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200-MW-1 Miscellaneous Waste Group Operable Unit RI/FS Work Plan

United States
Department of Energy

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April 2002

United States Department of Energy

P.O. Box 550, Richland, Washington 99352

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-MW-1 Miscellaneous Waste Group Operable Unit (OU). The 200-MW-1 OU is located in the 200 Areas near the center of the Hanford Site in south-central Washington State. The 200 Areas are within one of four areas on the Hanford Site that are on the U.S. Environmental Protection Agency's National Priorities List under CERCLA. The general CERCLA RI/FS process is described in the *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA 1988). The characterization and remediation of waste sites at the Hanford Site are addressed in the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1998). The schedule of work at the Hanford Site is governed by Tri-Party Agreement milestones. The milestone controlling the schedule for the 200-MW-1 OU is M-13-00L, "Submit 3 Operable Unit Work Plans," due December 31, 2001. All characterization work for nontank farm OUs in the 200 Areas is scheduled to be completed by December 31, 2008 (Tri-Party Agreement Milestone M-15-00C). The application of the CERCLA RI/FS process in the 200 Areas is described in the *200 Areas Remedial Investigation/Feasibility Study Implementation Plan - Environmental Restoration Program* (Implementation Plan) (DOE-RL 1999a).

The Miscellaneous Waste Category contains one OU, 200-MW-1, as defined in DOE-RL (1999a). Recently the Tri-Parties (the U.S. Department of Energy, the Washington State Department of Ecology, and the U.S. Environmental Protection Agency) initiated negotiations to revise a number of legally enforceable milestone commitments that include modifying the number of 200 Area RI/FS work plans to be submitted. An agreement has been reached among the Tri-Parties that 200 Area waste site characterization work will be focused on 12 OUs that are representative of the 23 OUs that currently have milestones for work plan submittals. A fundamental concept that supports this approach is that each of the major waste categories will have at least one OU characterized. The Tri-Parties anticipate public comments on the draft milestone change requests in April 2002.

The 200-MW-1 OU consists mainly of crib-, french drain-, and trench-type waste sites that received moderate to low-volume liquid waste from vehicle and heavy equipment decontamination, ventilation system wastes, and small-volume streams commonly disposed to french drains. The original waste sites assigned to this OU in the Implementation Plan have been updated by the addition of new waste sites and reclassification of accepted wastes sites in accordance with the *Tri-Party Agreement Handbook Management Procedures*, Guideline Number TPA-MP-14, "Maintenance of the Waste Information Data System (WIDS)" (DOE-RL 1998).

This work plan documents OU-specific background information; defines OU-specific characterization and assessment activities and schedules for representative sites, based on the framework established in the Implementation Plan; and identifies the steps required to complete the RI/FS process for the OU. A data quality objectives (DQO) process was conducted for the OU to validate the selection of representative sites; define the radiological and nonradiological constituents to be characterized; and to specify the number, type, and location of samples to be collected at representative sites. The results of the DQO process form the basis for this work plan and the associated sampling and analysis plan (SAP) included in Appendix A. The SAP includes an OU-specific quality assurance project plan and a field sampling plan for implementing the characterization activities in the field.

While three representative sites (216-A-4 Crib, 216-T-33 Crib, and 216-U-3 French Drain) were originally identified for the 200-MW-1 OU in the *Waste Site Grouping for 200 Areas Soil Investigations* report (DOE-RL 1997) and in the Implementation Plan (DOE-RL 1999a), it was decided during the DQO process that to represent the range of waste sites included in this OU, additional representatives waste sites were warranted. After reviewing the process history for each waste site, the following subgroups were developed within the OU based on the types and amount of waste received:

- Process facility ventilation stack and sand filter sources. This group also contains the 216-A-4 Crib, which received ventilation as well as Plutonium/Uranium Extraction

(PUREX) laboratory drainage that was routed through the PUREX canyon U cell tanks to the crib

- Vehicle/heavy equipment facility decontamination sources
- Vehicle/heavy equipment field decontamination source
- Low-level radioactive process or steam condensate sources, which were primarily discharged to french drains
- Nonradiological process steam condensate cross contaminated with radionuclides from other sources.

The following representative sites, by subgroup, were selected:

- 216-A-4 Crib for Process facility ventilation stack and sand filter sources
- 216-T-33 Crib for vehicle/heavy equipment facility decontamination sources
- 216-T-13 Trench for vehicle/heavy equipment field decontamination sources
- 216-U-3 French Drain for low-level radioactive process or steam condensate sources
- 200-E-4 French Drain for the nonradiological process steam condensate cross-contaminated with radionuclides from other sources.

The data generated through investigation activities associated with this OU will support activities in other core projects in the U.S. Department of Energy, Richland Operations Office's Groundwater/Vadose Zone Integration Project. Integration of the data collection activities with other projects on the Hanford Site results in more efficient and consistent remediation processes.

A preliminary conceptual contaminant distribution model was developed in the *Waste Site Grouping for 200 Areas Soil Investigations* report (DOE-RL 1997). The preliminary model was updated with conceptual contaminant distribution models of representative sites in this work plan based on physical conditions and the nature and extent of contamination at representative sites. The following general conclusions can be drawn regarding the conceptual contaminant distribution model for these waste streams:

- Effluents discharged to waste sites in the OU consisted of low-level radionuclide, low-organic, and low-inorganic solutions. The major radionuclide contaminants of concern include cesium, plutonium, strontium, and uranium.

- Some of the OU waste sites received enough effluent to potentially impact groundwater.

- Contamination migrated vertically beneath the waste sites after release. Lateral spreading of liquids and contaminants may have occurred at the bottom of the crib/trench/french drain, at the sand-dominated sequence of the Hanford formation, at the Plio-Pleistocene unit/early Palouse soil, and/or at the upper Ringold Formation, if present.

- Contaminants such as cesium and plutonium normally adsorb strongly onto shallow zone Hanford Site sediments and therefore have high distribution coefficients (K_d). These less mobile contaminants should be detected near points of release in the vadose zone. Contaminants with low K_d values (e.g., nitrite and tritium) are not readily adsorbed on soil particles and migrate to greater depth within the vadose zone. For example, cesium-137 (K_d > 2,000 mL/g) is likely to concentrate near the point of release; strontium-90 (K_d = 0.4 to 50 mL/g) and uranium (K_d = 2 mL/g) would be expected at greater depths. Tritium with a K_d value equal to 0 will migrate vertically with the wetting moisture front.

- Contaminant mobility may be enhanced at some decontamination waste sites due to complexing agents added to increase the effectiveness of decontamination solutions.

- Immobile contaminants will be detected high above the water table in the vadose zone. The concentration of high K_d contaminants will generally decrease with depth. Mobile contaminants will be detected at very low concentrations throughout the vadose zone, and their concentrations may actually increase with depth.

- Based on existing groundwater data, the contaminants whose concentration in groundwater exceed the maximum contaminant levels near representative sites are tritium, iodine-129, nitrate, carbon tetrachloride, and trichloroethylene.

- Waste sites in the 200-MW-1 OU no longer receive effluent. Most sites in this OU have been stabilized and covered with clean soil. With the cessation of artificial recharge, the downward flux of moisture through the vadose zone has decreased. Residual moisture should continue to decrease in the vadose zone over time and equilibrate with the natural recharge rate, thus reducing the potential for future impacts to groundwater.

Potential receptors (human and ecological) may be exposed to the affected media through several exposure pathways, including inhalation, ingestion, and direct exposure to external gamma radiation. Potential human receptors include current and future site workers and visitors (occasional users). Potential ecological receptors include terrestrial plants and animals, which are discussed in Section 3.3.7 of this work plan. The conceptual exposure pathway model for the 200-MW-1 OU is shown in Figure 3-15.

Future impacts to humans are largely dependent on exposure pathways indicated by future land uses, which are undetermined at this time. A restricted land-use scenario for the 200 Areas is favored by the Tri-Parties. All the sites within the 200-MW-1 OU are located within the "exclusive-use" boundary identified in the *Final Comprehensive Land-Use Plan Environmental Impact Statement* (DOE 1999) and the associated Record of Decision (64 *Federal Register* 61615). These waste sites will be evaluated on the basis of future land-use options and exposure scenarios.

A strategy to address ecological impacts in the 200 Areas has been developed and is being implemented. The strategy is phased and supports both 200 Area-wide and OU-specific evaluations. Phase I of the strategy consists of the compilation of existing 200 Area ecological data into an ecological summary report, which is scheduled to be completed in fiscal year 2002. Specific requirements for Phase II will be developed based on the results of the Phase I evaluation. For the 200-MW-1 OU, an ecological SAP will be prepared if waste site-specific soil samples are required to support an OU-specific ecological evaluation. The Phase II DQO is planned for completion in fiscal year 2003, at which time the 200-MW-1 ecological SAP will be prepared and implemented, if needed.

RI/FS characterization activities planned to collect the required data identified in the DQO process include borehole drilling and soil sampling and geophysical logging using spectral gamma, gross gamma, and neutron moisture tools. Sample analysis will be conducted by an offsite laboratory under a contract-required quality program. The sampling strategy is designed to provide access to potentially contaminated subsurface areas. Sample collection will be guided by field screening and a sampling scheme that identifies critical sampling depths.

The SAP directs sampling and analysis activities that will be performed to characterize the vadose zone at the five representative waste sites. The data will be used to refine the conceptual contaminant distribution models, support an assessment of risk, and evaluate a range of remedial alternatives for waste sites in the 200-MW-1 OU Miscellaneous Waste Category. The activities described in the SAP involve soil sampling and geophysical logging of deep vadose zone boreholes to obtain additional information on the distribution of contamination at the 216-A-4 Crib, the 216-T-33 Crib, and the 216-U-3 French Drain. Test pit excavation and soil sampling of the shallow vadose zone will take place at the 216-T-13 Trench and 200-E-4 French Drain. Boreholes will be drilled to groundwater, and soil samples will be collected through the vadose zone for laboratory analyses. Test pits will be excavated to at least 7.6 m (25 ft) below ground surface. Soil samples will be analyzed for radiological and nonradiological contaminants of concern, and physical property samples will be collected at major lithologic changes.

The boreholes will be geophysically logged for gamma-emitting radionuclides and neutron moisture content. At least one existing borehole in the vicinity of the 216-T-33 Crib will also be geophysically logged to provide additional information. A split-spoon sampler will be the primary sampling device used to collect the samples from the boreholes. Samples will be collected directly from the bucket for test pits. Table ES-1 summarizes the sample collection requirements for the representative waste sites to be investigated.

Table ES-1. Summary of Projected Sample Collection Requirements for the 200-MW-1 Operable Unit.

	216-A-4 Crib	216-T-13 Trench	216-T-33 Crib	216-U-3 French Drain	200-E-4 French Drain	Project Total
Chemical Parameters						
Maximum number of characterization samples	12	6	11	9	3	41
Detail of quality control samples						
Duplicates	1	1	1	1	1	5
Splits	1	1	1	1	1	5
Equipment blanks	1	1	1	1	1	5
Trip blank	1	1	1	1	1	10
Approximate number of field QC samples	4	4	4	4	4	15
Approximate total number of samples	16	10	15	13	7	61
Physical Properties						
Bulk density, moisture content, particle size distribution	2	TBD	4	4	TBD	10

TBD = To be determined by the field geologist based on soil conditions.

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ACRONYMS

ANN	aluminum nitrate nonahydrate
ARAR	applicable or relevant and appropriate requirement
bgs	below ground surface
BHI	Bechtel Hanford, Inc.
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
COC	contaminant of concern
COPC	contaminant of potential concern
CPP	CERCLA past-practice
DOE	U.S. Department of Energy
DQA	data quality assessment
DQO	data quality objective
EPA	U.S. Environmental Protection Agency
FS	feasibility study
GRA	general response action
HASP	health and safety plan
HPGe	high-purity germanium
IDW	investigation-derived waste
K_d	distribution coefficient
NAVD88	North American Vertical Datum 1988
OU	operable unit
PNNL	Pacific Northwest National Laboratory
PRG	preliminary remediation goal
PUREX	Plutonium/Uranium Extraction
QRA	qualitative risk assessment
RAO	remedial action objective
RAWP	remedial action work plan
RCRA	*Resource Conservation and Recovery Act of 1976*
RDR	remedial design report
REDOX	Reduction-Oxidation
RI	remedial investigation
RL	DOE, Richland Operations Office
ROD	record of decision
RPP	RCRA past-practice
SAP	sampling and analysis plan
SGL	spectral gamma-ray logging
TBP	tributyl phosphate
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
UNH	uranyl nitrate hexahydrate
URP	Uranium Recovery Process
WIDS	Waste Information Data System

METRIC CONVERSION CHART

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

1.0 INTRODUCTION

This work plan supports the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) remedial investigation/feasibility study (RI/FS) activities for the 200-MW-1 Miscellaneous Waste Group Operable Unit (OU). The 200-MW-1 OU is located in the 200 Areas near the center of the Hanford Site in south-central Washington State. The 200 Areas are within one of four areas on the Hanford Site that are on the U.S. Environmental Protection Agency's (EPA's) National Priorities List under CERCLA. The general CERCLA RI/FS process is described in the *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA 1988). The application of the CERCLA RI/FS process in the 200 Areas is described in the *200 Areas Remedial Investigation/Feasibility Study Implementation Plan - Environmental Restoration Program* (hereinafter referred to as the Implementation Plan) (DOE-RL 1999a); the Implementation Plan is summarized in Section 1.1 of this work plan.

The 200-MW-1 OU is the only OU defined in the Miscellaneous Waste Category in the *Waste Site Grouping for 200 Areas Soil Investigations* (DOE-RL 1997). Recently the Tri-Parties (the U.S. Department of Energy [DOE], the Washington State Department of Ecology, and the U.S. Environmental Protection Agency [EPA]) initiated negotiations to revise a number of legally enforceable milestone commitments that include modifying the number of 200 Area RI/FS work plans to be submitted. An agreement has been reached among the Tri-Parties that 200 Area waste site characterization work will be focused on 12 OUs that are representative of the 23 OUs that currently have milestones for work plan submittals. A fundamental concept that supports this approach is that each of the major waste categories will have at least one operable unit characterized. The Tri-Parties anticipate public comments on the draft milestone change requests in April 2002.

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Integration Project. Integration of the data collection activities with other projects on the Hanford Site results in more efficient and consistent remediation processes.

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 (CPP) sites; *Resource Conservation and Recovery Act of 1976* (RCRA) past-practice (RPP) sites; and RCRA treatment, storage, and/or disposal units. The plan outlines the framework for implementing assessment activities and evaluation of remedial alternatives in the 200 Areas to ensure consistency in documentation, level of characterization, and decision making. A regulatory framework is established in the Implementation Plan to integrate the requirements of RCRA and CERCLA into one standard approach for cleanup activities in the 200 Areas. This approach is illustrated in Figure 1-1. The 200-MW-1 OU consists entirely of CPP sites, with the EPA as the lead regulatory agency. The OU does not include any treatment, storage, and disposal units.

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

The Implementation Plan addressed more than 800 waste sites that were grouped into 23 process-based OUs, which in turn were grouped into 9 major waste categories (e.g., process waste, landfills, cooling water). This categorization facilitates the use of the analogous site approach, which was a fundamental concept under the Implementation Plan. As described in the Implementation Plan, the analogous site approach involves combining into groups waste sites with similar location, geology, waste site history, contaminants, and other characteristics. Within each group, one or more representative sites are then selected for comprehensive field investigations. Findings from site investigations at representative sites are extended to apply to other sites in the waste group that are not characterized. Sites for which field data have not been collected are assumed to have similar or "analogous" chemical and radiological characteristics to sites that were characterized. Confirmatory investigations of limited scope sampling of the analogous sites may be required to demonstrate that analogous conditions exist. The 200-MW-1 OU is the only OU within the Miscellaneous Waste Category.

