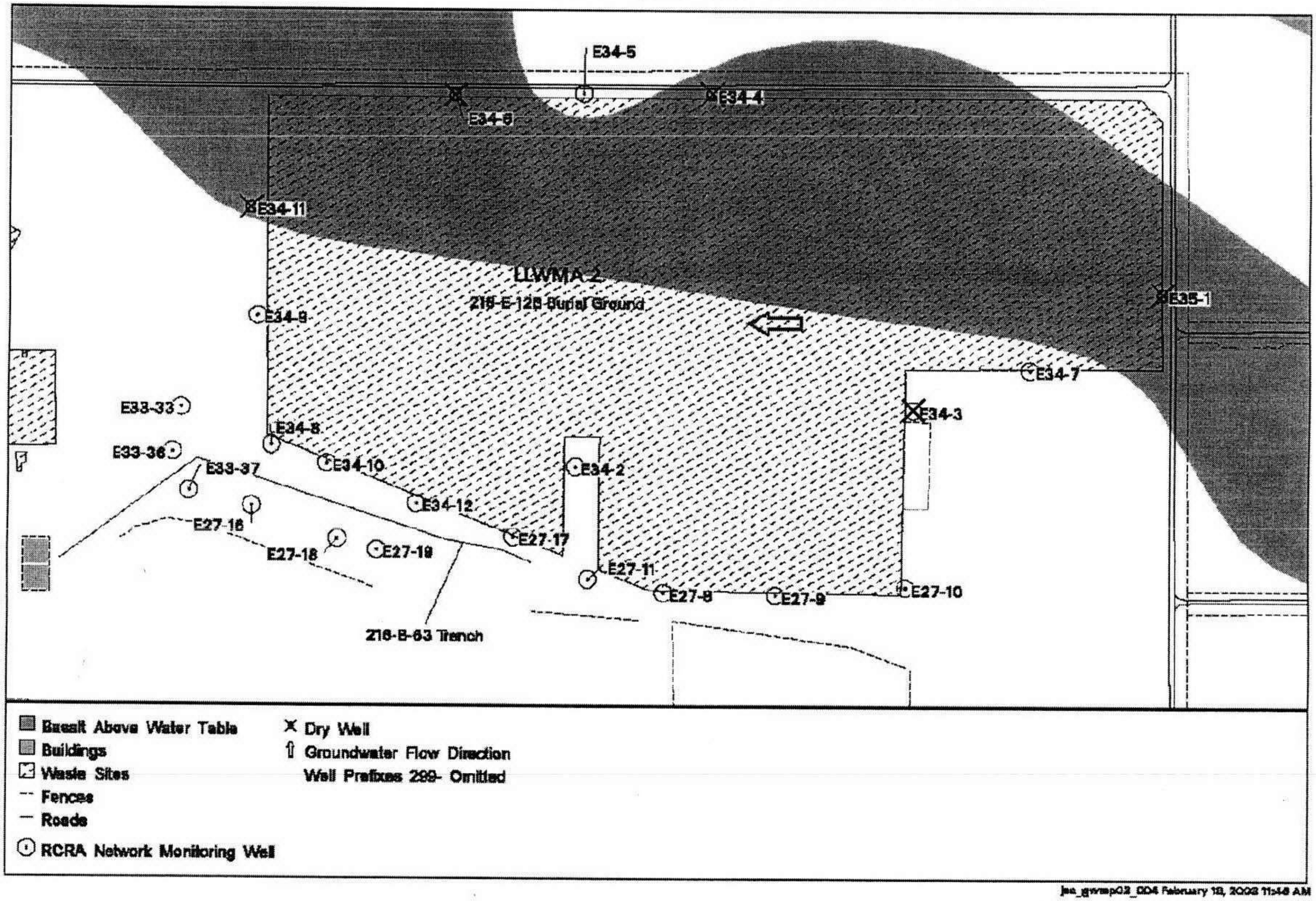
⑤ Groundwater contamination under the SWL and NRDWL indicates that the vapor and/or liquid phase has migrated to the water table. Groundwater contamination not found under other sites.

Figure 3-4. Groundwater Monitoring Wells at the 218-E-10 Burial Ground.



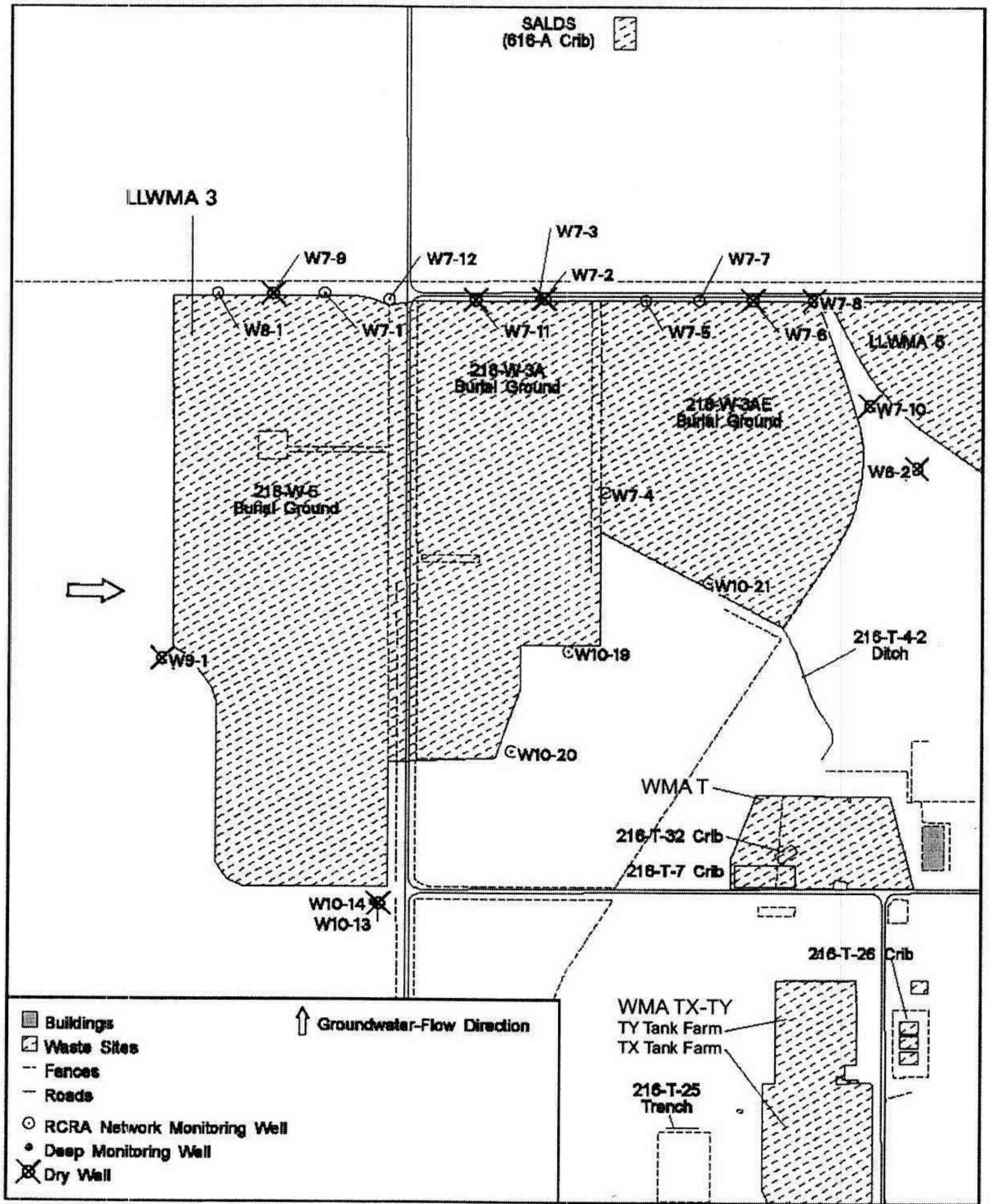
Source: Modified from PNNL-14187

Figure 3-5. Groundwater Monitoring Wells at the 218-E-12B Burial Ground.