1.2 SCOPE AND OBJECTIVES

This work plan documents OU-specific background information and defines OU-specific characterization and assessment activities and schedule based on the framework established in the Implementation Plan (DOE-RL 1999a), and identifies steps required to complete the RI/FS

process for the OU. Operable unit-specific detail is presented in this work plan, including background on the waste sites; existing data regarding contamination at the representative 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 for the OU is included, along with a schedule for the characterization work. Preliminary remedial action alternatives likely to be considered for this OU are identified in the work plan. These preliminary remedial alternatives will be further developed and agreed to in the FS, the proposed plan and the eventual record of decision (ROD).

A data quality objective (DQO) process was conducted for this OU to define the radiological and nonradiological constituents to be characterized and to specify the number, type, and location of samples to be collected at representative sites within the OU. The results of the DQO process form the basis for the work plan and the associated sampling and analysis plan (SAP) included in Appendix A. The SAP includes an OU-specific quality assurance project plan and a field sampling plan for implementing the characterization activities in the field.

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

1.3 CHANGE CONTROL

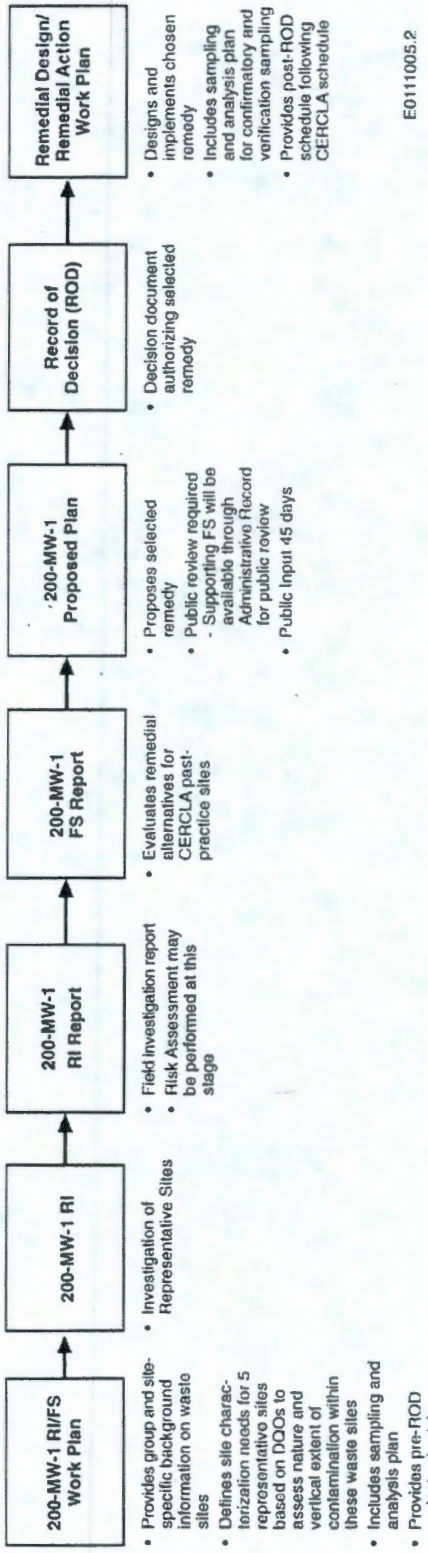
Following approval of the work plan, the major elements of the work plan (RI/FS steps) are requirements that are not expected to change, and as a result the work plan should not require modification. Specific work scope elements may require change or refinement as the work progresses. Changes that do not affect the overall intent of the approved work plan or schedule can be achieved using a change notice. Alternatively, and if agreed to by RL and the lead regulatory agency, unit managers' meetings or predecessor primary documents requiring RL and lead regulatory agency approval can also be used to document changes (e.g., the RI report can be used to document refinements to or focus the FS). Changes to the project schedule that impact assigned M-15 interim milestones will require approval through the Tri-Party Agreement change control process.

Changes to the remedial investigation scope detailed in the SAP may be required because of unexpected field conditions, new information, health and safety concerns, or other conditions. Minor changes that have no adverse effect on achieving the DQOs for the job or schedule can be

made in the field with the approval by the project manager or assigned task lead and documented in the field logbook and/or field summary reports. Changes that impact DQOs will require concurrence by RL and the lead regulatory agency and can be documented through unit managers' meetings. Alternatively, if substantial changes are required, the SAP can be revised and issued as a separate document requiring RL and regulator approval.

Additional discussion on work control can be found in Section 7.2.2 of the Implementation Plan (DOE-RL 1999).

Figure 1-1. Regulatory Process for the 200-MW-1 Operable Unit (Modified from DOE-RL 1999a).



2.0 BACKGROUND AND SETTING

This section describes the 200-MW-1 OU. Waste site information and the hydrogeologic conditions framework associated with this OU are described to provide a fundamental understanding of the physical setting and potential impacts on the environment. The information presented addresses the physical setting, waste site description and history, and waste generating processes. The section ends with a detailed discussion of each representative site. The representative sites are identified and discussed in Section 2.2.3. Summary information is provided in Table 2-1 for other OU waste sites that will not be immediately characterized but addressed in future planning efforts. Information in this section has been compiled from a number of sources, the most significant of which are listed below:

- *Remedial Investigation Data Quality Objectives Summary Report for the 200-MW-1 Operable Unit* (BHI 2002)
- *Waste Site Grouping for 200 Areas Soil Investigations* (DOE-RL 1997)
- *200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program* (DOE-RL 1999a)
- *PUREX Plant Source Aggregate Area Management Study Report* (DOE-RL 1993b)
- *T Plant Source Aggregate Area Management Study Report* (DOE-RL 1992b)
- *U Plant Source Aggregate Area Management Study Report* (DOE-RL 1992c)
- *Hanford Site Groundwater Monitoring for Fiscal Year 2000* (PNNL 2001b)
- *Evaluation of Scintillation Probe Profiles from 200 Area Crib Monitoring Wells* (Fecht et al. 1977)
- *Hanford Site Atlas* (BHI 1998)
- Waste Information Data System (WIDS).

2.1 PHYSICAL SETTING

The following is a summary of the geology and hydrology associated with the 200 Areas inclusive of the 200-MW-1 OU. More detail on the physical setting of the 200 Areas and vicinity is provided in Appendix F of the Implementation Plan (DOE-RL 1999a).

2.1.1 Topography

The 200-MW-1 OU includes waste sites located in both the 200 East and 200 West Areas on the 200 Area Plateau. The 200 Area Plateau is the common reference used to describe the broad, flat area that constitutes a local topographic high around the 200 Areas at the Hanford Site. The plateau was formed approximately 13,000 years ago during the cataclysmic Missoula floods. The northern boundary of the 200 Area Plateau is defined by an erosional channel that runs east-southeast before turning south just east of the 200 East Area. This erosional channel formed during waning stages of flooding as floodwaters drained from the basin. The northern half of the 200 East Area lies within this ancient flood channel. A secondary flood channel running southward off the main channel bisects the 200 West Area. The buried former river and flood channels may provide preferential pathways for groundwater and contaminant movement.

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

2.1.2 Geology

The 200-MW-1 OU is located in the Pasco Basin on the Columbia Plateau. It is underlain by basalt of the Columbia River Basalt Group and a sequence of suprabasalt sediments. From oldest to youngest, major geologic units of interest are the Elephant Mountain Basalt Member, the Ringold Formation, the Plio-Pleistocene unit, the Hanford formation/Plio-Pleistocene unit (?), and the Hanford formation. The fluvial-lacustrine Ringold Formation is informally divided into several informal units (from oldest to youngest): unit A, lower mud, unit E, and upper unit. It is overlain by a Plio-Pleistocene-aged unit in the 200 West Area consisting of a locally derived subunit that is interpreted to be a weathered surface that developed on the top of the Ringold Formation (WHC 1994, Bjornstad 1990) and an eolian facies (Slate 1996). The eolian facies was originally described as a separate unit called the early "Palouse soil." A recently identified unit of questionable origin, referred to as the Hanford formation/Plio-Pleistocene unit (?), is reported in the northeast corner of the 200 East Area. This unit may be equivalent or partially equivalent to the Plio-Pleistocene or it may represent the earliest ice age flood deposits overlain by a locally thick sequence of fine-grained nonflood deposits (Wood et al. 2000). Glaciofluvial cataclysmic flood deposits of the Hanford formation are present in both the 200 East and 200 West Areas. Hanford formation deposits consist of gravel-dominated and sand-dominated sequences. A generalized stratigraphic column for the 200 East and 200 West Areas is shown in Figure 2-1.

The Elephant Mountain Basalt Member is a medium- to fine-grained tholeiitic basalt with abundant microphenocrysts of plagioclase (DOE 1988). Basalt is overlain by the Ringold Formation over most of the 200 East Area and all of the 200 West Area. This formation consists of an interstratified sequence of unconsolidated clay, silt, sand, and granule to cobble gravel

deposited by the ancestral Columbia River. The fluvial-lacustrine Ringold is informally divided into several units; these are (from oldest to youngest) the fluvial gravel and sand of unit A, the buried soil horizons and lake deposits of the lower mud sequence, the fluvial sand and gravel of unit E, and the lacustrine mud of the upper Ringold.

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

Where the Ringold Formation and Plio-Pleistocene unit are not present, the Hanford formation/Plio-Pleistocene unit (?) and Hanford formation sediments overlie the basalt. The Hanford formation/Plio-Pleistocene unit (?) is made up of two facies and has only been identified in the 200 East Area near the B-BX-BY Tank Farms. The lower facies overlies basalt and is described in Wood et al. (2000) as loose, unconsolidated sandy gravel to gravelly sand. These gravels contain 50% to 70% basalt and are similar to and often indistinguishable from Hanford formation flood gravels in the absence of the second facies. The second facies consists of an olive brown to olive gray, well-sorted calcareous eolian/overbank silt with laminations, as well as pedogenic structures. However, it has also been observed to be massive and void of any sedimentary or pedogenic structures. The Hanford formation consists of unconsolidated gravel, sand, and silts deposited by cataclysmic floodwaters. These deposits consist of gravel-dominated and sand-dominated facies. The gravel-dominated facies consist of cross-stratified, coarse-grained sands and granule to boulder gravel. The gravel is uncemented and matrix poor. The sand facies consists of well-stratified fine- to coarse-grained sand and granule gravel. Silt in these facies is variable and may be interbedded with the sand. Where the silt content is low, an open-framework texture is common. An upper and lower gravel unit and a middle sand facies are present in the study area.

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

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

2.1.3 Vadose Zone

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

In the 200 West Area, the vadose zone thickness ranges from 79 m (261 ft) in the southeast corner to 102 m (337 ft) in the northwest corner. Sediments in the vadose zone are the Ringold Formation, the Plio-Pleistocene unit, and the Hanford formation. Erosion during cataclysmic flooding removed some of the Ringold Formation and Plio-Pleistocene unit.

Perched water has historically been documented above the Plio-Pleistocene unit at 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.

2.1.4 Groundwater

The unconfined aquifer in the 200 Areas occurs within the Hanford formation/Plio-Pleistocene unit (?), the Hanford formation, or the Ringold Formation, depending on location. Groundwater in the unconfined aquifer flows from recharge areas where the water table is higher (west of the Hanford Site) to areas where it is lower, near the Columbia River (PNNL 2000b). In the northern half of the 200 East Area, the water table is present within the Hanford formation, except in areas where basalt extends above the water table. Near the B-BX-BY waste management area, the water table occurs within the Hanford formation/Plio-Pleistocene unit (?). In the central and southern sections of the 200 East Area, the water table is located near the contact of the Ringold and Hanford Formations.

Depth to the water table in the 200 East Area and vicinity ranges from about 54 m (177 ft) near B Pond to over 104 m (340 ft) near the southern section. The water table across the 200 East Area is very flat (Figure 2-2), making it difficult to determine groundwater flow direction based on water level measurements from monitoring wells. The configuration of contaminant plumes, however, indicates that groundwater flows to the northwest in the northern half of the 200 East Area and to the east/southeast in the southern half of the 200 East Area. Identifying the specific location of the groundwater divide between the northern and southern sections is hampered by

the flat water table. Highly transmissive Hanford formation sediments are the cause of the flat water table in the 200 East Area (PNNL-2000b). Since surface liquid discharges were terminated in the 200 East Area, the water table has been declining rapidly, at a rate of about 0.13 m/yr (0.4 ft/yr) based on measurements collected between March 1999 and April 2001 (PNNL 2000b). Groundwater flow beneath the 216-A-4 Crib waste site is believed to be to the southeast based on contamination migration patterns from the Plutonium/Uranium Extraction (PUREX) cribs (PNNL 2000b).

Groundwater beneath the 200 West Area occurs primarily in the Ringold Formation. Depth to water varies from about 50 m (164 ft) to greater than 100 m (328 ft). Groundwater flow is predominately to the east (Figure 2-2). The surface elevation of the water table beneath the 200 West Area is currently dropping at a rate of 0.41 m/yr (1.3 ft/yr) (PNNL 2001b).

Recharge to the unconfined aquifer within the 200 Areas is from artificial and possibly natural sources. Any natural recharge originates from precipitation. Estimates of recharge from precipitation range from 0 to 10 cm/yr (0 to 4 in./yr) and are largely dependent on soil texture and the type and density of vegetation. Artificial recharge occurred when effluent such as cooling water was disposed to the ground. Zimmerman et al. (1986) report that between 1943 and 1980, 6.33×10^{11} L (1.67×10^{11} gal) of liquid wastes were discharged to the soil column. Most sources of artificial recharge have been halted. The artificial recharge that does continue is largely limited to liquid discharges from sanitary sewers, 2 state-approved land disposal structures, and 140 small-volume, uncontaminated, miscellaneous streams. One of the approved land disposal structures, the Treated Effluent Disposal Facility (a liquid waste disposal facility), is located 600 m (2,000 ft) east of the 216-B-3C lobe and receives plant-treated liquid wastes from the 200 East and 200 West Area facilities.

2.1.5 Summary of Hydrogeologic Conditions at Representative Sites

Lithology, stratigraphy, and general location information about each of the representative waste sites is presented in this section.

2.1.5.1 216-A-4 Crib. The 216-A-4 Crib is located in the southern half of the 200 East Area on the Cold Creek bar (DOE-RL 1993b). The surface at this site is 217.78 m (714.49 ft) NAVD88. Stratigraphic units at this site (in ascending order) consist of basalt of the Elephant Mountain Member, Ringold Formation (units A, lower mud, and E), and the Hanford formation sand- and gravel-dominated sequences. The Hanford formation and part of unit E of the Ringold Formation occur within the vadose zone. The stratigraphy at the 216-A-4 Crib is based on data from wells 299-E24-54 and 299-E24-9 (Figure 2-3). Groundwater beneath 216-A-4 Crib occurs within unit E of the Ringold Formation, about 95.07 m (311.9 ft) below ground surface (bgs).

2.1.5.2 216-T-33 Crib. The 216-T-33 Crib is located in the north section of the 200 West Area on the Cold Creek bar (DOE-RL 1992b). The surface at this site is 220.04 m (721.9 ft) NAVD88. Stratigraphic units at this site (in ascending order) consist of basalt of the Elephant Mountain Member; three units of the Ringold Formation (units A, lower mud, and E); the undifferentiated early Palouse soil/Plio-Pleistocene units; and the Hanford formation sand- and gravel-dominated sequences. Of these units, the Ringold E, the undifferentiated early Palouse

soil/Plio-Pleistocene units, and the Hanford formation are within the vadose zone and are the principal units of interest in this site. The stratigraphy at the 216-T-33 Crib is shown in Figure 2-4 and is based on the geology at well 299-W11-14. Groundwater beneath the 216-T-33 Crib occurs within the Ringold Formation unit E, about 83.14 m (272.76 ft) bgs.