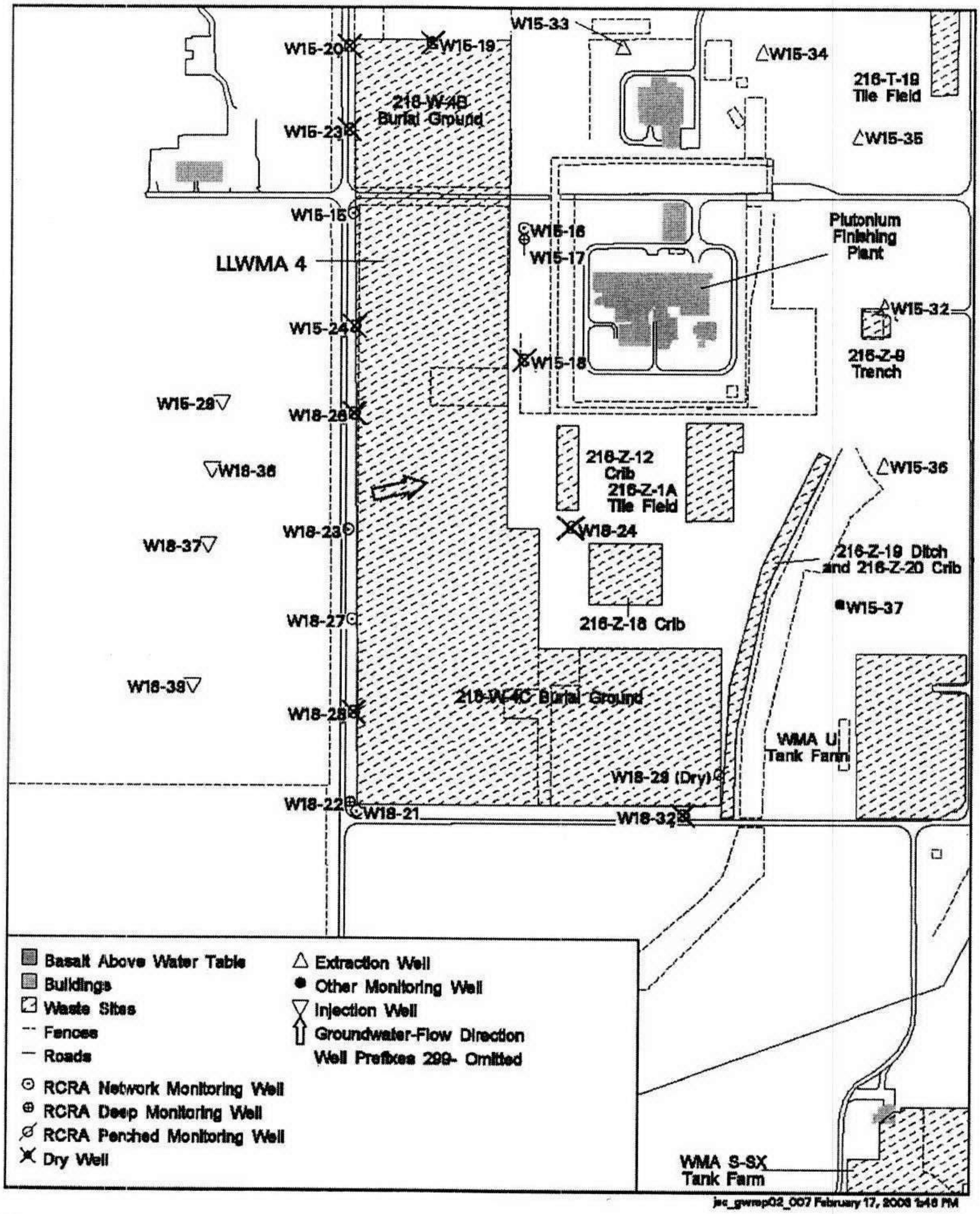
Source: Modified from PNNL-14187

Figure 3-6. Groundwater Monitoring Wells at the 218-W-3A, 218-W-3AE, and 218-W-5 Burial Grounds.



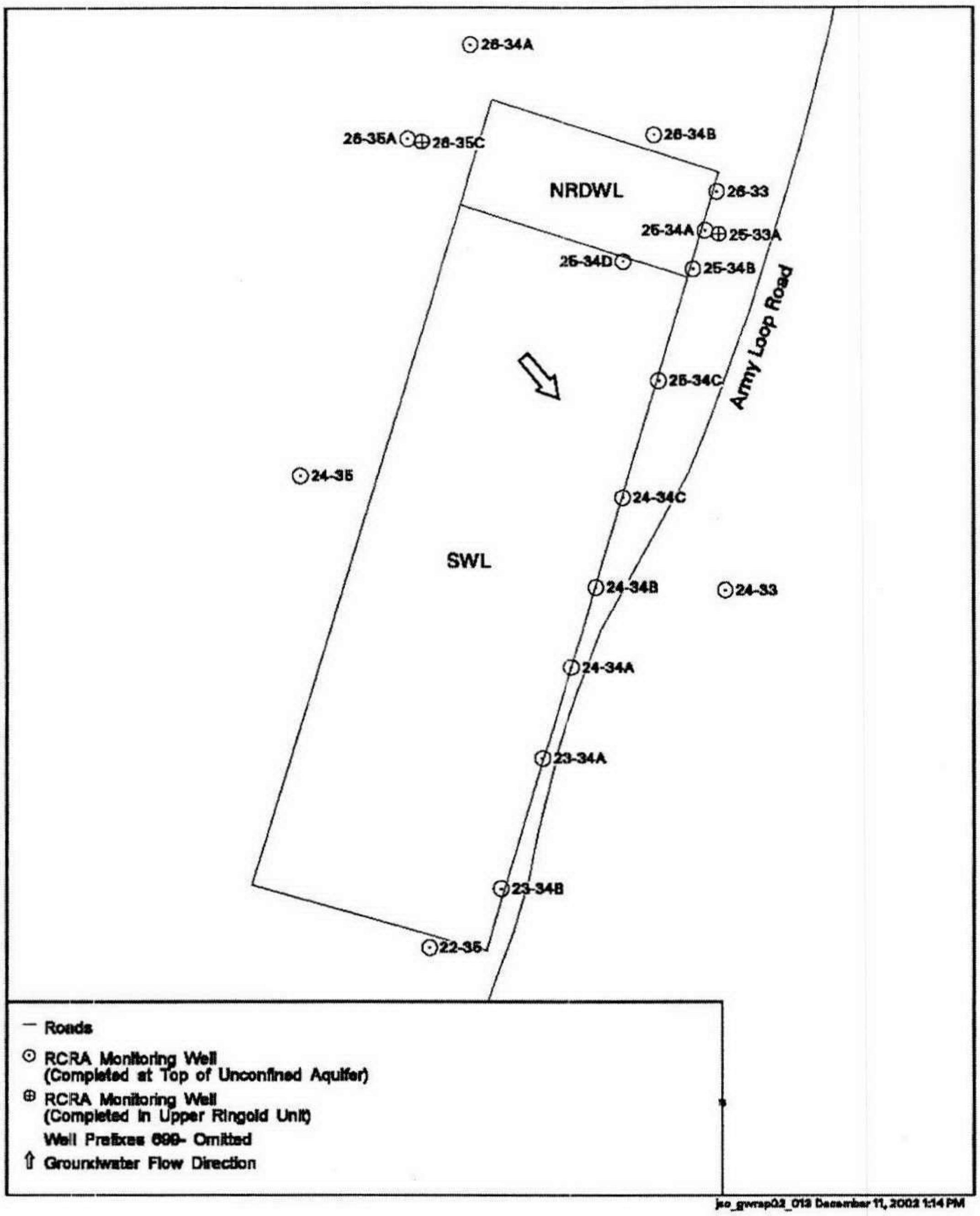
Source: Modified from PNNL-14187

Figure 3-7. Groundwater Monitoring Wells at the 218-W-4B and 218-W-4C Burial Grounds.



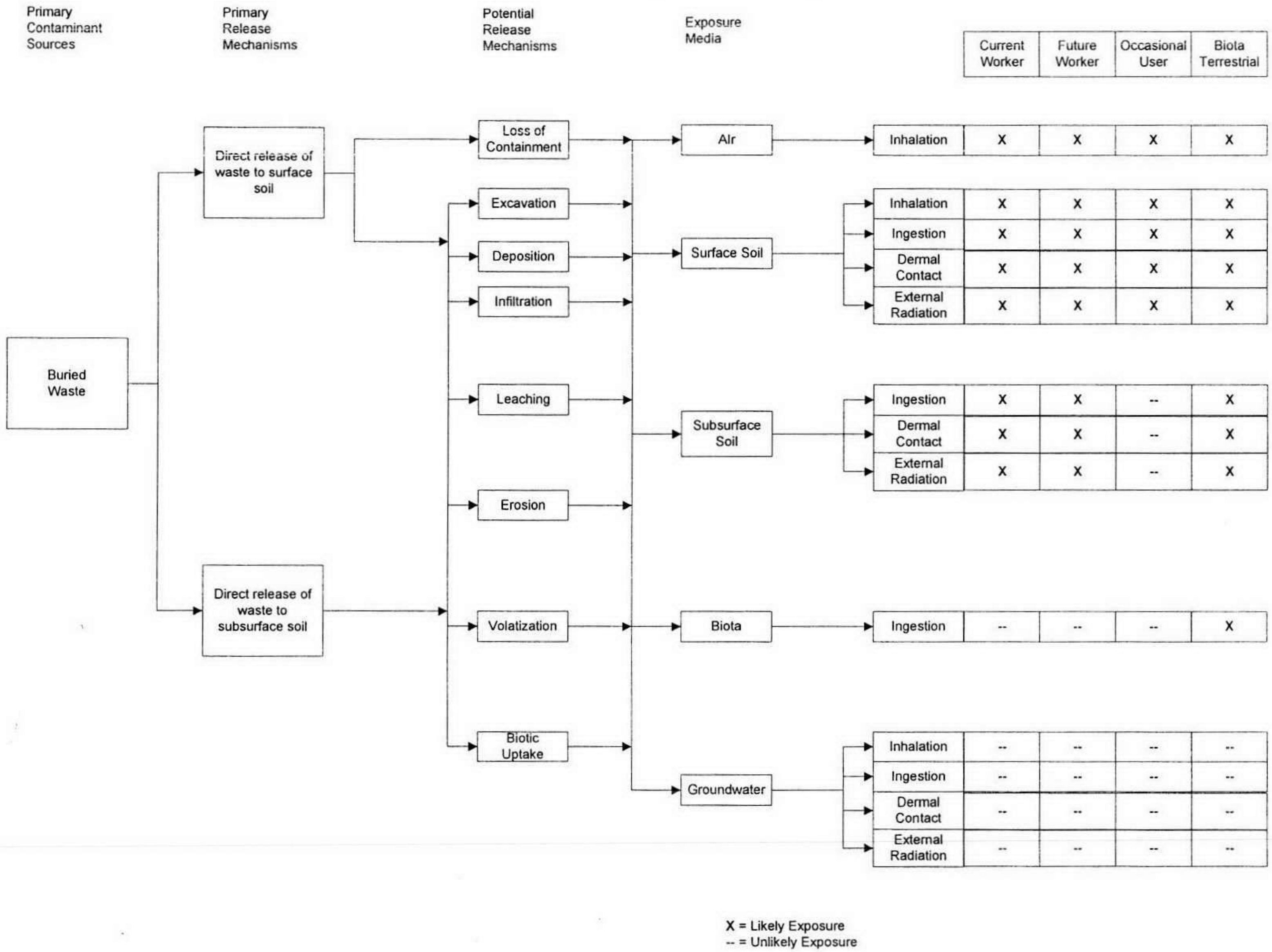
Source: Modified from PNNL-14187

Figure 3-8. Groundwater Monitoring Wells at the Nonradioactive Dangerous Waste Landfill and Solid Waste Landfill.