2.1.5.3 216-T-13 Trench. The 216-T-13 Trench is located in a north-south-trending secondary flood channel in the Cold Creek Bar in the 200 West Area (DOE-RL 1992b). The surface at this site is 204.81 m (671.96 ft) NAVD88. Stratigraphic units at this site (in ascending order) consist of basalt of the Elephant Mountain Member, four units of the Ringold Formation (units A, lower mud, E, and upper), the undifferentiated early Palouse soil/Plio-Pleistocene units, and the Hanford formation sand- and gravel-dominated sequences (Woods et al. 2001). Of these units, the Ringold E, the upper Ringold, the undifferentiated early Palouse soil/Plio-Pleistocene units, and the Hanford formation are within the vadose zone and are the principal units of interest in this site. The stratigraphy at the 216-T-13 Trench is shown in Figure 2-5 and is based on the geology at well 299-W10-17. Groundwater beneath the 216-T-13 Trench occurs within the Ringold Formation unit E, about 66.96 m (219.7 ft) bgs.

2.1.5.4 216-U-3 French Drain. The 216-U-3 French Drain is located in the southern half of the 200 West Area within a north-south-trending secondary flood channel (DOE-RL 1992c). The surface at this site is 204.78 m (671.85 ft) NAVD88. Stratigraphic units at this site (in ascending order) consist of basalt of the Elephant Mountain Member, three units of the Ringold Formation (units A, lower mud, and E), the undifferentiated early Palouse soil/Plio-Pleistocene units, and the Hanford formation sand- and gravel-dominated sequences. Of these units, the Ringold E, the undifferentiated early Palouse soil/Plio-Pleistocene units, and the Hanford formation are within the vadose zone and are the principal units of interest in this site. The stratigraphy at the 216-U-3 French Drain is shown in Figure 2-6 and is based on the geology at well 299-W19-1. Groundwater beneath the 216-U-3 French Drain occurs within the Ringold Formation unit E, about 66.98 m (219.75 ft) bgs.

2.1.5.5 200-E-4 French Drain. The 200-E-4 French Drain is located in an east-west-trending secondary flood channel in the northern half of the 200 East Area (PNNL 2000c). The surface at this site is approximately 210.5 m (690.6 ft) NAVD88. Stratigraphic units at this site (in ascending order) consist of basalt of the Elephant Mountain Member, Ringold Formation (unit A), and the Hanford formation sand-dominated sequence (BHI 1995a). The Hanford formation and Ringold Formation unit A occurs within the vadose zone. The stratigraphy at the 200-E-4 French Drain is based on data from borehole 299-E27-126 and well 299-E24-8 (Figure 2-7). Groundwater beneath the 200-E-4 French Drain occurs in the Ringold Formation unit A, about 87.84 m (288.19 ft) bgs.

2.2 WASTE SITE DESCRIPTION AND HISTORY

The actual waste sites assigned to this OU in the Implementation Plan (DOE-RL 1999a) have been revised by the addition of new waste sites and reclassification of accepted waste sites in accordance with TPA-MP-14 (DOE-RL 1998). Section 4.1 describes the method used during the

DQO process to determine the waste sites that this work plan will consider (Table 2-1). The following are source waste streams from which 200-MW-1 OU waste sites received waste:

- 221-B/Bismuth phosphate process operations (B Plant)
- T Plant
- U and UO_3 Plants
- Reduction-Oxidation (REDOX) Plant (S Plant)
- PUREX Plant (A Plant)
- Z Plant complex
- Semi-Works Plant (C Plant)
- Critical Mass Laboratory
- SX Tank Farm
- U Tank Farm.

All of the 200-MW-1 waste sites are located within the 200 Area exclusive-use boundary as defined in the *Final Hanford Comprehensive Land-Use Environmental Impact Statement* (DOE 1999) (Figure 2-8). Figures 2-9 through 2-12 depict the location of the waste sites.

Summary information on 200-MW-1 OU waste sites is presented in Section 2.2.3 and Table 2-1.

2.2.1 200 Area Plant History

The following discussion summarizes historical information on facilities in the 200 Areas that were sources of liquid wastes disposed to the 200-MW-1 sites.

B Plant. B Plant was constructed in 1944. From 1945 to 1952, B Plant operations consisted of a batch-wise, inorganic chemical separation of weapons-grade plutonium from irradiated uranium. This was known as the bismuth phosphate/lanthanum fluoride process. From 1952 to 1965, B Plant was used for waste treatment operations. In 1963, the 221-B Building began recovering strontium, cerium, and rare earths as part of the Phase I processing for the 221-B Building Waste Fractionalization Project. Phase I processing at the 221-B Building ended in June 1966 to accommodate Phase II construction. The Phase III waste fractionalization processing began at the 221-B Building in 1968. This process separated the long-lived radionuclides, strontium-90 and cesium-137, from high-level PUREX and REDOX wastes, and stored a concentrated solution of strontium-90 and cesium-137 at the 221-B Building. In 1968, B Plant underwent renovations and the Waste Encapsulation and Storage Facility was added to concentrate, encapsulate, and store radioactive waste. Waste fractionalization and encapsulation efforts continued until 1986 (DOE-RL 1993a). The 222-B Laboratory supported operations at the 221-B Building complex and other 200 Area facilities from 1945 to 1952. The liquid waste stream generated from the laboratory included sample disposal waste, hood, and radiological hot cell cleanup waste. Sampling and testing equipment, gloves, empty containers, and other materials were buried as solid waste.

T Plant. T Plant was constructed in 1944. From 1945 to 1956, T Plant operations consisted of a batch-wise, inorganic chemical separation of weapons-grade plutonium from irradiated uranium. This was known as the bismuth phosphate/lanthanum fluoride process. In 1957, the 221-T Building was converted to a decontamination and equipment refurbishment facility. The facility provided services in radioactive decontamination, reclamation, and decommissioning of process equipment. It currently still serves the Hanford Site in this capacity. A series of testing programs by Pacific Northwest National Laboratory and the Westinghouse Hanford Company also occurred intermittently from 1964 to 1990 (DOE-RL 1992b, 1993a, 1993c). The 222-T Laboratory supported operations at the 221-T Building from 1945 to 1956. After 1956, all laboratory analyses of T Plant operations were sent to the 222-S Laboratory. The liquid waste stream generated from the laboratory facility that included sample disposal waste and hood and hot cell cleanup waste. Sampling and testing equipment, gloves, empty containers, and other materials were buried as solid waste (DOE-RL 2001, 2002a).

U Plant. U Plant was constructed in 1944 and included the 221-U Canyon Building and the 224-U Building. U Plant was based on the design of T and B Plants and was initially used to train personnel for the bismuth/phosphate plutonium separation and purification operations. During the training phase, only water was used in the plant systems, and no waste streams were generated. However, in 1951, U Plant was modified for the Uranium Recovery Process (URP). From 1952 to 1958, U Plant was used to recover uranium from bismuth/phosphate wastes stored in the single-shell tanks for reuse in the reactor plants. A later operation conducted at U Plant was the "scavenging" or precipitation of long-lived fission products during the liquid waste settling process before discharge to the soil column.

The 222-U Laboratory, located directly southeast of the 221-U Building, was used from about 1947 to 1970 for laboratory analysis in support of the URP and the UO_3 process. Various small-scale experiments and soil tests were done inside the facility.

The final operation of U Plant involved converting uranyl nitrate hexahydrate (UNH) to uranium trioxide (UO_3). This operation was accomplished by calcining the UNH in a batch process within the 224-U Building. In 1957, the batch conversion of UNH to UO_3 was renovated. The operation was updated to a continuous flow, and the 224-U Building became known as the UO_3 Plant (DOE-RL 1992c). The UO_3 Plant operated from 1958 until 1972 when PUREX was put in "stand-down." During that time, the UO_3 Plant converted UNH from the PUREX and REDOX Plants to UO_3 powder. The UO_3 Plant resumed operations in 1984 to process UNH from the PUREX Plant. As the feed lines from REDOX and 221-U were no longer in use, they were disconnected and capped in the UO_3 Plant. UO_3 Plant operations ceased in 1988 (DOE-RL 1992c, 2001, 2002a).

REDOX Plant. The Reduction/Oxidation or REDOX Plant (also known as "S Plant") was the first continuous plutonium separation operation at the Hanford Site. Not only did REDOX separate weapons-grade plutonium from the irradiated fuel rods, but it recovered the uranium as well. REDOX was a solvent extraction process that used hexone and aluminum nitrate nonahydrate (ANN) in nitric acid to complete these separations. Plant operations began in 1952 and continued until 1967 (DOE-RL 1992a). The 222-S Laboratory is one of the primary waste generators in the S Plant Aggregate Area. It was constructed during 1950 and 1951 and is

located immediately south of the 202-S Building. The laboratory provides high-level and low-level radiological and nonradiological analytical services for operations in the 200 Areas. It continues to support Hanford Site operations with emphasis on waste management, offsite shipment certification, chemical processing, and environmental monitoring programs throughout the 200 West and 200 East Areas including B Plant, U Plant, the tank farms, 242-A and 242-S Evaporators, Waste Encapsulation and Storage Facility, PUREX Plant, and Plutonium Finishing Plant (Z Plant) (DOE-RL 2002a).

PUREX Plant. The separation process used at the PUREX Plant (also known as "A Plant") replaced the REDOX separation process. The PUREX process used a recoverable salting agent (nitric acid) that proved to be economically more feasible, generated less waste, and operated more safely than the REDOX process. The construction of the PUREX Plant was completed in late 1955. The PUREX Plant operated continuously from November 1955 until 1972, separating plutonium and uranium products from irradiated fuel. PUREX was put on standby from 1972 until 1983. PUREX restarted in 1983 and continued operations until 1985 when it was deactivated. The 202-A Laboratory supported PUREX operations at the 202-A Building from 1955 to 1972, and again from 1983 to 1988. However, other samples from the PUREX facility were also sent to 222-S Laboratory for analysis (DOE-RL 1993b, 2002a).

The Z Plant Complex. From 1945 until 1990, the Z Plant complex was used to isolate and purify plutonium solutions, produce metallic plutonium and plutonium oxides, and recover plutonium and americium from plutonium scrap materials. Throughout its lifetime, the Z Plant complex (Plutonium Finishing Plant) received different types of processed (uranium and fission products removed) plutonium solutions from each of the 200 Area separations facilities. Beginning in 1944, plutonium from T and B Plants was refined and converted to a nitrate paste in the 231-Z Building prior to shipment offsite. In 1949, after the 234-5Z Building was constructed and operating, plutonium nitrate pastes were no longer produced. The 231-Z Building was then converted into a plutonium metallurgy laboratory and operated in this capacity during the 1950s until the 1970s. The research included tensile strength, stress testing, coating, and other material science properties of plutonium and plutonium alloys. Beginning in the 1960s, the Atomic Energy Commission's Division of Military Application began design, development, and fabrication of experimental weapons that supported the weapons testing program at the Nevada Test Site. Other projects including "state of the art" sampling methods for plutonium buttons, new coating processes, and development work in reactor fuels containing plutonium and other alpha-emitting materials were also completed at the 231-Z Building in the late 1960s and early 1970s. In 1975, the Division of Military Application experimental work was phased out (DOE-RL 2002a).

Semi-Works Plant. The 201-C Process Building was the main processing facility for the Semi-Works Plant. During its history the 201-C Process Building went through three distinct operational modes. The 201-C Process Building was constructed in 1949 as a pilot plant for reprocessing reactor fuel using the REDOX (S Plant) chemical process and later the PUREX chemical process in 1954. In 1961, it was again converted to recover strontium from fission product waste. Cerium, technetium, and promethium, as well as minor amounts of americium and curium in the final production run, were also extracted. This facility operated until 1967. The facility remained in safe storage mode until decommissioning began in 1983.

The 276-C Solvent Handling Facility and the 215-C Gas Preparation Building have been decontaminated for reuse. The 2707-C Storage and Change House and the 271-C Aqueous Makeup & Control Building have been decontaminated and dismantled. Portions of the 201-C Process Building and the 291-C Ventilation System have been dismantled, while other portions have been entombed on site. The initial base layer of bottom ash has been put in place; however, construction was suspended in 1989 when CERCLA activities superceded decommissioning activities at Semi-Works (DOE-RL 1993c).

Critical Mass Laboratory. The Critical Mass Laboratory (209-E Building) was operated from 1960 to 1987 by the Pacific Northwest Laboratory (PNL). Criticality experiments and research were conducted at this location. Currently the laboratory is closed, and the facility was transferred to Westinghouse Hanford Company for use by Waste Tank Management.

241-SX Tank Farm. The SX Tank Farm contains 15 single-shell tanks that were constructed in 1953 to 1954 to contain hot, self-boiling waste in support of the REDOX process. The bases of the tanks were placed 17 to 18 m (56 to 59 ft) bgs and consist of vertical cylinders constructed with carbon-steel liners surrounded by reinforced concrete. The tank top is an ellipsoidal concrete dome covered with 1.8 to 2.7 m (6 to 9 ft) of soil/gravel fill on top. The tanks have been removed from liquid processing services and pumped to minimum supernatant heel and are awaiting stabilization. Each tank has a 22.9 m (75 ft) diameter and can contain approximately 1 million gallons. Standard operations at the SX Tank Farm include cooling operations, core and air sampling activities, liquid level monitoring, lateral monitoring, surface level monitoring, temperature monitoring, in-tank photography, dry well monitoring, dome elevation monitoring, waste sampling, filter changing, and salt well pumping (RHO 1985, DOE-RL 1999b).

241-U Tank Farm. The 241-U Tank Farm contains 16 single-shell tanks, 12 with the capacity of 1,892,700 L (500,000 gal) each and 4 smaller tanks with the capacity of 208,197 L (55,000 gal) each. The tanks are arranged in groups of three for usage of the settling cascade concept in which waste solutions were passed in series through three tanks. Cooling and precipitation occurred in each tank causing the bulk of the radionuclides to collect in the tank's bottoms. To prevent the wastes from heating up, air-cooled reflux condensers were installed that returned the condensate to the tank and vented the noncondensables to the atmosphere. There are several dry wells within the tank farm that were used to monitor the soil for radioactivity, thus serving as a leak detection system. The tank farm was constructed between 1943 and 1944, began operation in 1946, and completed its last documented transfer in 1979.

2.2.2 Process Information

The 200-MW-1 wastes included wastes from several 200 Area processes, including the following:

- Bismuth/phosphate and lanthanum/fluoride (B and T Plants)
- Uranium recovery and scavenging operations (U Plant)
- REDOX

- PUREX
- Strontium/cesium separations, recovery, and storage operations (Semi-Works)
- Critical Mass Laboratory
- Plutonium/americium scrap recovery processes (RECUPLEX, Plutonium Recovery Facility, and americium recovery) along with several experiments including tritium production, uranium, plutonium, and thorium studies (Z Plant)
- 200 Area decontamination wastes which included wastes from the T Plant complex after it was converted to a decontamination and equipment refurbishment facility in 1957. The 2706-T Building was used to steam clean heavy equipment and vehicles
- SX Tank farm cooling water condensates
- U Tank farm tank condensate.

The processes conducted in the 200 Area facilities (i.e., B/T, U/UO_3, REDOX, PUREX, Semi-Works Plants, and the Z Plant complex) that generated the primary waste streams into the 200-MW-1 OU waste sites included the processes discussed in the following paragraphs.

B and T Plants. The bismuth/phosphate process was an inorganic, step-wise, precipitation process that separated plutonium from uranium and fission products. This process occurred in the 221-B/T canyon building and used sodium hydroxide to remove the aluminum cladding and concentrated nitric acid to dissolve the fuel rods. Bismuth phosphate and bismuth oxynitrate were used to support precipitation of plutonium, while hydrogen peroxide, sodium dichromate, ferrous hydroxide, and ferrous ammonium sulfates were used to change the plutonium valence during the oxidation reactions. Phosphoric, sulfuric, and nitric acids were added to dissolve the precipitants formed. The bismuth/phosphate process preferentially attracted plutonium from the solution and, as a precipitate, was physically separated by centrifuging.