Source: Modified from PNNL-14187

Figure 3-9. Conceptual Exposure Pathway Model.



Exposure Media	Route	Current Worker	Future Worker	Occasional User	Biota Terrestrial
Air	Inhalation	X	X	X	X
Surface Soil	Inhalation	X	X	X	X
	Ingestion	X	X	X	X
	Dermal Contact	X	X	X	X
	External Radiation	X	X	X	X
Subsurface Soil	Ingestion	X	X	--	X
	Dermal Contact	X	X	--	X
	External Radiation	X	X	--	X
Biota	Ingestion	--	--	--	X
Groundwater	Inhalation	--	--	--	--
	Ingestion	--	--	--	--
	Dermal Contact	--	--	--	--
	External Radiation	--	--	--	--

Table 3-1. Plutonium and Uranium Inventories of Bin 3 Sites in the 200-SW-2 Operable Unit. (2 Pages)

Burial Ground	Size (ac)	Total Plutonium Inventory (g)	Inventory per Acre of Plutonium (g/ac)	Total Uranium Inventory (g)	Inventory per Acre of Uranium (g/ac)
Bin 3A (Sites Located within the LLBG TSD Unit Boundary)					
218-E-10	56.7	4,940	87	836,000	14,800
218-E-12B	173.1	1,560	9	283,000	1,640
218-W-3A	50.3	29,300	583	72,700,000	1,450,000
218-W-3AE	49.4	581	12	356,500,000	7,220,000
218-W-4B	8.6	66,300	7,730	5,900,000	688,000
218-W-4C	51.7	383,000	7,410	132,000,000	2,550,000
218-W-5	474.0	893	2	39,000,000	82,200
Bin 3B					
218-C-9*	1.8	0	0	0	0
218-E-1	2.4	900	380	400,000	169,000
218-E-2A*	0.3	--	--	--	--
218-E-5	2.3	620	270	120,000	52,200
218-E-5A	1.1	1,380	1,240	120,000	108,000
218-E-8	1.2	20	19	2,000	1,900
218-E-12A	24.6	8,930	364	990,000	40,300

Table 3-1. Plutonium and Uranium Inventories of Bin 3 Sites in the 200-SW-2 Operable Unit. (2 Pages)

Burial Ground	Size (ac)	Total Plutonium Inventory (g)	Inventory per Acre of Plutonium (g/ac)	Total Uranium Inventory (g)	Inventory per Acre of Uranium (g/ac)
218-W-1	5.5	94,000	17,200	700,000	128,000
218-W-1A	8.3	2,000	241	900,000	108,000
218-W-2	7.0	126,000	17,900	1,400,000	199,000
218-W-2A	39.8	6,380	161	2,690,000	67,700
218-W-3	8.0	68,000	8,490	70,000,000	8,740,000
218-W-4A	17.0	35,400	2,080	394,000,000	23,100,000
218-W-11	2.1	--	--	--	--
UPR-200-E-95*	0.03	--	--	--	--

NOTES:
Except as noted, the data, including burial ground sizes, are from SWITS, June 2004.
Burial ground sizes in SWITS do not always match the data in WIDS.
Plutonium and uranium data are rounded to three significant figures.

*218-C-9, 218-E-2A, and UPR-200-E-95 data are from WIDS.

Solid Waste Information Tracking System, Hanford Site database.
Waste Information Data System Report, Hanford Site database.

-- = The inventory is unknown.
LLBG = Low-Level Burial Ground.
SWITS = *Solid Waste Information Tracking System*.
TSD = treatment, storage, and disposal (unit).
WIDS = *Waste Information Data System*.

Table 3-2. Nonradioactive Contaminant Inventory for Bin 3 and Select Bin 2 Sites.

Site	Inventory
	Bin 3 Sites
218-E-10 Burial Ground	Lead and di-n-octyl phthalate (SWITS)
218-E-12B Burial Ground	Lead, mercury, sulfuric acid, coal tar creosote, and dichlorodifluoromethane (SWITS)
218-W-3A Burial Ground	1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene pyrrolidine, 1-heptene, 1-octene, 2,2,4-trimethylpentane, 2-methyl-propene, 3-methyl pyridine, acetaldehyde, acetone, acetonitrile, alpha-methylstyrene, aniline, barium, beryllium, butyl acetate, cadmium, carbon tetrachloride, chromium, cumene, cyclohexane, cyclohexanone, dibutyl phosphate, dioxane (1,4-diethylene dioxide), ethanolamine, ethyl acetate, ethylene, formaldehyde, heptane, indan, indene, isopropyl alcohol, kerosene, lead, mercury, methanol, methylcyclohexane, naphthalene, n-hexane, n-hexanol, nitric acid, phosphoric acid, sec-butylbenzene, silver, silver nitrate, sodium, sodium hydroxide, tert-butylbenzene, tetrahydrofuran, toluene, trichlorofluoromethane, 2,4,6-trimethylpyridine, uranium fluoride, xylene, and zirconium (SWITS)
218-W-3AE Burial Ground	Aluminum, asbestos, beryllium, bis(2-ethylhexyl) phthalate, calcium carbonate, cement, charcoal, clay, silicas, talc, copolymer of styrene, copper, graphite, uranium, steel, yttrium oxide, and various solvents (WIDS)
218-W-4B Burial Ground	Lead, beryllium, and zirconium (SWITS)
218-W-4C Burial Ground	Beryllium, lead, acetic anhydride, zirconium, sodium, 2,2,4-trimethylpentane, isopropyl iodide, mercury, phenol, cumene hydroperoxide, acetophenone, naphthalene, t-butyl hydroperoxide, nitric acid, bis(2-ethylhexyl)phthalate, uranium fluoride, vinyl chloride, chromium, silver, carbon tetrachloride, barium, 2,4-dinitrotoluene, arsenic, cadmium, and selenium (SWITS)
218-W-5 Burial Ground	1,1,1-trichloroethane, 4-methyl-2-pentanone, acetone, butyl alcohol, cresol, dichloromethane, methyl ethyl ketone, nitrate, potassium, sodium, sodium nitrate, and toluene (SWITS)
Nonradioactive Dangerous Waste Landfill	Inventory data are extensive and can be found in DOE/RL-90-17, *Nonradioactive Dangerous Waste Landfill Closure/Post Closure Plan*, Appendix 4A.

Solid Waste Information Tracking System, Hanford Site database.
Waste Information Data System Report, Hanford Site database.

SWITS = *Solid Waste Information Tracking System.*
WIDS = *Waste Information Data System.*

Table 3-3. Summary of Soil-Gas Survey Data for the 218-W-4C Burial Ground, August 2002 (*Hanford Environmental Information System*).

Borehole	Carbon Tetrachloride (ppmv)	Chloroform (ppmv)
C4011	6.91 – 10.5	2.07 – 2.80
C4012	7.25 – 62.1	2.32 – 12.2
C4013	<1	1.08
C4014	1.36	1.07 – 1.85
C4015	<1	2.09 – 2.31
C4016	4.8 – 14.8	3.37 – 5.77
C4017	<1	1.41 – 1.72
C4018	<1	1.16 – 1.50
C4019	<1	1.55 – 2.57
C4020	<1	1.47 – 1.52
C4022	2.39	1.56 – 2.78

ppmv = parts per mission by volume.

Table 3-4. Summary of Soil-Gas Survey Data for the Nonradioactive Dangerous Waste Landfill, 1993-1997.

Year/ Depth	1,1,1-TCA (ppmv)	1,1-DCA (ppmv)	PCE (ppmv)	TCE (ppmv)	Carbon Tetrachloride (ppmv)	Chloroform (ppmv)
1997 Shallow	<0.10	<0.10	0.60	<0.10	45	25
1997 Deep	0.37	0.10	0.43	0.25	42	46
1993 Shallow	8.7	ND	8.1	0.20	8	8.8
1993 Deep	ND	ND	ND	ND	9.7	ND

Source: BHI-01115, *Evaluation of the Soil-Gas Survey at the Nonradioactive Dangerous Waste Landfill.*

Data are maxima reported at shallow and deep concentrations for each sampling event.

DCA = dichloroethane.
ND = not detected.
PCE = tetrachloroethylene (perchloroethylene).
ppmv = parts per million by volume.
TCA = trichloroethane.
TCE = trichloroethylene.

Table 3-5. List of the 200-SW-1 and 200-SW-2 Operable Unit Contaminants of Concern. (2 Pages)

Radioactive Constituents (200-SW-2 Operable Unit Sites Only)	
Americium-241	Nickel-63
Antimony-125	Plutonium-238
Carbon-14	Plutonium-239/240
Cesium-137	Radium-226
Cobalt-60	Radium-228
Europium-152	Strontium-90
Europium-154	Technetium-99
Europium-155	Thorium-232
Hydrogen-3 (Tritium)	Uranium-234
Iodine-129	Uranium-235
Neptunium-237	Uranium-238
Chemical Constituents – Metals (200-SW-1 and 200-SW-2 Operable Unit Sites)	
Antimony	Manganese
Arsenic (Total)	Mercury
Barium	Molybdenum
Beryllium	Nickel
Cadmium	Selenium
Chromium (Total)	Silver
Hexavalent Chromium	Strontium
Cobalt	Tin
Copper	Uranium
Lead	Vanadium
Lithium	Zinc
Chemical Constituents – Other Inorganics (200-SW-1 and 200-SW-2 Operable Unit Sites)	
Ammonia/ammonium	pH
Asbestos	Iodine
Chloride	Nitrate/Nitrite
Cyanide	Phosphate
Fluoride	Sulfate/Sulfite
Chemical Constituents – Volatile Organics (200-SW-1 and 200-SW-2 Operable Unit Sites)	
1,1-dichloroethane (DCA)	4-methylphenol (p-cresol)
1,1-dichloroethene	Carbon Tetrachloride
1,1,1-trichloroethane (TCA)	Chlorobenzene
1,1,2-trichloroethane	Chloroform
1,1,2,2-trichloroethane	Cis-1,2-dichloroethylene
1,2-dichlorobenzene	Dichloromethane (Methylene Chloride)
1,2-dichloroethane (DCA)	Ethylbenzene
1,3-dichlorobenzene	Naphthalene
2,4-dinitrotoluene	n-butyl Benzene

Table 3-5. List of the 200-SW-1 and 200-SW-2 Operable Unit Contaminants of Concern. (2 Pages)

2-butanone (Methyl Ethyl Ketone/MEK)	Tetrachloroethylene (PCE)
2-hexanone (Methyl Isobutyl Ketone/MIBK)	Toluene
2-methylphenol (o-cresol)	Trans-1,2-dichlorotheylene
Benzene	Trichloroethylene (TCE)
Butanol	Xylene
Chemical Constituents – Semivolatile Organics (200-SW-1 and 200-SW-2 Operable Unit Sites)	
Normal paraffin hydrocarbon*	Phenol
Tributyl Phosphate	Polychlorinated biphenyls (PCB)
Creosote	
Petroleum (200-SW-1 and 200-SW-2 Operable Unit Sites)	
Gasoline Range Organics	Diesel Range Organics

*Analyzed as kerosene total petroleum hydrocarbons.

Table 3-6. Summary of Contaminants, Sources, Receptors, and Exposure Mechanisms for the 200-SW-1 and 200-SW-2 Operable Units.

Contaminant Category	Sources	Potential Exposure Mechanisms	Receptors
Radionuclides	Soil	Ingestion, inhalation (fugitive dust), direct dermal contact, and external exposure	Workers, visitors, plants, and animals
Metals	Soil	Ingestion and inhalation (fugitive dust)	Workers, visitors, plants, and animals
Organic compounds (volatile and semivolatile compounds)	Soil, air	Ingestion, inhalation	Workers, visitors, plants, and animals
Asbestos	Soil, air	Inhalation	Workers

4.0 WORK PLAN APPROACH AND RATIONALE

This chapter presents an overview of the approach that is planned to conduct additional investigations of the 200-SW-1 and 200-SW-2 OUs.

4.1 SUMMARY OF DATA QUALITY OBJECTIVE PROCESS

The RI needs for the 200-SW-1 and 200-SW-2 OUs were developed in accordance with the DQO process (EPA/600/R-96/055 [QA/G-4]), *Guidance for the Data Quality Objectives Process*). The DQO process is a seven-step planning approach that is used to develop a data collection strategy consistent with data uses and needs. The goals of the process are to identify the data required to refine the preliminary site conceptual model and support remedial decisions.

The DQO process to support this work plan was implemented by a team of subject matter experts and key decision makers. Subject matter experts provided input on regulatory issues, the history and physical condition of the sites, and sampling and analysis methods. Key decision makers from the DOE, Ecology, and EPA participated in the process to develop the characterization approach outlined in the DQO summary report. The DQO process and involvement of the team of experts and decision makers provide a high degree of confidence that the right type and quality of data are collected to fulfill informational needs of the RI decisional process. The DQO report presents the results of the DQO process for characterization of the waste sites in the 200-SW-1 and 200-SW-2 OUs (WMP-22210).

The DQO process determined that the large number of sites in the two OUs argue in favor of developing a binning approach to support decisions for the sites. Bins were developed based on conceptual models for sites, using existing site knowledge. For each bin, the most likely remedial approach was chosen from those identified in the Implementation Plan to the extent that available information supports selection of an approach. The choice of bins and corresponding presumed remedial approaches do not preclude proceeding with the FS. The intention is for the conceptual models to focus the sampling and analysis approach, and it is consistent with the RI/FS process.

Bin 1 consists of sites that primarily are within the 200-SW-1 OU (nonradioactive) and are believed to contain only minimal, if any, contamination. In general, contamination that is present should be located at or near the surface. These sites are believed to require no remedial action. Work plan activities will be directed toward verifying that any site contamination is below action levels.

Bin 2 sites also are predominantly nonradioactive sites (200-SW-1). These sites are assumed to contain some level of contamination, which is believed to be well understood and amenable to commonly available remedial techniques. Work plan activities will be directed toward characterizing the nature and extent of the contamination that exceeds action levels. If the characterization of Bin 2 sites indicates that minimal RTD would result in meeting the PRG, the RTD activity and final characterization can be completed under the ROD. If the results of screening are above levels of concern, or the remediation approach is uncertain or extensive, the site could be reassigned to Bin 3 for more extensive site characterization to support evaluation of alternative remedies.

Bin 3 includes the majority of the burial grounds on the 200 Plateau. These sites include the LLBG and NRDWL TSD unit sites (Bin 3A), as well as the older, historical burial grounds (Bin 3B), including the industrial and dry waste burial grounds going back to the early years of site operations.

Bin 3A sites are located within TSD unit boundaries. There generally is more available information for these sites than for Bin 3B sites. Characterization of Bin 3A sites is performed under this work plan, because no specific closure plan has been incorporated into the Hanford Site RCRA Permit (WA7890008967, *Hanford Facility RCRA Permit*). The waste sites are included in the CERCLA OU; therefore, characterization to support closure will be performed under CERCLA. Sufficient data will be generated to meet the RCRA closure requirements. The ROD for the Solid Waste Program (69 FR 39449) indicated that the LLBG TSD unit sites will be closed with an engineered barrier (i.e., a cap). The NRDWL TSD unit also is included in Bin 3A. The closure plan for NRDWL identifies a cover as the closure alternative for this site (DOE/RL-90-17). The use of a cover for landfills is consistent with the approach described in Tri-Party Agreement Section 5.3.

Bin 3B sites include both industrial waste and dry waste burial grounds. Industrial waste sites typically contain equipment and other large items such as vehicles. Dry waste sites contain many types of wastes such as rags, cans, clothing, filters, and small items such as tools. Wastes in both types of burial grounds typically display both chemical and radioactive contamination.

The DQO process determined that the most appropriate method to evaluate sites in all three bins is through an approach that uses nonintrusive methods to focus the locations for intrusive work. This approach will help to ensure that remediation activities are performed at sites where there is a potential risk to human health or the environment because of the presence of contamination above remediation standards. This approach initially will require survey or field screening (or both) of the waste sites within a bin to determine the presence of contamination. The surveys and screening methods will involve the use of field instrumentation to evaluate the levels of radioactive and chemical constituents of concern. The results from the surveys and screening will provide a basis for determining the need for and the extent of site remediation. If surveys and screening indicate contamination does not exist at the site at levels that exceed remedial goals, samples will be collected for laboratory analysis to support close out. Survey and screening results also will be used to guide more extensive site characterization and remediation for those sites determined to be contaminated above remedial goals. When survey and screening data indicate the site has been cleaned sufficiently to meet remediation goals, samples will be collected to support close out.

4.1.1 Data Uses

Existing information, as provided through the WIDS records for these waste sites, was used to perform the initial grouping or binning of the sites. The waste inventory information in WIDS also was used to establish and refine specific details for each waste site. This information includes any available disposal history for the site that will assist the field team to do the following:

- Establish the boundaries of a waste site
- Identify the primary constituents of concern

- Focus on a subset of the constituents of concern
- Provide a basis for estimating the lateral and vertical extent of contamination.

Data generated during the initial characterization of Bins 1 and 2 will consist of the output from field instrumentation used to survey sites for the presence of radioactive and/or chemical contamination. These data will be used to confirm or refute the presence of contamination above remedial action limits. If contamination is found above the remedial action limits, additional survey and/or field screening data will be collected to guide the appropriate remedial activity through identification of the depth and lateral extent of contamination. If contamination is not found above the action limits or survey readings indicate that action levels have been achieved, the data will be used to support the development of a statistically based sampling process, which will be implemented to collect samples for laboratory analysis to support closure.

Existing information was reviewed for the Bin 3 sites to determine the dimensions of the sites, operating history, and potential waste inventory and forms. This information was used to develop the sampling approach for the Bin 3 sites and to develop site-specific characterization activities for individual waste sites. Data generated during the initial characterization of Bin 3 sites also will consist of output from field-screening instruments and nonintrusive surveys. These data will be used to focus intrusive sampling in the vadose zone to support evaluation of the need for interim remedial measures for Bin 3A sites and evaluation of remedial alternatives for Bin 3B sites.