The lanthanum/fluoride process was performed in the 224-B/T Building and further purified the dilute plutonium solution created in the last step of the bismuth/phosphate process. The dilute plutonium nitrate supernatant was oxidized with sodium metabismuthate. Phosphoric acid was added to precipitate impurities and the resulting solution treated with oxalic and hydrofluoric acids and lanthanum salt. As a result, lanthanum fluoride and plutonium fluorides were co-precipitated. The lanthanum and plutonium fluoride solids were then converted to hydroxides by the addition of a hot potassium hydroxide solution. The hydroxides were washed with water, dissolved in nitric acid, and heated to form a concentrated plutonium nitrate solution. This solution was sent to the isolation building (231-Z) for further purification treatments and evaporation. A concentrated plutonium nitrate paste was the final product. For every batch (760 L [200 gal]) of dilute, unpurified plutonium solution entering the 224-B/T Building, an estimated 30 L (8 gal) of purified concentrated weapons-grade plutonium was produced

(GE 1944). Laboratory liquid wastes were directed to other waste sites in the waste category from 1945 to 1952.

Uranium Recovery Process (URP) U/UO_3 Plant and Scavenging Operations. The URP was implemented at U Plant to recover the spent uranium from the metal waste and first-cycle waste streams generated in T and B Plants for reuse in weapons-grade plutonium production. The URP was performed in three phases. The first phase included the removal of bismuth/phosphate waste (metal waste, first-cycle supernatants, and cell 5 and 6 drainage) from T, TX, TY, B, BX, and BY Tank Farms and preparation of the sludge/slurry solution using nitric acid to dissolve the uranium metal and jet it into the plant. The second phase consisted of the separation of the uranium from remaining plutonium, fission products, and chemicals by a solvent extraction process. The counter-current solvent extraction process used tributyl phosphate (TBP) in a normal paraffin hydrocarbon diluant such as AMSCO or kerosene to bond with the uranium. Sulfamic acid and ferrous ammonia sulfate were used to ensure the correct valence states was obtained. The separated UNH was then sent to the 224-U Building or the UO_3 Plant where it was heated (to 400°F) to drive off nitrate, resulting in UO_3. The UO_3 powder was removed from the vessels, packaged, and shipped offsite to Oak Ridge, Tennessee. There the UO_3 powder was converted to uranium metal and then sent back to the 300 Area at the Hanford Site to be reincorporated into the uranium fuel rod production (GE 1951b).

In 1953, tests to further treat URP aqueous waste streams generated at T, U, and B Plants during the bismuth/phosphate campaign proved successful. The "scavenging" process separated the long-lived fission products (including strontium-90 and cesium-137) from the waste solutions by precipitation. The order of operations was often modified throughout the duration of the scavenging process. After URP processing, TBP column wastes were sent to a neutralization tank at U Plant where the pH was adjusted to 9 ± 1. Chemicals used to scavenge fission products included potassium and sodium derivatives of the metal/ferrocyanide complex ion. The most notable and widely used metals (used to assist precipitation) were iron, nickel, and cobalt. Calcium nitrate and/or strontium nitrate were often added to enhance the precipitation of strontium-90. Phosphate ions were also added to aid the soil retention of strontium-90. After the TBP waste had been scavenged, it was returned to the B, BX, BY, T, TX, and TY Tank Farms to allow the solids (containing the fission products and scavenging chemicals) to settle. The waste liquid was sampled from the tanks at various depths and analyzed before the liquid effluent was sent to cribs and/or trenches pending the concentrations of cesium-137 and strontium-90 or was rerouted to other nearby tanks where settling continued. The U/UO_3 and scavenging operations process samples were analyzed at the 222-U or 222-S Laboratories. Liquid waste was disposed from the 222-U Laboratory to other sites in the waste category.

REDOX. The REDOX process was a solvent-extraction process that extracted plutonium and uranium from dissolved fuel rods into a methyl isobutyl ketone (or hexone) solvent. The solvent-extraction process was based on the preferential distribution of uranyl nitrate and the nitrates of plutonium between an aqueous phase and an immiscible organic phase (DOE-RL 1992a). The REDOX process included fuel decladding with boiling sodium hydroxide/sodium nitrate solution or a boiling solution of ammonium fluoride and ammonium nitrate. Feed dissolution using concentrated nitric acid and plutonium oxidation was completed simultaneously with potassium permanganate and sodium dichromate. The prepared feed

entered the packed counter-current solvent extraction column where acidified hexone was fed to the bottom of the column and the aqueous phase (ANN scrub solution or salting agent) was fed to the column from the top. The aqueous solubility of the uranium and plutonium nitrates was reduced by increasing the nitrate concentration in the aqueous phase. The uranium and plutonium were extracted into the organic phase and routed to the second extraction column while the fission products remained in the aqueous phase. Uranium and plutonium (present in the organic phase) were chemically separated in the second extraction column using ferrous sulfamate solution containing ANN to reduce the plutonium to the +III valence state. Further purification cycles of uranium and plutonium were conducted during operations using the same chemical constituents. The solvent was recovered and recycled back into the process after sampling and analysis. Waste generated in the 202-S Building was also treated and routed to cribs after sampling and analysis. Radioactive and radioactive mixed liquid wastes from the laboratory were treated in the 219-S Waste Handling Facility. Laboratory wastewater (along with wastewater from the 291-S Stack Complex and 219-S Waste Handling Facility) was then directed through the 207-SL Retention Basin and ultimately to the 216-S-26 Crib and other sites in the waste category. The 222-SA Chemical Standards Laboratory contributed nonradiological, nonhazardous wastewater downstream of the 207-SL Retention Basin.

PUREX. The PUREX process was an advanced solvent extraction process that replaced the REDOX process. PUREX used a recyclable salting agent, nitric acid (which greatly lessened costs and amount of waste generated), and TBP in a normal paraffin hydrocarbon solution as a solvent. The main purpose of the PUREX facility (202-A) was to extract, purify, and concentrate plutonium, uranium, and neptunium contained in irradiated uranium fuel rods discharged from Hanford Site reactors. Fuel decladding was performed with a boiling sodium hydroxide/sodium nitrate solution or a boiling solution of ammonium fluoride and ammonium nitrate. Feed dissolution used concentrated nitric acid and ANN. The prepared feed entered the pulsing, counter-current solvent extraction column where TBP in a normal paraffin hydrocarbon diluant was fed to the bottom of the column and the aqueous phase (sodium nitrite/nitric acid salting agent solution) was fed to the column from the top. Dilute nitric acid, ferrous sulfamate, and sulfamic acid descended from the top of the second column to remove uranium and neptunium from plutonium. Chemical separation processes were based on conducting multiple purification operations on the resulting aqueous nitrate solution containing each of the separated products. The driving forces for the separations consisted of varying partition coefficients between aqueous and organic phases; controlled by valence state changes of the element of interest (DOE-RL 1993b). The solvent and salting agent (nitric acid) were both recovered, treated, and recycled back into the process operations. An analytical laboratory was also located within the 202-A facility. Waste generated by the 202-A Laboratory operations were routed to the 216-S-20 Crib and other sites in the waste category.

Semi-Works. The 201-C Process Building and 209-E Critical Mass Laboratory comprise the Semi-Works Plant. During its history, the 201-C Process Building went through three distinct operational modes. These operations included pilot-plant testing for REDOX, PUREX, and the strontium recovery process. The strontium recovery process was performed via solvent extraction using a complexant di-2-ethyl-hexyl phosphoric acid to extract strontium from acid solutions of waste fuels.

Critical Mass Laboratory. The Critical Mass Laboratory (209-E Building) conducted criticality experiments from 1960 to 1983 using plutonium nitrate and enriched uranium solutions. Criticality research was also conducted with solid nuclear materials and fuels such as plutonium blocks, uranium blocks and slabs, and fuel assemblies from the Fast Flux Test Facility and other reactors (DOE-RL 1993c). Process samples from Semi-Works operations were often sent and analyzed at the 222-S Laboratory. Liquid waste effluents derived from this analysis at the 222-S Laboratory were routed to the 216-S-20 Crib and other sites in the waste category. Waste streams included condensates and drainages from the 209-E equipment room steam traps, heat exchangers, high-efficiency particulate air (HEPA) filters were sent to the 200-E-4 and 209-E-WS-2 French Drains. Contact with radionuclides and nonradiological constituents may have resulted from process upsets and equipment malfunctions, stress fractures, etc., occurring during experimental process operations (DOE-RL 1993c).

Plutonium Isolation Facility (231-Z). The 231-Z Building had several missions throughout its operation. From 1945 to 1949, it further decontaminated plutonium product from both T and B Plants before shipment offsite. This process consisted of adding ammonium nitrate to the plutonium nitrate solution and thus changing the valence state. Next, sulfates and peroxide were added to the mixture, causing plutonium to precipitate as plutonium peroxide. Nitric acid was added to this precipitate, forming a more concentrated plutonium nitrate solution. This product was placed in small shipping containers and boiled using hot air to form a wet plutonium nitrate paste prior to shipment offsite. In 1949, the 231-Z Building was converted into a plutonium metallurgy laboratory and operated in this capacity from the 1950s until the 1970s. The research included tensile strength, stress testing, coating, and other material science properties of plutonium and plutonium alloys. Beginning in the 1960s, the Atomic Energy Commission's Division of Military Application began design, development, and fabrication of other experimental weapons that supported the weapons testing program at the Nevada Test Site. Other projects including "state of the art" sampling methods for plutonium buttons, new coating processes, and development work in reactor fuels containing plutonium and other alpha-emitting materials were also completed at the 231-Z Building in the late 1960s and early 1970s.

200 Area Decontamination Wastes. The decontamination of heavy equipment and vehicles was conducted in the 200 West Area.

Contamination of heavy equipment, railcars, and vehicles usually consisted of particles of fission products (e.g., cesium and strontium). These particles were drawn into the radiator and other engine components and became attached to oily surfaces of the engine compartment. To continue use of this equipment, a decontamination facility was established at the 269-W garage. Removal of contamination was accomplished using commercial cleaners (Actresol, Kerful Cleaner, Aeso Wash) and a steam jet spray on the radiators, engines, and undercarriages. Painted automobile surfaces and all interior surfaces and materials were hand cleaned using mild detergents such as Calgon. Sometimes external surfaces required more stringent methods, such as aggressive chemicals like Kleeno Bowl and other harsh acids and caustics, and occasional sandblasting (Kingsley and Short 1960).

These decontamination operations initially were performed outdoors in open pit areas such as the 216-U-13 Trench (1952 to 1956) and the 216-T-13 Trench (1954 to 1964). These sites had

limited facilities for handling steam and water. Provisions for waste collection, drainage, and disposal were considered unsatisfactory. Cold and inclement weather further complicated the work. In 1964, a new decontamination facility, the 2706-T Building (originally known as 2706-W), was completed. This facility provided improved steam, high-pressure water, and chemical cleaning capabilities for all of the site's railroad equipment and heavy and light duty automotive equipment. Means for adding chemicals to the steam spray or high-pressure water were made available. Adequate waste collection, drainage, and disposal facilities were provided. Commercial chemicals were tested for their application to this decontamination work. Among the waste sites used for disposal of decontamination wastes from the 2706-T Building were the 216-T-33 Crib in the 200-MW-1 OU and the 216-T-27 and 216-T-28 Cribs in the 200-LW-1 OU. After the line to the 216-T-33 Crib plugged in February 1963, waste was routed to the 216-T-28 Crib. The 216-T-27 and 216-T-28 Cribs were active from February 1960 to December 1966.

Over the course of equipment decontamination and refurbishment operations at the various facilities, numerous chemical compounds were used. *Inventory of Chemicals Used at Hanford Site Production Plants and Support Operations* (WHC 1990a) provides a listing of compounds that were used at either 221-T or at U Plant over the period from 1961 through 1980. It is assumed that similar compounds were used prior to this effort at other decontamination sites and at other facilities such as 2706-T. Records from decontamination activities that took place at the operating reactor facilities in the 100 Areas identify a similar list of compounds. While consumer products such as Tide® or SANI-FLUSH® Toilet Bowl Cleaner were potentially used, they are not included since the quantities are expected to be small. In addition, only where the compounds that make up commercial products can be identified are they included in screening of potential contaminants of concern (COCs).

The SX Tank Farm and Ancillary Facilities. Waste streams included equipment compressor condensates that originated from the 241-SX-701 Compressor House Building. This facility housed instrument air compressors needed to cool and dry all ventilation exhaust equipment associated with the self-boiling REDOX waste tanks in the SX Tank Farm. Also present is surface contaminated soil from the S, SX, and SY Tank Farms due to windblown specks or dust particles that were radioactively contaminated (RHO 1985, DOE-RL 1999b).

The U Tank Farm and Ancillary Facilities. The first liquid wastes to flow to the U Tank Farm were bismuth phosphate high-level wastes from T Plant. This waste, high in uranium content and radioactive fission products, was discharged from T Plant in an alkaline waste solution (pH of about 10.5). The U Tank Farm next received two high-level liquid waste streams generated from the U Plant that were ultimately transferred back to the 241-U Tank Farm for long-term storage. It also received high-level liquid waste from the REDOX Facility.

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2.2.3 Representative Sites

The concept of using analogous sites to reduce the amount of site characterization and evaluation required to support remedial action decision making is discussed in the Implementation Plan (DOE-RL 1999a). The use of this approach relies on grouping sites with similar waste site histories, and contaminants, then choosing one or more representative site(s) for comprehensive field investigations, including sampling. Findings from site investigations at representative waste sites are then extrapolated to the analogous sites in the waste group based on similarities of their conceptual contaminant distribution model.

Data from representative sites are used to evaluate remedial alternatives and to select one (or more) to apply for the entire waste group in the group-specific feasibility study. Confirmatory sampling at the analogous sites is built into the remedial design planning to ensure the remedy is appropriate for the analogous sites. Although a degree of uncertainty exists in employing the analogous site concept, substantial benefit is realized in the early selection of a remedy that allows early cleanup action to be performed. The Implementation Plan (DOE-RL 1999a) identified three representative sites for the 200-MW-1 OU: the 216-A-4 Crib, the 216-T-33 Crib, and the 216-U-3 French Drain. During the DQO process for the 200-MW-1 OU, these sites were confirmed, and the 216-T-13 Trench and 200-E-4 French Drain were selected as additional representative waste sites (see Section 4.1.1).

The following sections describe the representative sites in detail. The information presented was obtained from the WIDS database and WIDS historical files unless otherwise noted.

2.2.3.1 216-A-4 Crib. The 216-A-4 Crib or "cavern" is an inactive liquid waste disposal site located 79 m (260 ft) south of the 202-A Building and east of the 216-A-2 Crib. It is inside the PUREX exclusion fence (Figure 2-9). The term cavern was used during this time period to differentiate this underground seepage waste disposal facility from the standard Hanford Site "crib" made by cross-stacking timbers to form an underground box structure. The site consists of a square crib with perforated vitreous clay pipe in a gravel layer. Figure 2-13 shows the construction of the 216-A-4 Crib.

From 1955 to 1958, the crib received approximately 6,210,000 L (1,640,000 gal) of liquid waste (Stenner et al. 1988). The waste originated from the ventilation fans (fan bearing, fan turbine condensate, and control house drain), PUREX laboratory low-activity waste tanks TK-U-3 and TK-U-4, the 241-A-151 Diversion Box Drain, and several sources associated with the 291-A Stack. The 291-A Stack sources include stack drain, stack liner drain after neutralization in tank 216A-TK1, sampler house sink and floor drain, stack gas filter drain, stack gutter drains, and the stack pit plenum (GE 1955).

In December 1958, the crib became plugged and flooded an area between the crib and the 291-A-1 Stack, causing an area of surface contamination. The contaminated soils were removed to a trench (200-E-102) along the southern boundary of the crib and were covered with 0.3 m (1 ft) of soil (GE 1959). The crib was deactivated in 1958 by blanking off the effluent piping after the crib had reached its specific retention capacity. At the present time the site is located

within a large gravel area, known as the PUREX Stabilized Area (200-E-103). Only a large green vent riser is visible above the surface.

According to the waste site grouping report (DOE-RL 1997), the radionuclide inventory included 395 kg (880 lb) of uranium, 140 g (0.3 lb) of plutonium, and minor amounts of cesium-137 (6.93 Ci) and strontium-90 (4.39 Ci). Nonradionuclides included nitrate (300 kg) and sodium dichromate (110 kg).