4.1.2 Data Needs

Information has been presented in Chapters 2.0 and 3.0 regarding the 200-SW-1 and 200-SW-2 OU waste sites. Existing data are sufficient to develop an initial conceptual understanding of radioactive and chemical contaminant distribution for the sites within the OUs. For the Bin 1 "No Further Action" under CERCLA candidate sites, data are required to support verification that contamination is below levels that would justify taking action to clean up the waste site. For the RTD candidate sites (Bin 2), data needs focus on gathering sufficient data to determine the lateral and vertical extent of contamination, identifying the contaminants present, and supporting evaluations for subsequent removal actions. Determination of contaminant levels present and recommendations for remediation will be accomplished through field screening surveys and analytical laboratory analysis of soil samples.

Data collection is needed for the Bin 3 sites to support cap design and evaluation of the need for interim remedial measures for Bin 3A waste sites as well as for human health, ecological, and remedial alternatives cost-benefit evaluations for Bin 3B sites. Because of the size of the burial grounds and complexity of the decisions concerning potential remedial alternatives, the data collection strategy for the Bin 3B sites is to use results of nonintrusive, surface-based sampling methods and field screening analyses to guide selection of locations for intrusive soil sampling and laboratory analyses.

4.1.3 Data Quality

Data quality was addressed during the DQO process for all waste sites. Previously completed work plans in the 200 Areas provided the basis for selection of COCs (see Section 3.6). Because there are no RODs for the Central Plateau source OUs, remedial action goals have not been established. Therefore, potential PRGs have been assigned that are consistent with the planned land uses for the Central Plateau. Soil screening levels for direct exposure for nonradionuclides based on human health risk were obtained from Ecology 94-145 for nonradioactive analytes regulated under WAC 173-340-745, "Soil Cleanup Standards for Industrial Properties," and WAC 173-340-747, "Deriving Soil Concentrations for Ground Water Protection." To support the potential evaluation of other exposure scenarios for sites outside the core zone, WAC 173-340-740, "Unrestricted Land Use Soil Cleanup Standards," screening levels were identified to ensure that appropriate detection limits were established. Screening levels pertaining to soil for protection of groundwater were developed based on the WAC 173-340-747(4), "Fixed Parameter Three-Phase Partitioning Model," fixed-parameter (default values) variant of the three-phase equilibrium model. Soil-screening levels for protection of ecological receptors for nonradionuclides were obtained from Table 749-3 in WAC 173-340-900, "Tables." For radioactive constituents, EPA (1997), *Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination*, OSWER Directive 9200.4-18, sets radiation doses from contaminated sites at 15 mrem/yr above natural background for 1,000 yr following the completion of cleanup. Tables that summarize the potential PRGs for the 200-SW-1 and 200-SW-2 OU waste sites are provided in the SAP (Appendix A). To provide the necessary data quality to support project requirements, when possible, detection limits should be lower than potential PRGs. Analytical detection limit tables provided in the SAP define the minimum detection limit, human health action levels, quantitation limit, precision, and accuracy requirements for each analytical method. Clean-up levels protective of ecological receptors also are defined in the tables to verify that analytical detection limits can meet additional potential data collection requirements. Additional data quality is gained by establishing the specific policies and procedures to be followed, and specifying field quality assurance/quality control requirements. These procedures and requirements are discussed in detail in the SAP.

4.1.4 Data Quantity

Data quantity refers to the number of samples collected. Screening data will be collected to provide an initial overview of site conditions. An adequate number of survey points will be established based on an evaluation of site-specific conditions to ensure that the site is characterized sufficiently to support a basis for decisions. Because radioactive contamination survey and other field-screening results at the 200-SW-1 and 200-SW-2 OU sites will provide a significant amount of onsite data, the number of samples needed for laboratory analysis can be reduced. For Bin 1, candidate "No Further Action" under CERCLA sites, an adequate number of samples must be collected to document that potentially contaminated material is at sufficiently low levels to justify the "No Further Action" status. For candidate RTD sites (Bin 2), an adequate number of samples must be collected to document that removal of contaminated material will be a cost-effective remedial alternative. For sites slated to be capped (Bin 3A), a sufficient number of samples is needed to evaluate the need for interim remedial measures. For the candidate RI sites (Bin 3B), a sufficient number of samples and/or radioactive contamination survey locations are needed to refine the conceptual contaminant models and support remedial decisions. The sample quantities currently defined for collection during scoping of the 200-SW-1 and 200-SW-2 OU waste sites are presented in the SAP (Appendix A).

4.2 CHARACTERIZATION APPROACH

This section provides an overview of characterization approaches planned to meet the data needs for the 200-SW-1 and 200-SW-2 OU sites, as determined during the DQO process. The overall strategy for site characterization is to use an approach that progresses from less intrusive to more intrusive techniques to develop an adequate definition of site conditions to support a decision. The first step for all sites will be to reassess the detailed, site-specific information available through WIDS, as well as any additional or new documentation that may provide a clear picture of site conditions. The documentation in some cases will provide sufficient information to support the design of a site survey plan. Field instruments and nondestructive analysis equipment can provide an overview of site condition, such as the types and levels of contamination present and location and configuration of wastes. Results from these studies will be used to provide a basis for the next steps in the characterization (e.g., determination of locations requiring special attention, whether additional field screening or surveys are required, and/or whether samples should be collected to support closeout). Additional characterization needs will be defined on a site-specific basis. The sampling approach for each bin is described in the following sections.

4.2.1 Characterize Potential "No Further Action" Sites (Bin 1)

Bin 1 contains 20 sites, 17 of which are in the 200-SW-1 OU (nonradioactive). The sites are predominantly burn pits, ash disposal sites, and locations of random contamination from miscellaneous site activities. The sites were not used for the disposal of packaged waste forms. The sites generally are believed to be not (or only minimally) contaminated; any contamination that is present is anticipated to be at or near the surface. Contamination is anticipated to be lower than the levels set in the potential PRGs; therefore, no remediation should be required at the Bin 1 sites. The records are sufficiently ambiguous, however, that the contamination status must be confirmed. The objective of characterization for Bin 1 sites will be to verify that the conditions do not require any remedial activity.

Figure 4-1 illustrates the decision logic and characterization steps for the Bin 1 sites, as described in the following paragraphs.

1. Records Review: The historical data for the waste sites within Bin 1 (Table 1-2) will be reassessed to evaluate the available information regarding existing and/or remaining contamination at these sites, as well as pertinent details regarding site history, location, size, disposal records, waste inventory, etc. This information then will be used to guide the field investigation program.
2. Site Walk Down: Wastes and contamination at the Bin 1 sites are anticipated to be present primarily at or near the surface. As a first step in the field activities, the project will conduct a walk down of each site, observing and recording the presence of waste materials, and any significant site conditions. The project also will establish a sampling grid, as described in the SAP (Appendix A), to provide the basis for the survey and sample activities described below.
3. Surface Radioactive Contamination Survey: Although the majority of the sites are from the 200-SW-1 OU, due diligence requires that all sites within the 200 Areas be screened for radioactive contamination, particularly given the operating period and associated

records, or lack thereof, for many of these sites. Sites will be screened for radioactive contamination using surface-based survey techniques. If the survey indicates the presence of radioactive contamination significantly above background, the site will be reassigned to Bin 2 for management under the strategy described for those sites.

4. Soil-Gas Survey and Field Screening: If the information for an individual site indicates the potential for organic constituents have been disposed at that location, a systematic sampling approach will be applied to evaluate the presence of contamination. Sites will be screened for volatile organic chemicals using passive soil-gas surveys (e.g., EMFLUX[1] technology) with confirmatory soil samples where screening indicates the presence of contamination.

5. Site-Specific Sampling: In addition to the above screening methodologies, individual waste sites within this bin may have a specific contaminant issue that needs to be addressed in a targeted sampling approach. X-ray fluorescence technologies will be applied in a systematic manner appropriate to each site to evaluate the presence of toxicity characteristic metals. Shallow soil samples can be collected and analyzed for polychlorinated biphenyls or other specific constituents if site records indicate their specific presence. Soil sampling may require both shallow, surface-based collection methods and shallow, subsurface-based methods such as test pits or direct push technologies such as GeoProbe.[2]

6. Follow-up Targeted Sampling: If results from the previous steps show that contamination potentially is present above levels of concern, follow-up targeted sampling may be needed to define the lateral and/or vertical extent of the soil contamination at these sites. These sites will be considered candidates for the RTD approach and reassigned as Bin 2 sites.

If screening indicates that contaminants are not present, or present at concentrations below levels of concern, the results will be used to support the design of a statistically based sample collection process for laboratory analysis of samples to confirm site conditions. Samples also will be evaluated at these locations for the 0 to 0.3 m (0 to 1 ft) depth to support an ecological risk evaluation. If characterization does not indicate the presence of contamination above PRGs, the site will be proposed for "No Further Action" under CERCLA. If samples indicate contamination present above PRGs, the site will no longer meet the criteria for assignment to Bin 1 and will be managed under the approach described for Bin 2 sites, using the data collected as described above to support characterization for Bin 2 needs.

4.2.2 Characterize Potential Remove/Treat/Dispose Candidate Sites (Bin 2)

Bin 2 contains 30 sites that generally are near-surface sites whose records indicate a history of waste disposal. Twenty of the sites in Bin 2 are from the 200-SW-1 OU, indicating that they belong to the nonradioactive group and are anticipated to not contain radioactively contaminated wastes. All of the sites that are included in Bin 2 are assumed to contain some amount of

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[1]EMFLUX is a registered trademark of Beacon Environmental Services, Inc., Bel Air, Maryland.