2.2.3.2 216-T-33 Crib. The 216-T-33 Crib is an inactive liquid waste disposal site located in the 200 West Area approximately 76.2 m (250 ft) west of the 2706-T Building and 274 m (900 ft) north of 23rd Street (Figure 2-11). The site is presently surrounded with light metal posts and chain and is posted as an underground radioactive materials area. The site consists of a rectangular crib with a perforated vitreous clay inlet pipe set into a gravel layer. Figure 2-14 shows the construction of the 216-T-33 Crib.

The site was only active from January to February 1963 as a subsurface liquid disposal site for the 2706-T Building (also known as 2706-W). After the perforations in the tile line plugged, the waste was routed to the 216-T-28 Crib, via tank 241-T-112 (Lundgren 1970). Sections of the tile line to the crib were removed in 1963 after the line was rerouted to the 216-T-28 Crib. No surface contamination has been found at this site (Maxfield 1979). The site was stabilized in July 1991.

The crib received 1,900,000 L (500,000 gal) of dilute decontamination waste from the 2706-T Building. The liquid waste is mainly a dilute sodium hydroxide solution (DOE-RL 1997). According to the waste site grouping report (DOE-RL 1997), the radionuclide inventory included 5.94 kg (13 lb) of uranium, 5 g (0.01 lb) of plutonium, and minor amounts of cesium-137 (0.3 Ci) and strontium-90 (0.3 Ci).

2.2.3.3 216-T-13 Trench. The 216-T-13 Trench is an inactive liquid waste disposal site located in the 200 West Area approximately 853 m (2,800 ft) southwest of the 221-T canyon building and 69.5 m (228 ft) south of 23rd Street (Figure 2-11). The trench was located in the vicinity of the 269-W regulated garage, which no longer exists. The trench is not marked or posted. Figure 2-15 shows the construction of the 216-T-13 Trench.

The site operated from June 1954 to June 1964 and was used to decontaminate vehicles prior to repair at the 269-W regulated garage. Based on the descriptions given for other waste sites (e.g., 216-U-13) that served a similar function, it is assumed that the trench sides were sloped such that vehicles could be driven down to the decontamination area at the bottom. The site received wastes from vehicle decontamination activities or heavy equipment steam cleaning.

According to *Radioactive Contamination in Liquid Wastes Discharged to Ground Within the Chemical Separations Area Control Zone* (ARHCO 1970), the site received approximately 98,400 L (26,000 gal) of vehicle decontamination liquid waste. The waste included <0.05 kg (<0.1 lb) of uranium, <0.1 g of plutonium, 1 Ci each of strontium-90 and cesium-137, 40 Ci of ruthenium-106, and <0.1 Ci of cobalt-60. ARHCO (1973) indicates that the concentration of strontium-90 and cesium-137 was at only 0.1 Ci each.

The site was deactivated in June 1964 when all vehicle decontamination operations were transferred to the 2706-T Building (also known as 2706-W), and the pit was backfilled with soil.

In April 1972, the site was excavated. Approximately 3.06 m^3 (4 yd^3) of contaminated soil was taken to the 200 West Area dry waste burial ground. The maximum contamination level found was 1,500 cpm. The site was then removed from radiological control.

2.2.3.4 216-U-3 French Drain. The 216-U-3 French Drain is an inactive liquid waste disposal site located in the 200 West Area just south of the 241-U Tank Farm on the south side of 16th Street (Figure 2-12). The site is surrounded by concrete posts and is marked as an underground radioactive material area. Figure 2-16 shows the construction of the 216-U-3 French Drain.

The drain operated from May 1954 to August 1955 and received condensate from condensers on the 241-U-104 and 241-U-110 waste tanks (BHI 1995c). According to the waste site grouping report (DOE-RL 1997), the site received 791,000 L (209,000 gal) of dilute tank condensate. The radionuclide inventory included 18 kg (40 lb) of uranium, 0.1 g of plutonium, and minor amounts of cesium-137 (0.4 Ci) and strontium-90 (0.04 Ci).

2.2.3.5 200-E-4 French Drain. The 200-E-4 French Drain is an inactive waste site located approximately 4 m (13 ft) north of the 209-E Critical Mass Laboratory Service Building in the 200 East Area and is connected to 209-E Critical Mass Laboratory via underground piping (Figure 2-9). The site is a 1.2-m (4-ft)-diameter dry well, covered with a yellow metal cover. Figure 2-17 shows the construction of the 200-E-4 French Drain.

The site received steam condensate from the steam trap in a valve pit located approximately 1 m (3 ft) northwest of the french drain and steam condensate from the equipment room in the service building portion of the 209-E Building. Criticality experiments were conducted in the Critical Mass Laboratory from 1960 to 1983 using plutonium nitrate and enriched uranium solutions. Criticality research was also conducted with solid special nuclear materials and fuels such as plutonium blocks, uranium blocks and slabs, and fuel assemblies from the Fast Flux Test Facility and other reactors (DeFord 1992, DOE-RL 1993c). The laboratory is currently closed but not decommissioned. No research has occurred there since 1983. The site received condensate from 1958 until 1983.

Figure 2-1. Generalized Stratigraphic Column for the 200 Areas.

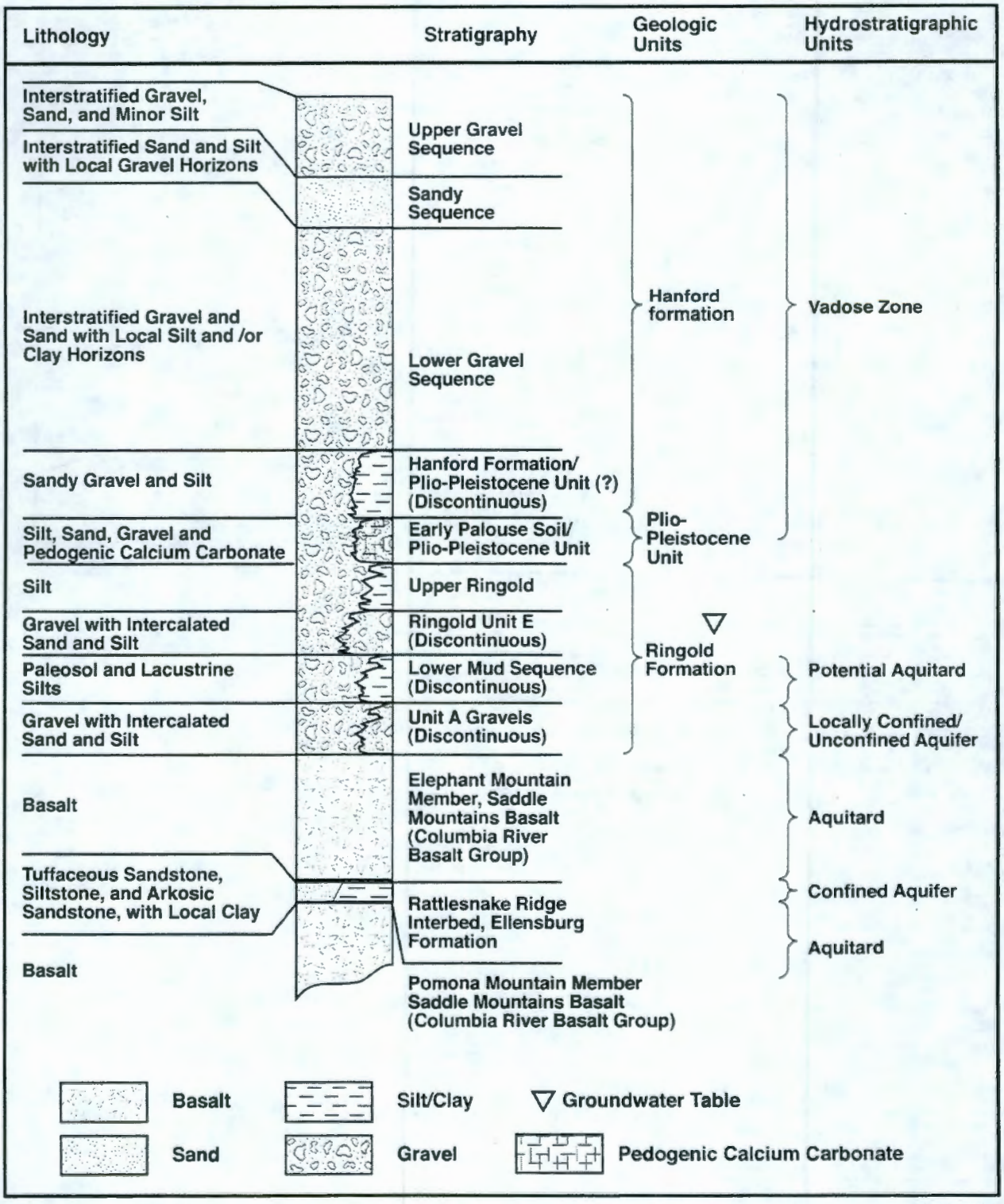


Figure 2-2. Groundwater Table Around the 200 East and 200 West Areas, April 2001.

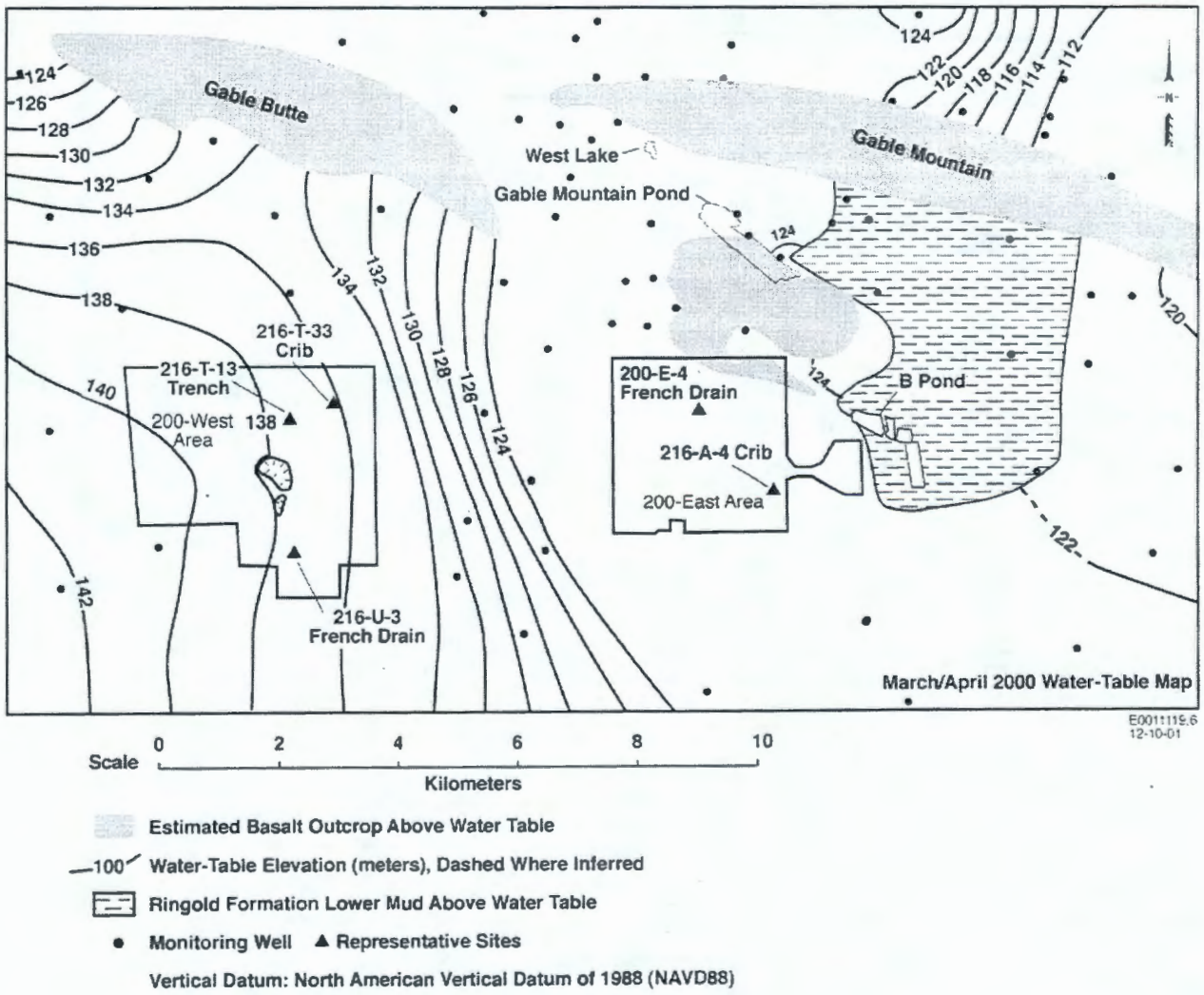


Figure 2-3. Stratigraphy Near the 216-A-4 Crib.

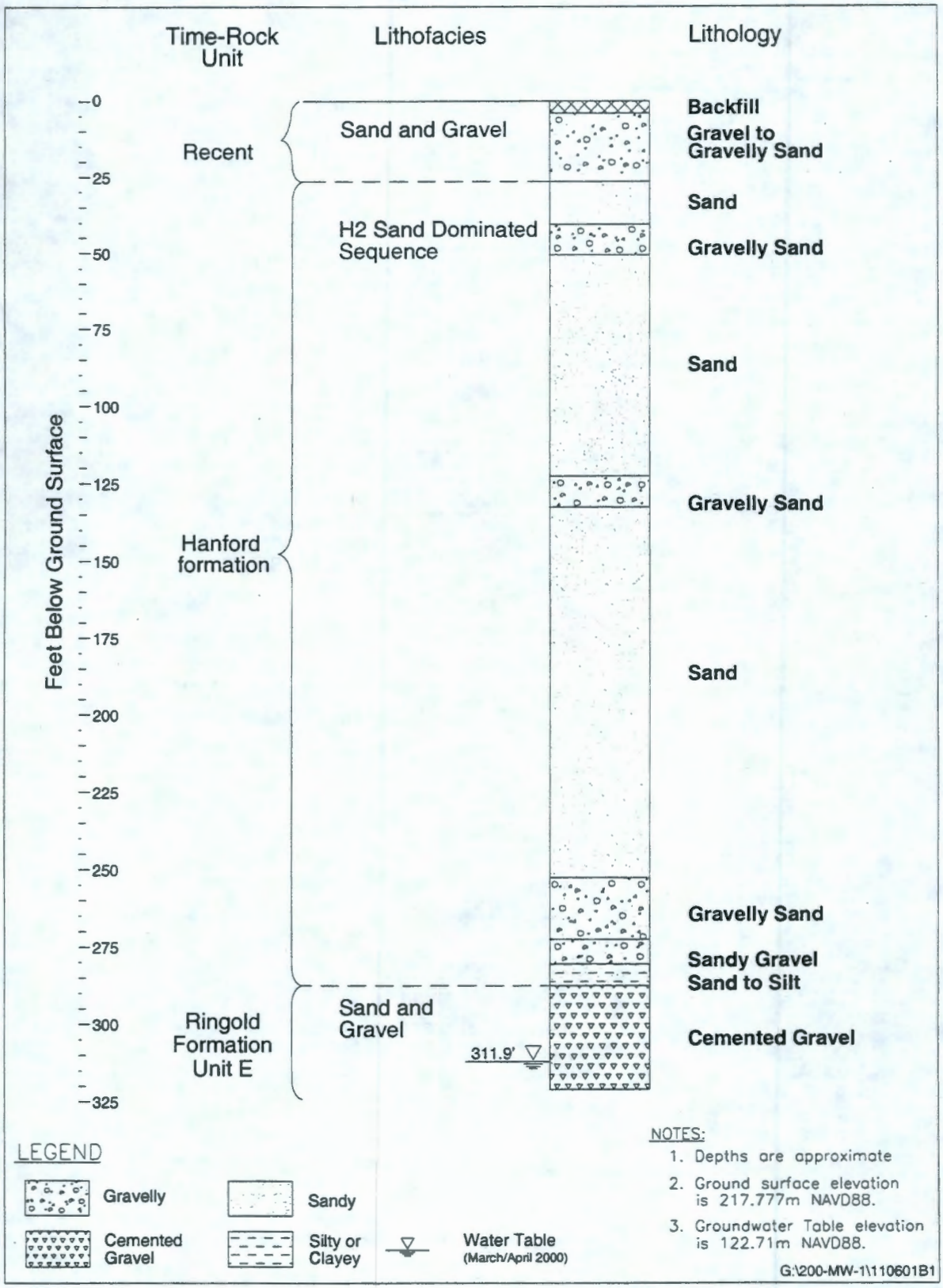


Figure 2-4. Stratigraphy in the Vicinity of the 216-T-33 Crib.

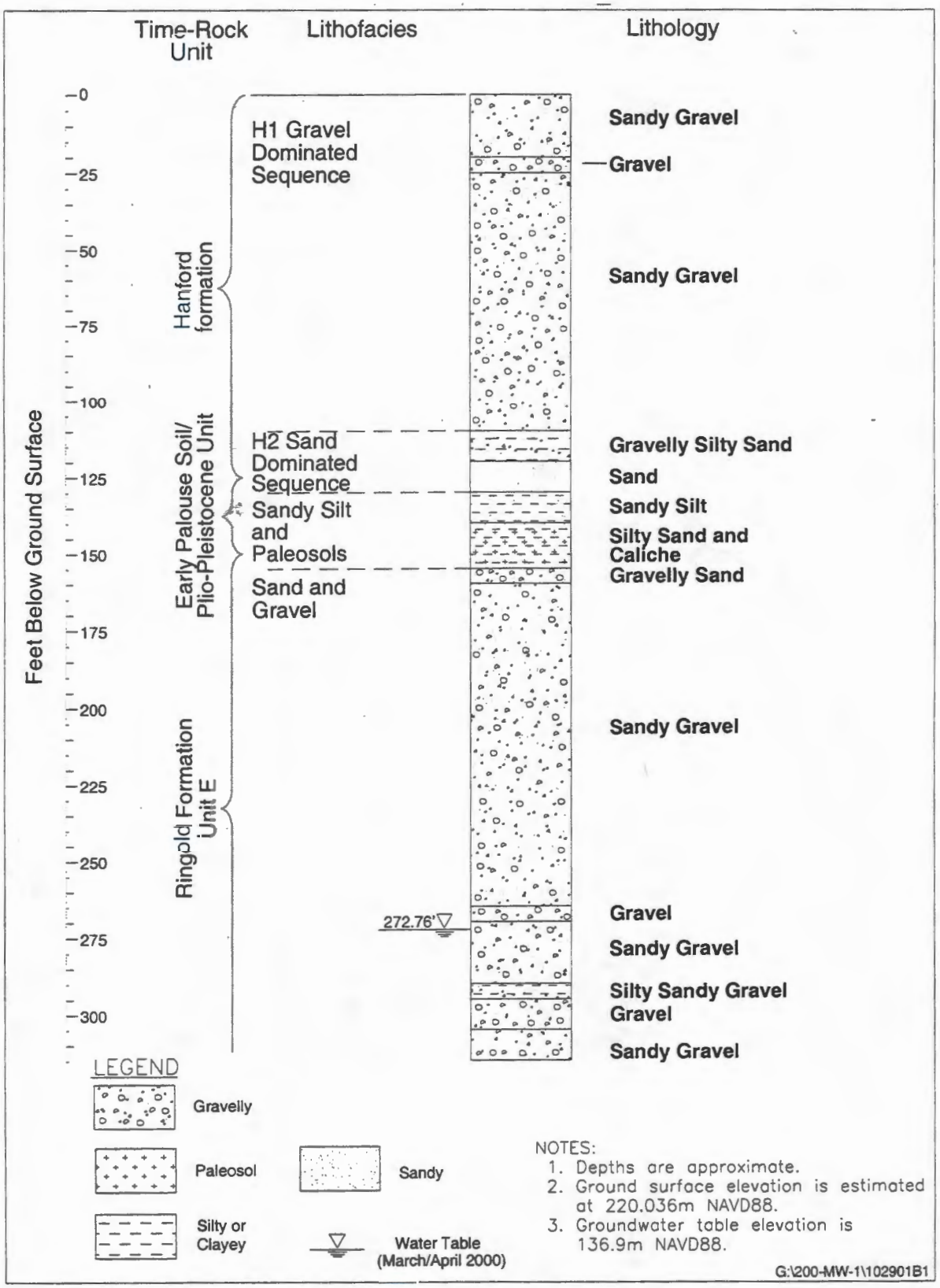


Figure 2-5. Stratigraphy in the Vicinity of the 216-T-13 Trench.

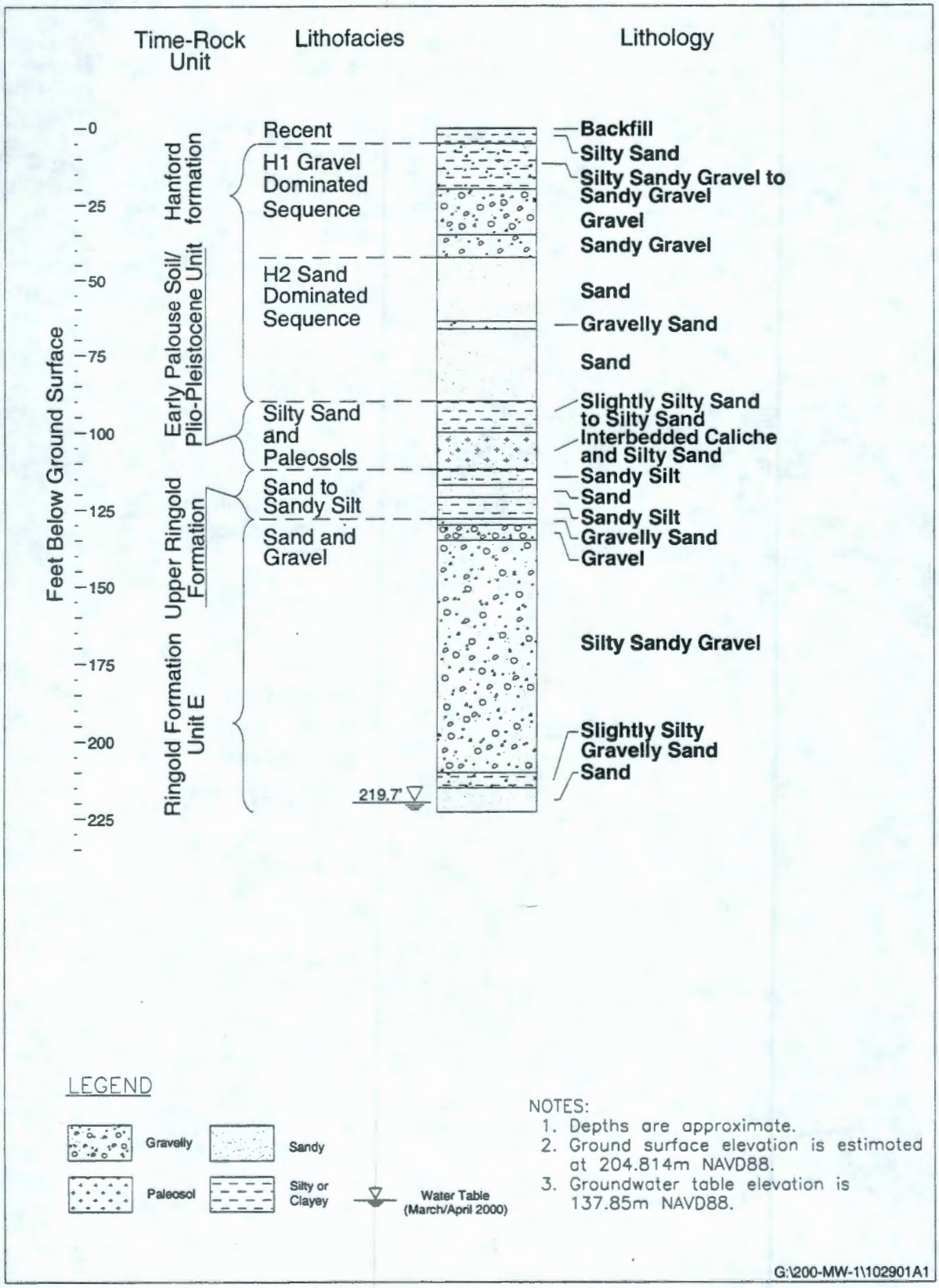


Figure 2-6. Stratigraphy Near the 216-U-3 French Drain.

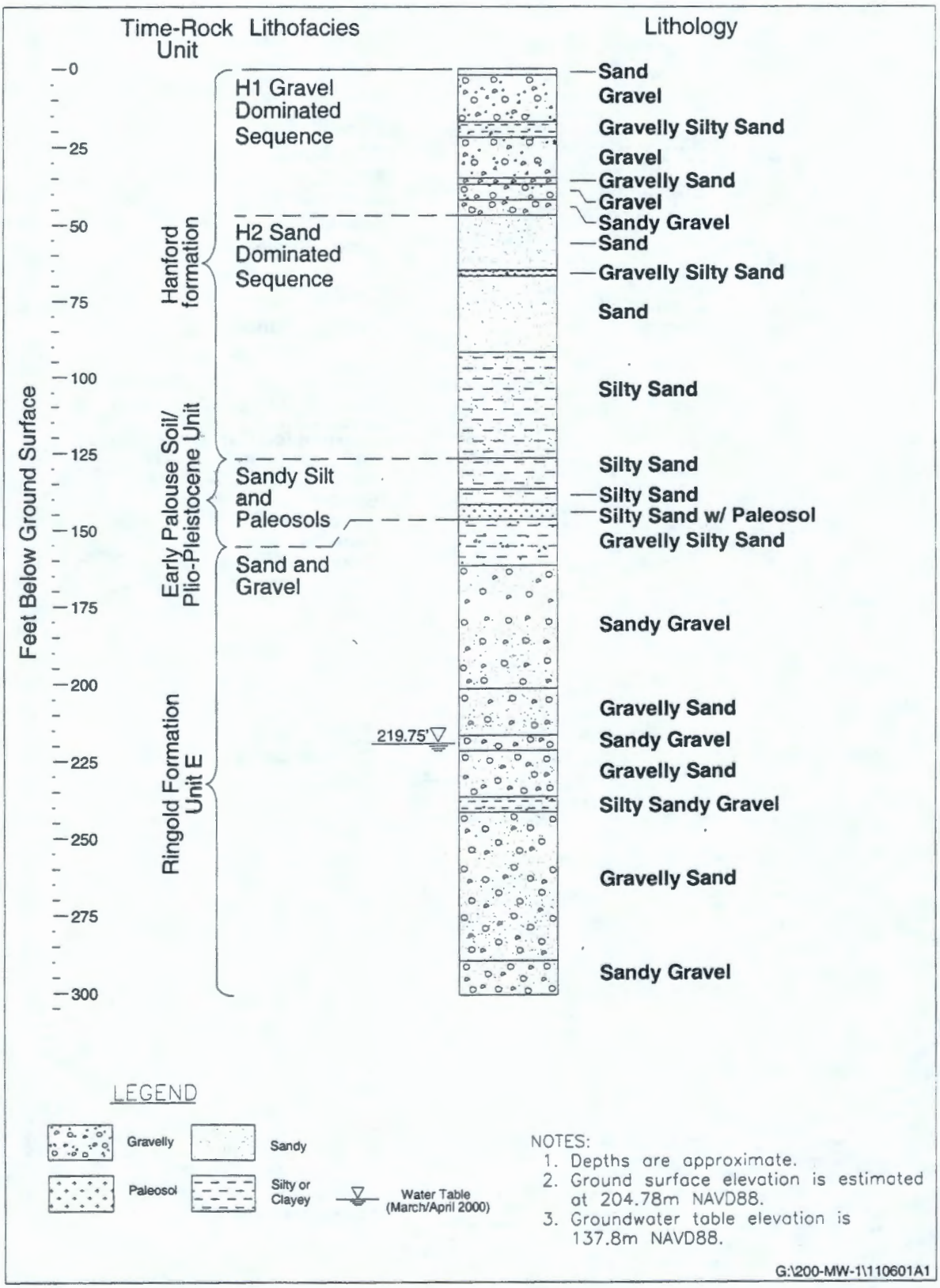


Figure 2-7. Stratigraphy Near the 200-E-4 French Drain.

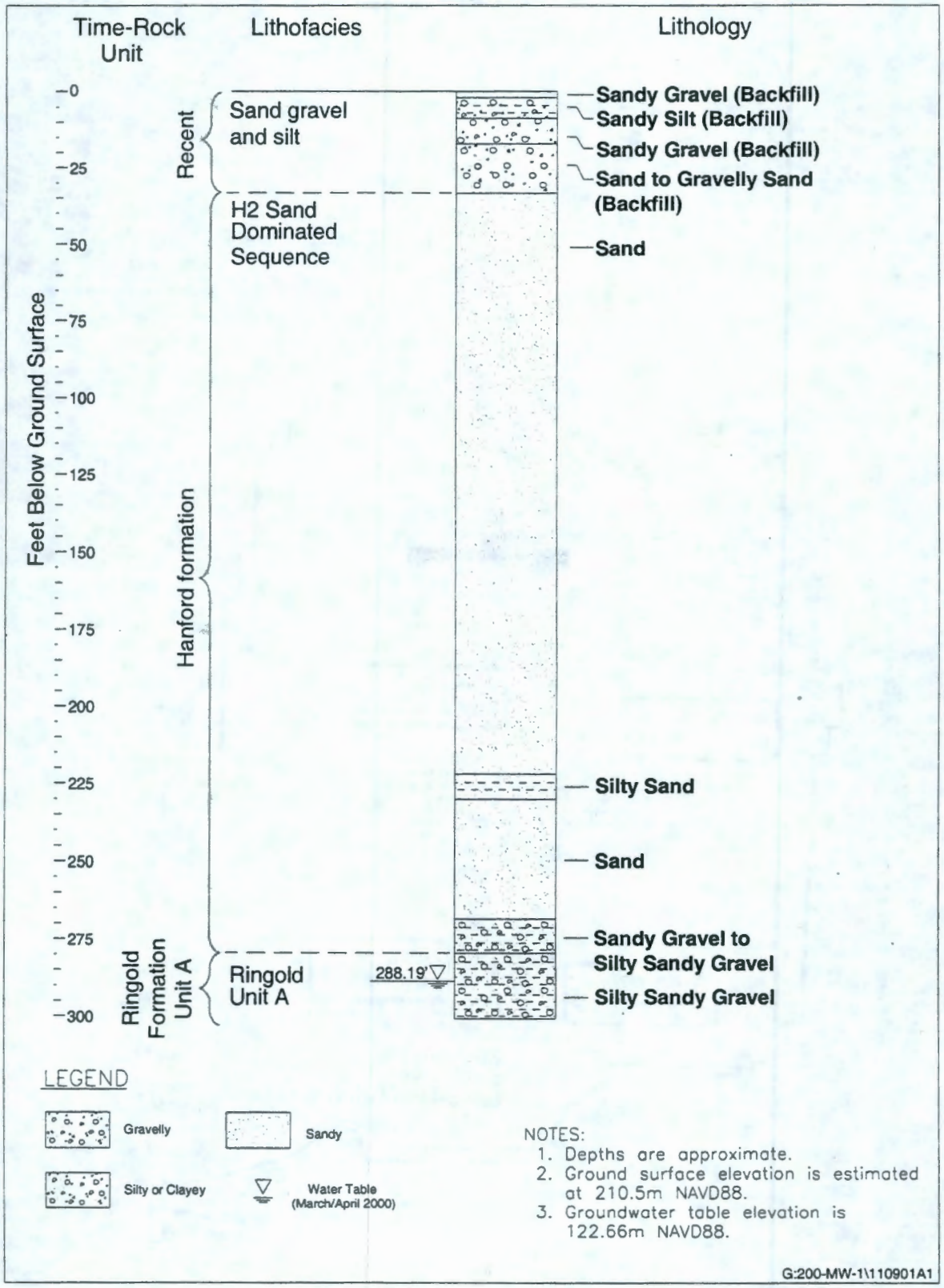


Figure 2-8. Location of the Hanford Site and 200-MW-1 Operable Unit Waste Sites.