[2]GeoProbe is a registered trademark of GeoProbe Systems, Salina, Kansas.

material with contaminant concentrations above PRGs; it is anticipated that this material will require removal. Because the waste inventory is fairly well defined for these sites, remediation should be relatively straightforward using commonly available techniques. The RTD approach is considered to be appropriate for these sites; however, because of the area covered by some sites and the question of whether all waste exceeds levels of concern, an approach will be used to define the areas that require remediation.

In general, the inventory for these sites consists of materials disposed at the surface, with the exception of the three vault sites (218-E-7, 218-W-7, and 218-W-8) and the burial grounds at 218-E-2 and 218-E-4, and the 600 OCL. The inventory generally has been well defined and should not present a significant challenge for remediation through an RTD process.

Although some of the Bin 2 sites encompass a relatively large geographic area, the records and site inspections indicate that the waste at these sites is for the most part not spread over the entire site. Therefore, the approach to these sites will be to define the area of contamination that requires remedial action before initiating any waste removal.

Figure 4-2 illustrates the approach that will be used to characterize the Bin 2 sites; this approach is described below.

1. Records/Site Review: The historical data for the waste sites in Bin 2 will be reassessed to better define the information regarding waste disposal and contamination at these sites. The review also will consider the results from other Hanford Site remedial activities at analogous waste sites (e.g., 618 Burial Grounds) to determine whether approaches used at those locations can be applied to the Bin 2 sites (e.g., 600 OCL). The results from this review will be used to establish a survey grid to guide the survey activities to follow.
2. Field Screening: The presumption is that most of the waste sites in Bin 2 are contaminated. The intention for this step will be to confirm the presence of contamination before initiating the removal action.
    - Field radioactive contamination screening methods will be used to establish the boundaries of contamination (area and depth) and provide data to support an ALARA evaluation for subsequent RTD work. Field-screening methods also will be used to determine if chemical contamination (organics and inorganics) is present above levels of concern, using the same approach as described for Bin 1. The data will be used to identify the extent of contamination and to identify health and safety concerns.
    - If contamination is below levels of concern, variance will be estimated from the field-screening measurements to develop a statistically based sampling and laboratory analysis process, which in turn will be applied to verify the site conditions. If the laboratory samples confirm the results of the field screening, no remediation is needed and the site will be identified for no-further action under CERCLA.
    - If laboratory samples indicate contamination is present above potential PRGs, a cost-benefit analysis will be conducted before recommending the RTD process.
3. RTD Approach: The presumptive remedy for contaminated media and materials at the Bin 2 sites is RTD. Backhoes, front-end loaders, and other equipment, as appropriate,

will be used to excavate and remove the waste at these locations. Field-screening techniques for radionuclides, volatile organic chemicals, and selected metals (e.g., lead, chromium) will be used to determine the lateral and vertical extent of contaminated media, as well as the contaminant concentrations, during waste removal actions at these sites using the "observational approach." Waste will be segregated, as appropriate, for treatment and repackaging for disposal to an approved waste disposal facility. Following removal actions, the variance, calculated using field-screening data, will be used to determine a statistically based soil sampling location scheme to verify clean-up (using laboratory analysis) as a basis for site closure. Samples for laboratory analysis also will be collected at these locations from the 0 to 0.3 m (0 to 1 ft) soil depth to support ecological evaluation.

Sites requiring extensive remediation or requiring significant characterization to determine the optimal approach for remediation will be moved to Bin 3 and characterized using the approach noted below.

4.2.3 Characterize Remedial Investigation/Feasibility Study Sites (Bin 3)

The characterization strategy presented below describes the approach that will be used for Bin 3A and Bin 3B waste sites.

Bin 3A Characterization Approach

The Bin 3A site grouping includes the burial grounds in the LLBG TSD unit slated to be closed with a cap as determined under the ROD for the Solid Waste Program (69 FR 39449), which was prepared under NEPA. Bin 3A also includes the NRDWL TSD unit. The 600 CL, which is adjacent to NRDWL, also is included because of the assumption that it will be remediated along with the NRDWL. The closure plan for the NRDWL also identifies closure with a cover as the pathway for that site (DOE/RL-90-17). Tri-Party Agreement, Section 5.3, indicates that Hanford Facility TSD units will be closed pursuant to WAC 173-303-610, "Closure and Post-Closure." For landfills, WAC 173-303-610 requires compliance with WAC 173-303-665(6), "Landfills," "Closure and Post-Closure Care," which requires a final cover. Clean closure, although allowed for landfills under the Tri-Party Agreement, Section 6.3.1, is not a practical option for these TSD units. In addition, the NEPA Solid Waste ROD states "LLW and MLLW disposal facilities will be closed with an engineered barrier (cap) designed and installed to meet regulatory requirements applicable to MLLW" (69 FR 39449). DOE/RL-2000-70, *Closure Plan for Active Low-Level Burial Grounds*, states that "During the Final Closure period, engineered surface barriers will be constructed over LLBGs." The inventory for these sites is generally well defined, and they have been operated under the *Hanford Facility RCRA Permit* (WA7890008967) and monitored through a system of groundwater monitoring wells. The TSD units will be characterized, based on the available monitoring information, site characterization studies, and waste inventory records.

Because the LLBG sites have been operated under the *Hanford Facility Part A Permit Application* (DOE/RL-88-20) and the monitoring program does not indicate any releases, minimal characterization is planned for these sites. Some of the trenches within these burial grounds, however, accepted waste before becoming regulated under RCRA. Because the bulk organic liquid soil column disposal facilities at the Hanford Site were not available after 1973, the possibility remains that containerized liquids may have been disposed to these trenches between 1973 and 1986. Therefore, the trenches within the Bin 3A sites that operated during this time frame will be characterized for any residual volatile organics to determine the need for an interim action before the engineered barrier is placed. Burial Ground 218-W-2A, a Bin 3B site, also operated during the 1973-1986 time frame and also will be characterized for presence of volatile organic constituents.

To the extent that waste inventory information from the Bin 3A burial grounds may represent materials disposed to the industrial or dry waste burial grounds in Bin 3B, the information generated from a review of these records will be applied, as appropriate, to assist in the development of characterization profiles for the Bin 3B sites.

In addition, as noted elsewhere in this document, four of the Bin 3A burial grounds include trenches that contain retrievably stored, suspect TRU wastes. In accordance with Tri-Party Agreement Milestone M-91-40, the TRU retrieval program will characterize the substrate soils underlying the locations of retrievably stored waste to evaluate whether contaminants have been released to the environment. The data developed from these studies also will be used to establish contaminant profiles for wastes in the Bin 3B sites, to the extent that the information is available and can be shown to be relevant for these sites.

Bin 3B Characterization Approach

Bin 3B includes historical burial grounds; the majority of these sites received some or all of their wastes in the 1944 to mid-1960s time frame, when records of waste inventory and waste disposal practices were incomplete. A UPR site, UPR-200-E-95, also has been placed in the Bin 3B category because of its proximity to some of the burial grounds (e.g., 218-E-2A, 218-E-5), and because of the assumption that it will be remediated along with the associated burial grounds. Bin 3B ultimately may also include sites reassigned from Bin 2 that require additional characterization information or alternatives analysis to support remedial decisions and/or remedial design. Bin 3B sites may be either industrial waste or dry waste sites as discussed above (Section 4.1).

Characterization data will be gathered to support an FS for remedial action at the Bin 3B sites. Data will be sought to allow evaluation of the burial grounds against the following considerations:

1. Human health exposure
2. Ecological risk
3. Release to groundwater
4. Practical concerns associated with implementing the alternatives identified for the burial grounds; these constructability concerns could include issues such as ALARA, subsidence, and cost.

The activities to support characterization of the Bin 3B sites will follow the steps defined for the Industrial and Dry Waste sites.

Bin 3B Industrial Waste Site Characterization Approach

Bin 3B Industrial Waste sites are anticipated to contain primarily discrete pieces of equipment, machinery, tanks, pulsers, cover blocks and other highly contaminated items from process operations. These items generally have a high dose associated with the residual radionuclide inventory. These items may have been disposed of in containers (e.g., drag-off boxes) or may have been placed directly into the disposal ground. Industrial wastes sometimes were placed into trenches. Excavations also were created within burial grounds for specific pieces of equipment but outside the boundaries of defined trenches. A concern with these burial grounds will be to identify the physical location of all wastes. The approach described below takes into account the potential for random placement of waste at these sites.

1. The types of waste expected to have been disposed to Bin 3B Industrial Waste sites frequently can be located with geophysical surveys. Electromagnetic, magnetometer and/or ground penetrating radar will be used to define the location of the buried items, geophysical features and other anomalies.
2. Once the locations are outlined, a grid will be established based on the size of the area and number of anomalies. Readings will be obtained using thermoluminescent dosimeters (TLD) (i.e., aluminum oxide type dosimeters or similar) or equivalent technology placed in the burial grounds to measure accumulated gamma readings over time. In addition, passive soil-gas screening will be performed at a statistically based set of grid locations to determine whether organics are present.
3. After review of the data, the three areas at each burial ground with the highest dose and/or highest soil-gas levels will be characterized using direct-push technologies. The boreholes will undergo radioactive contamination screening and active soil-gas analyses as described in the SAP. Soil samples will be collected and submitted to the laboratory as described in Appendix A (SAP).
4. The data will be validated per Appendix A and assessed against the potential PRGs. If the PRGs are exceeded, human health and ecological risk assessment will be performed. The project will proceed to perform the FS.

Decision logic for the characterization of Bin 3B Industrial Waste sites is shown in Figure 4-3; additional detail is found in the SAP (Appendix A).