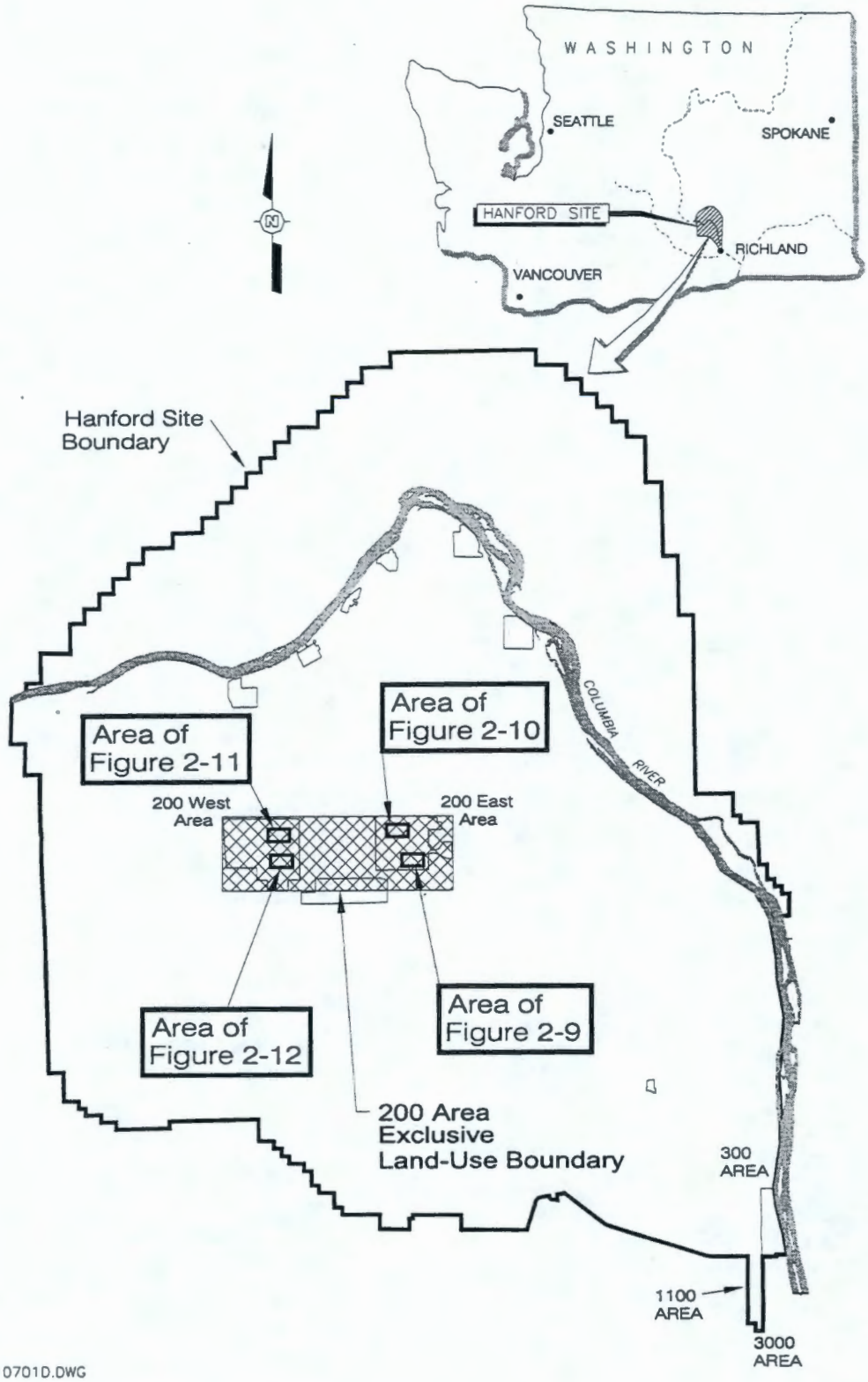
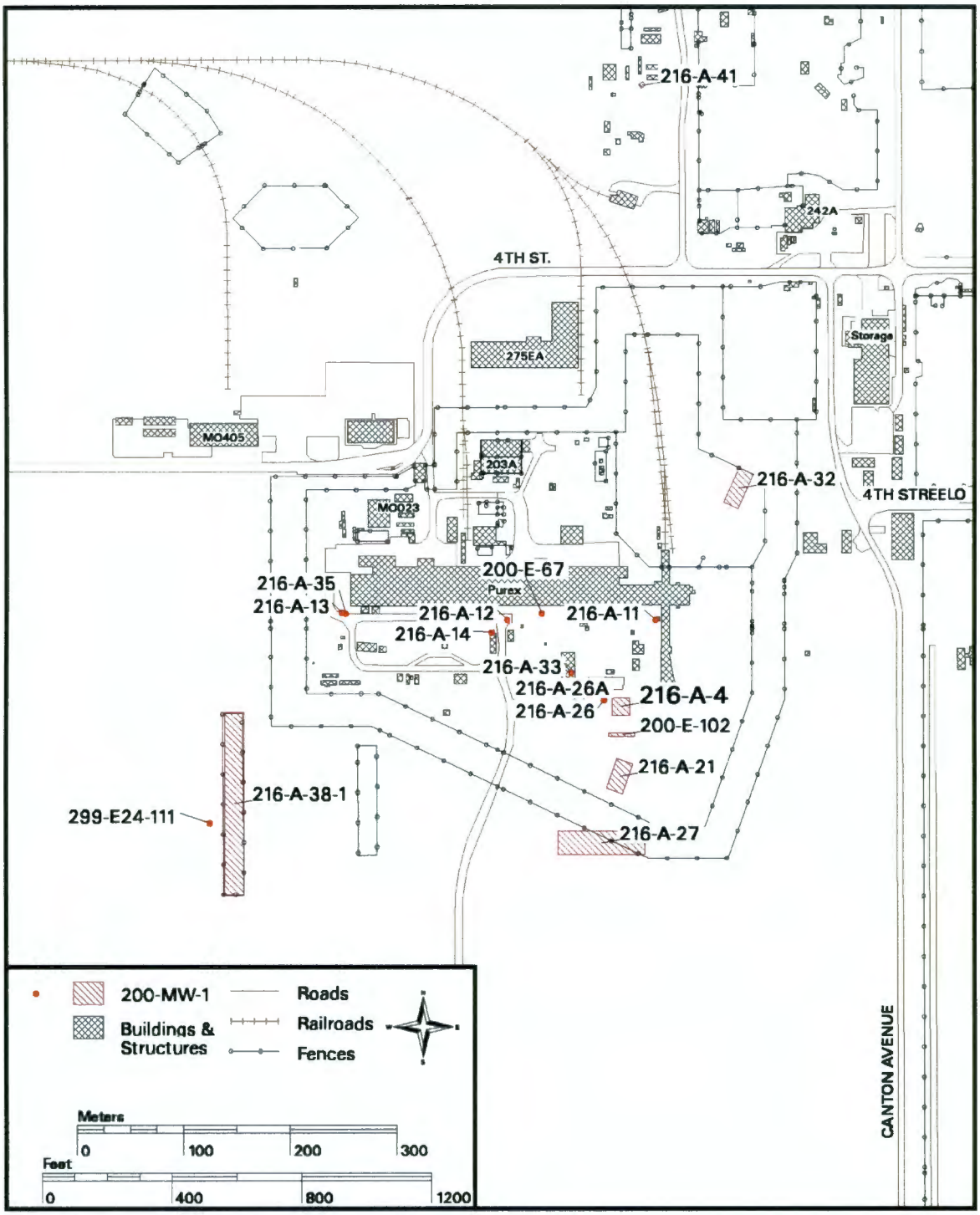
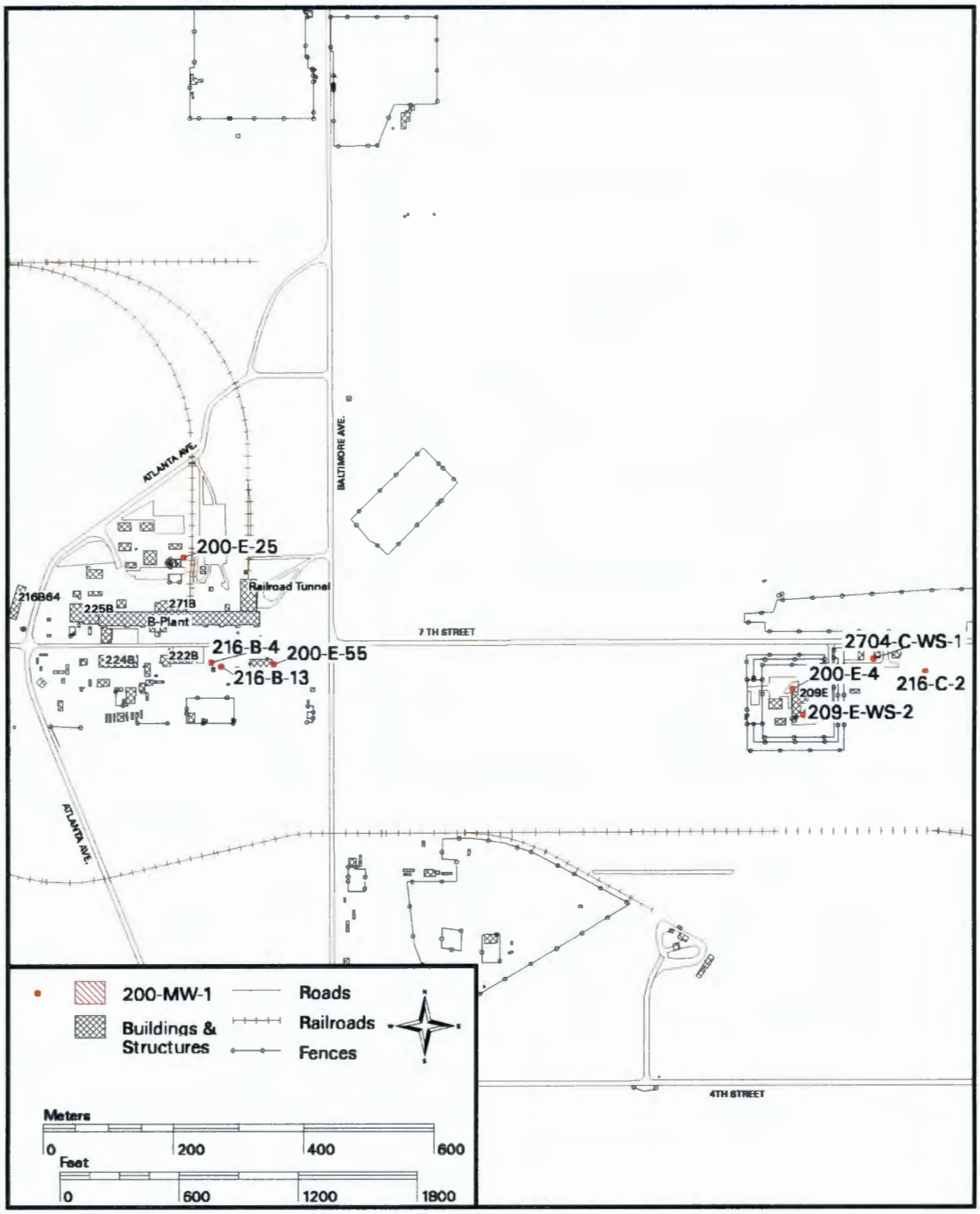


Figure 2-9. Location of the 200-MW-1 Operable Unit Waste Sites in the 200 East Area. (1 of 2)



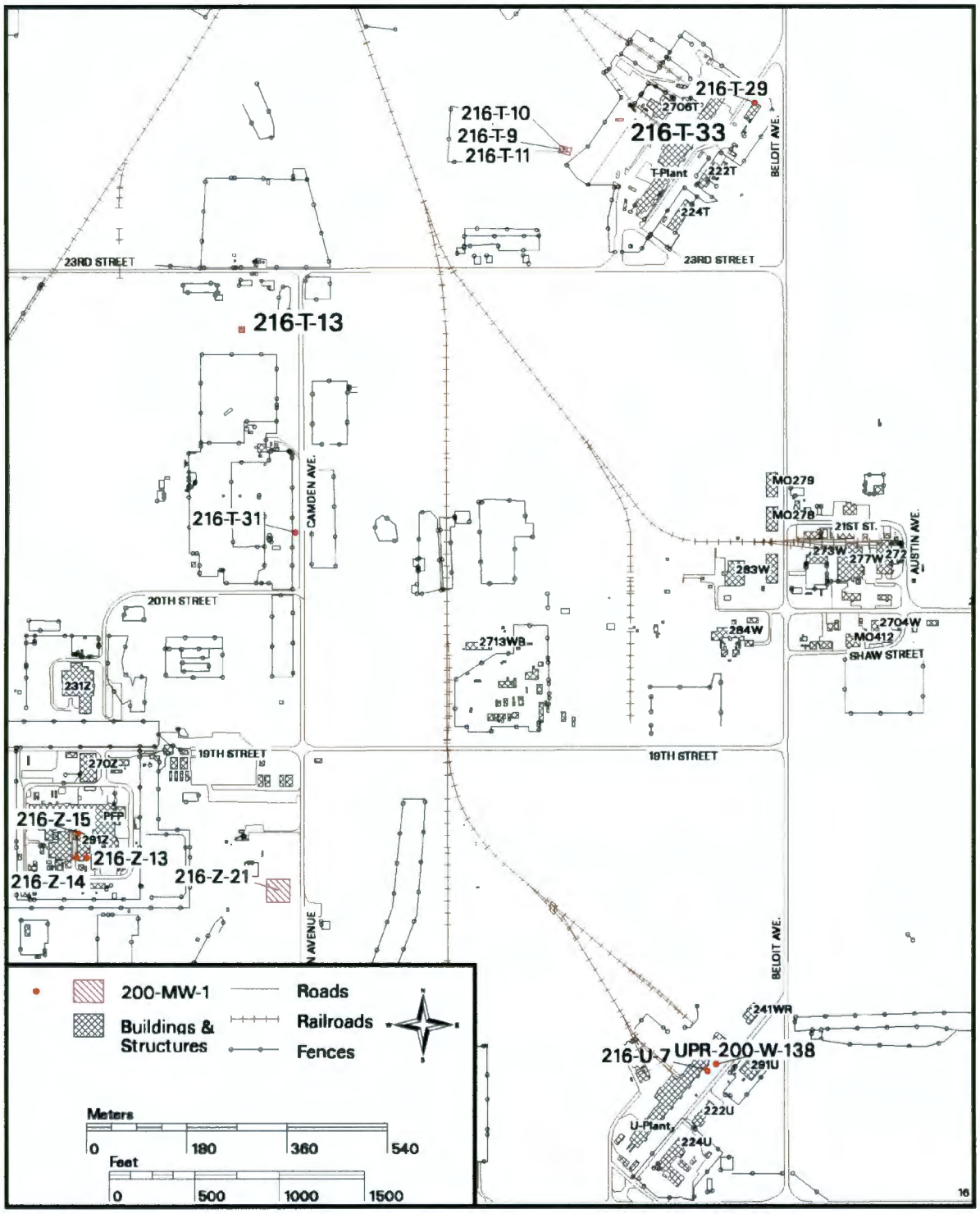
BHI:maa 10/29/01 /home/maa/amls/mw_easts1.aml Database: 05-DEC-2001

Figure 2-10. Location of the 200-MW-1 Operable Unit Waste Sites in the 200 East Area. (2 of 2)