Bin 3B Dry Waste Site Characterization Approach

In general, the placement of waste in the Dry Waste burial grounds was more systematic than in the Industrial Waste burial grounds. Waste is variable and includes protective clothing, small pieces of equipment, lab packs, and other items that would as a rule be packaged before disposal.

1. Data from WIDS and any other pertinent records will be reassessed. If the records allow the identification of longitudinal trenches in the burial ground for investigation, then the project will proceed to Step 2 and characterize the trenches longitudinally. If the records do not allow the identification of the footprint of the trenches for focused investigation, then three cross trench survey lines will be established, based on available information, and the cross trenches will be characterized per Step 2.
2. Some of the types of waste expected to have been disposed to Bin 3B waste sites frequently can be located with geophysical surveys. Electromagnetic, magnetometer and/or ground penetrating radar will be used to define the location of the buried items, geophysical features, and other anomalies (e.g., moisture zones).

3. Once the locations are outlined, surveys will be conducted using TLDs (or alternative technology) placed in the burial grounds to measure accumulated gamma readings over time. In addition, passive soil-gas surveys will be performed.
4. After review of the data, the three areas with the highest dose and/or highest soil-gas levels will be characterized using direct-push technologies. The boreholes will undergo radioactive contamination screening and active soil-gas analyses as described in the SAP. Soil samples will be collected and submitted to the laboratory as described in Appendix A (SAP).
5. The data will be validated per Appendix A (SAP) and assessed against the potential PRGs. If the PRGs are exceeded, human health and ecological risk assessment will be performed. The project will proceed to perform the FS.

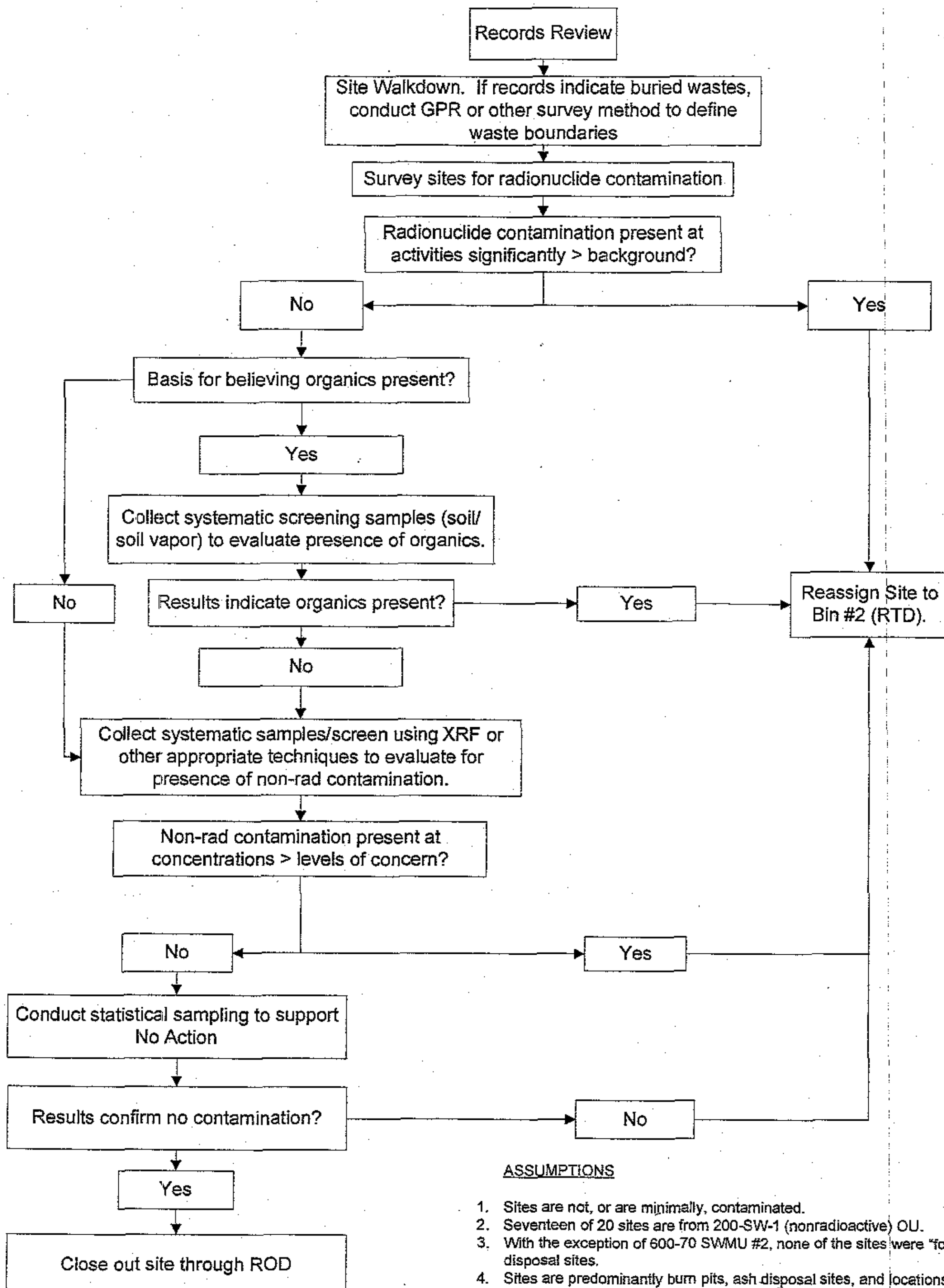
Decision logic for the characterization of Bin 3B dry waste sites is shown in Figure 4-4; additional detail is found in the SAP (Appendix A).

4.2.3.1 Characterization Using Thermoluminescent Dosimetry and Evaluation of Plutonium and Uranium

To fully assess the results of the TLD screening and potential personnel exposure, a method of correlating results of the measured accumulated gamma readings over time to expected uranium and plutonium inventories is required. The TLDs detect radioactive cesium and strontium but do not detect alpha emitters such as uranium and plutonium. The concern is how to assess whether these metals are present, based on information from the TLDs.

For the Bin 3B waste sites, average values of cesium, strontium, plutonium, and uranium per unit of waste volume can be obtained using estimated radionuclide inventories and waste volumes. By assuming a similar ratio of plutonium and uranium to gamma-emitting radioisotopes in the burial grounds, a decay-corrected ratio may be calculated to estimate total inventories for all waste sites that have TLD gamma results. When the inventory estimate is calculated, it can be used to develop internal and external dose rate estimates. By comparing radionuclide-specific inventories and ratios, an assessment can be made of the amount of time personnel are able to stay in the waste sites without exceeding dose criteria for external and internal exposures for various scenarios.

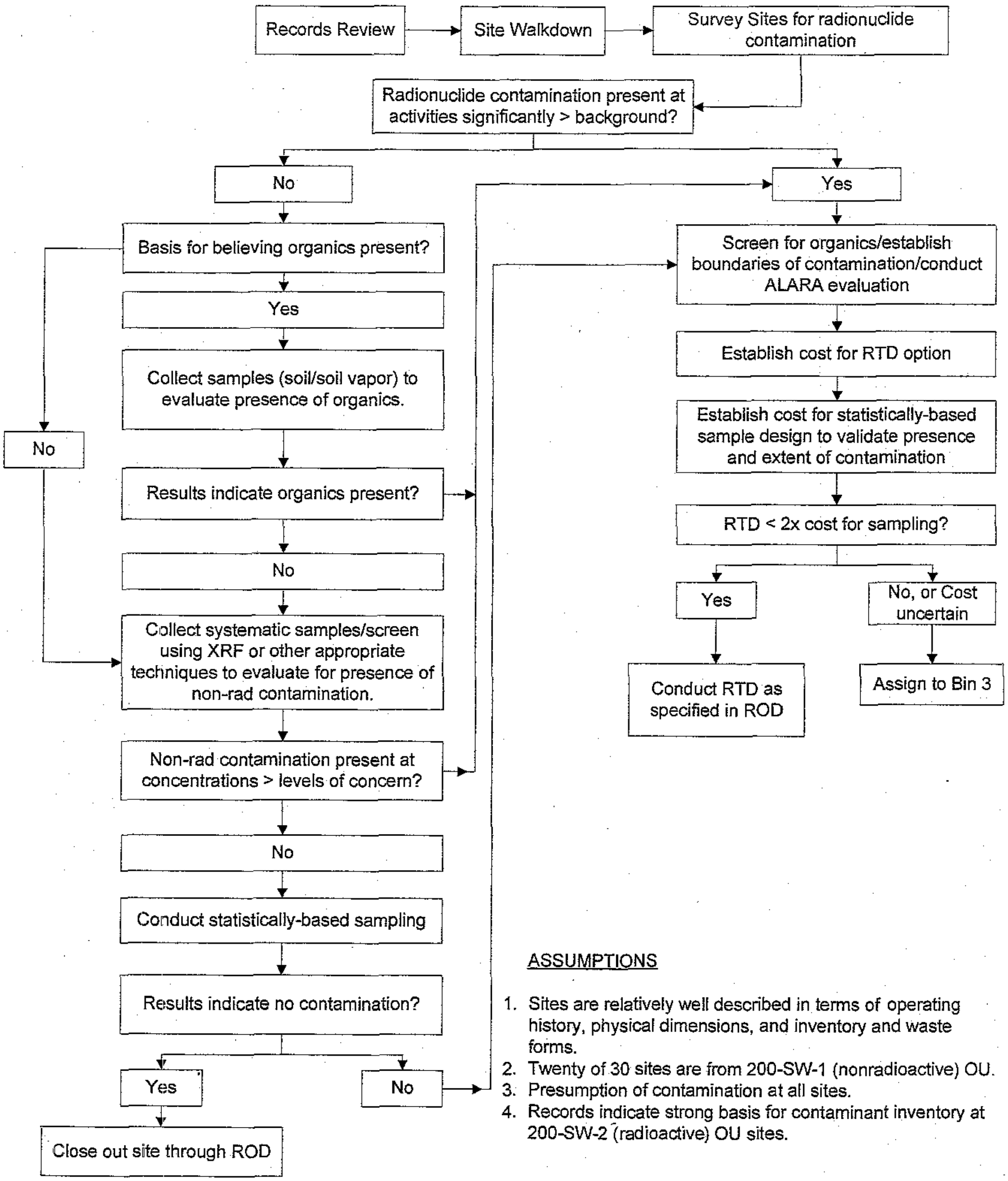
Figure 4-1. Characterization Logic for Bin 1 Sites.



ASSUMPTIONS

1. Sites are not, or are minimally, contaminated.
2. Seventeen of 20 sites are from 200-SW-1 (nonradioactive) OU.
3. With the exception of 600-70 SWMU #2, none of the sites were "formal" waste disposal sites.
4. Sites are predominantly burn pits, ash disposal sites, and locations of random contamination from miscellaneous activities.
5. Most contamination thought to be surface or near surface.

Figure 4-2. Bin 2 Characterization Logic.



<u>ASSUMPTIONS</u>

1. Sites are relatively well described in terms of operating history, physical dimensions, and inventory and waste forms.
2. Twenty of 30 sites are from 200-SW-1 (nonradioactive) OU.
3. Presumption of contamination at all sites.
4. Records indicate strong basis for contaminant inventory at 200-SW-2 (radioactive) OU sites.

Figure 4-3. Bin 3B Industrial Waste Characterization Concept.

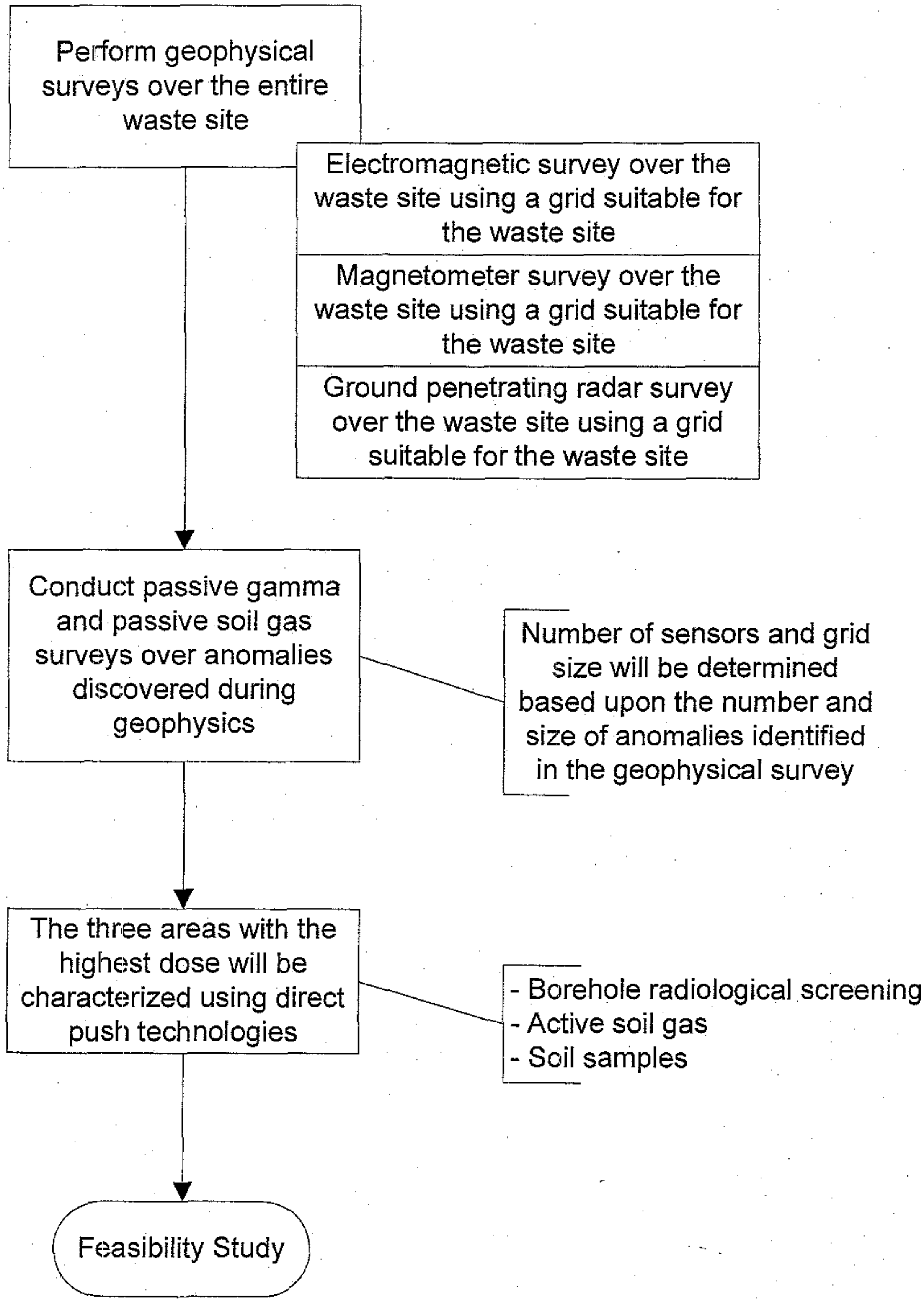
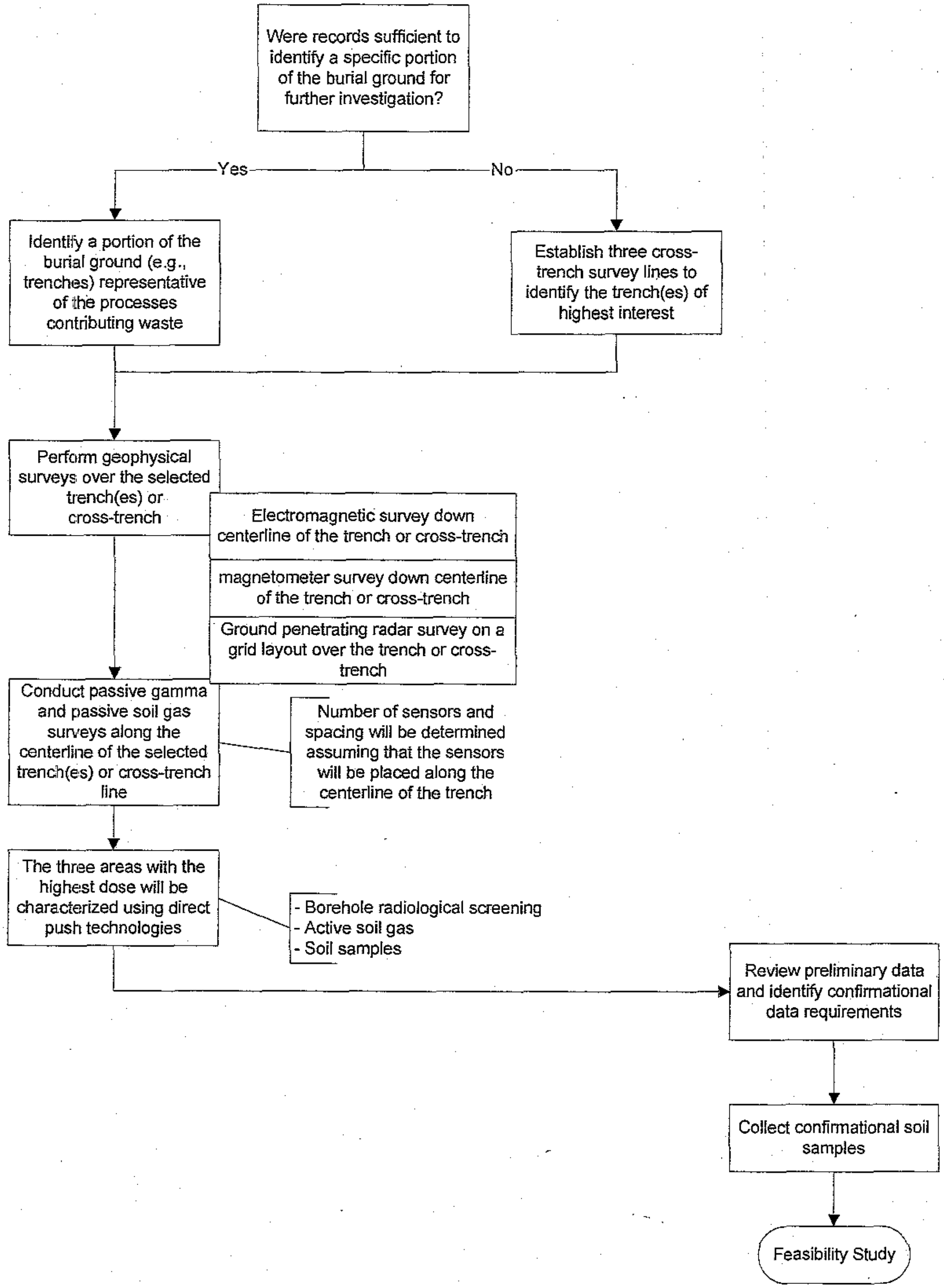


Figure 4-4. Bin 3B Dry Waste Characterization Concept.



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