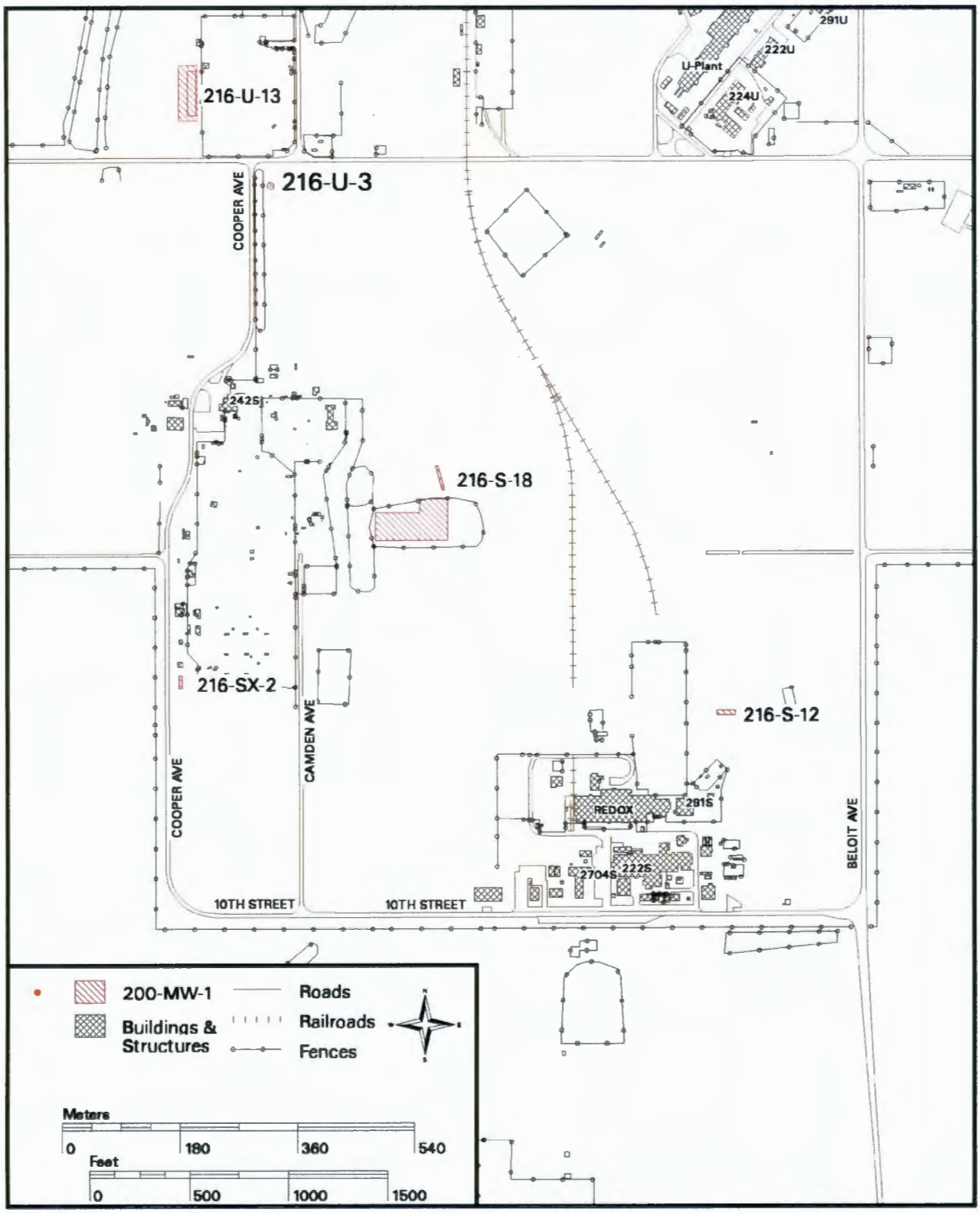
BHI:maa 10/29/01 /home/maa/amls/mw_casts2.aml Database: 26-NOV-2001

Figure 2-11. Location of the 200-MW-1 Operable Unit Waste Sites in the 200 West Area. (1 of 2)



BHI:maa 10/29/01 /home/maa/amls/mw_wests1.aml Database: 05-DEC-2001

Figure 2-12. Location of the 200-MW-1 Operable Unit Waste Sites in the 200 West Area. (2 of 2)



BHI:maa 10/29/01 /home/maa/amls/mw_wests2.aml Database: 05-DEC-2001

Figure 2-13. 216-A-4 Crib Construction Diagram.

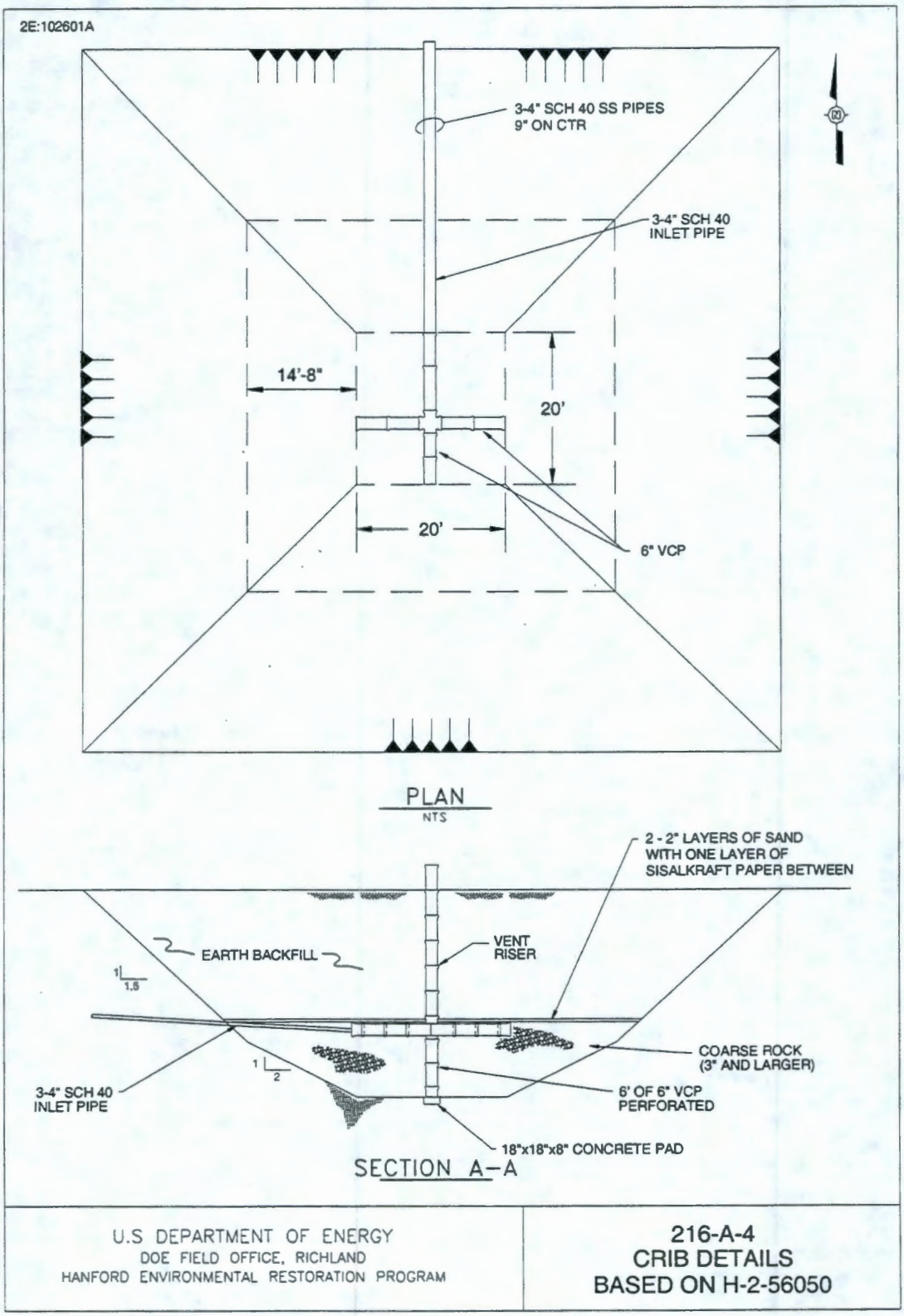


Figure 2-14. 216-T-33 Crib Construction Diagram.

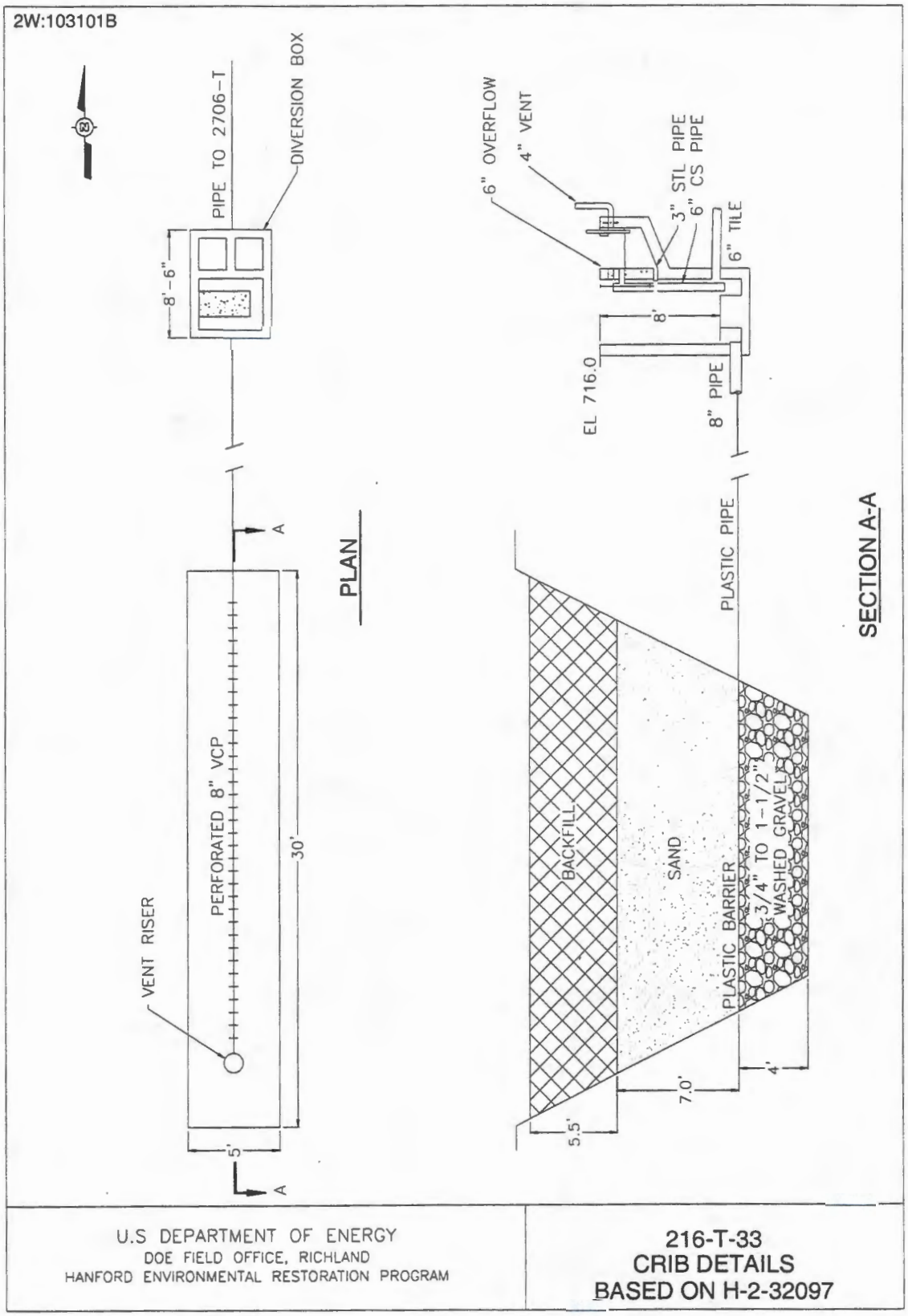


Figure 2-15. 216-T-13 Trench Construction Diagram.

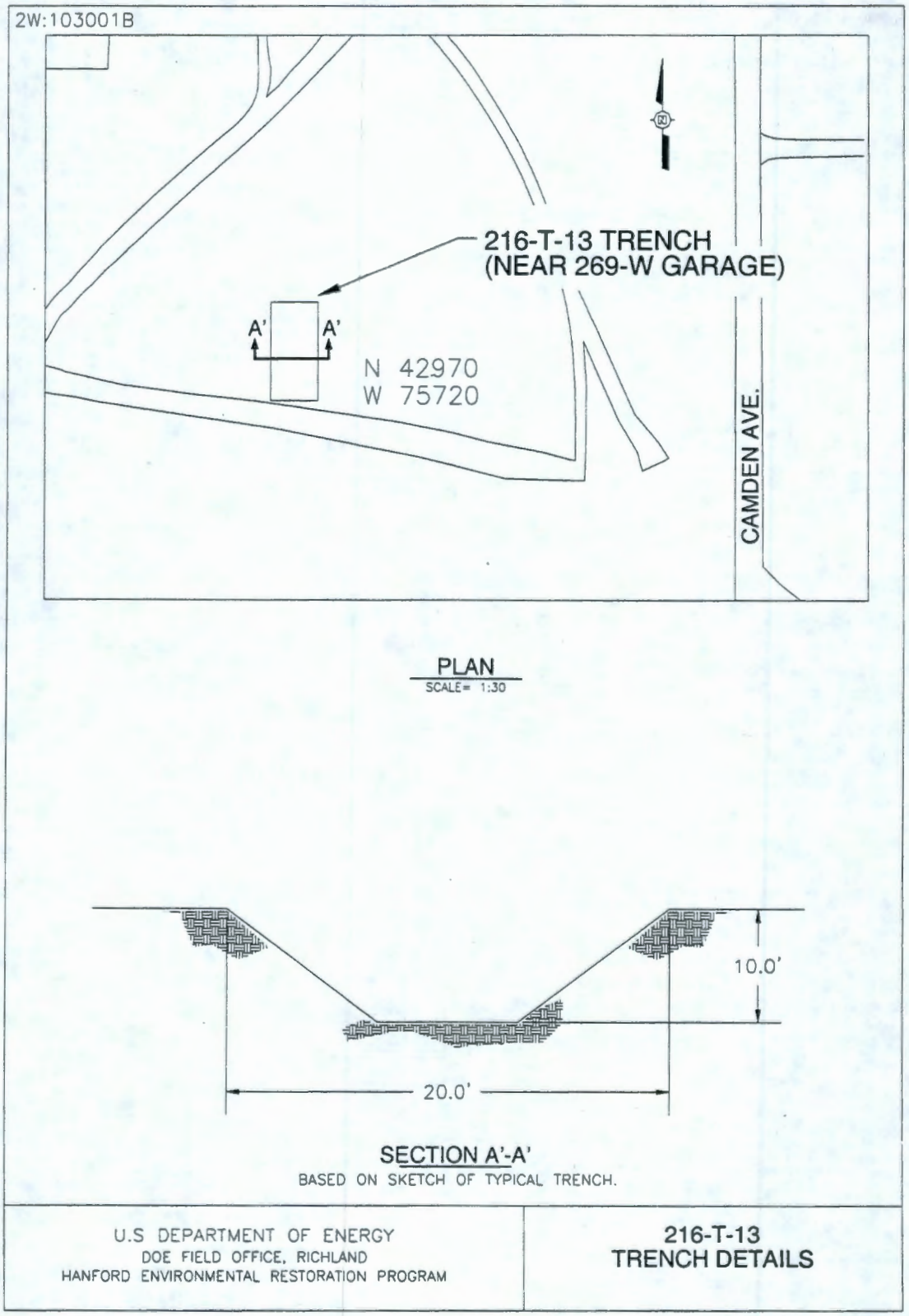


Figure 2-16. 216-U-3 French Drain Construction Diagram.

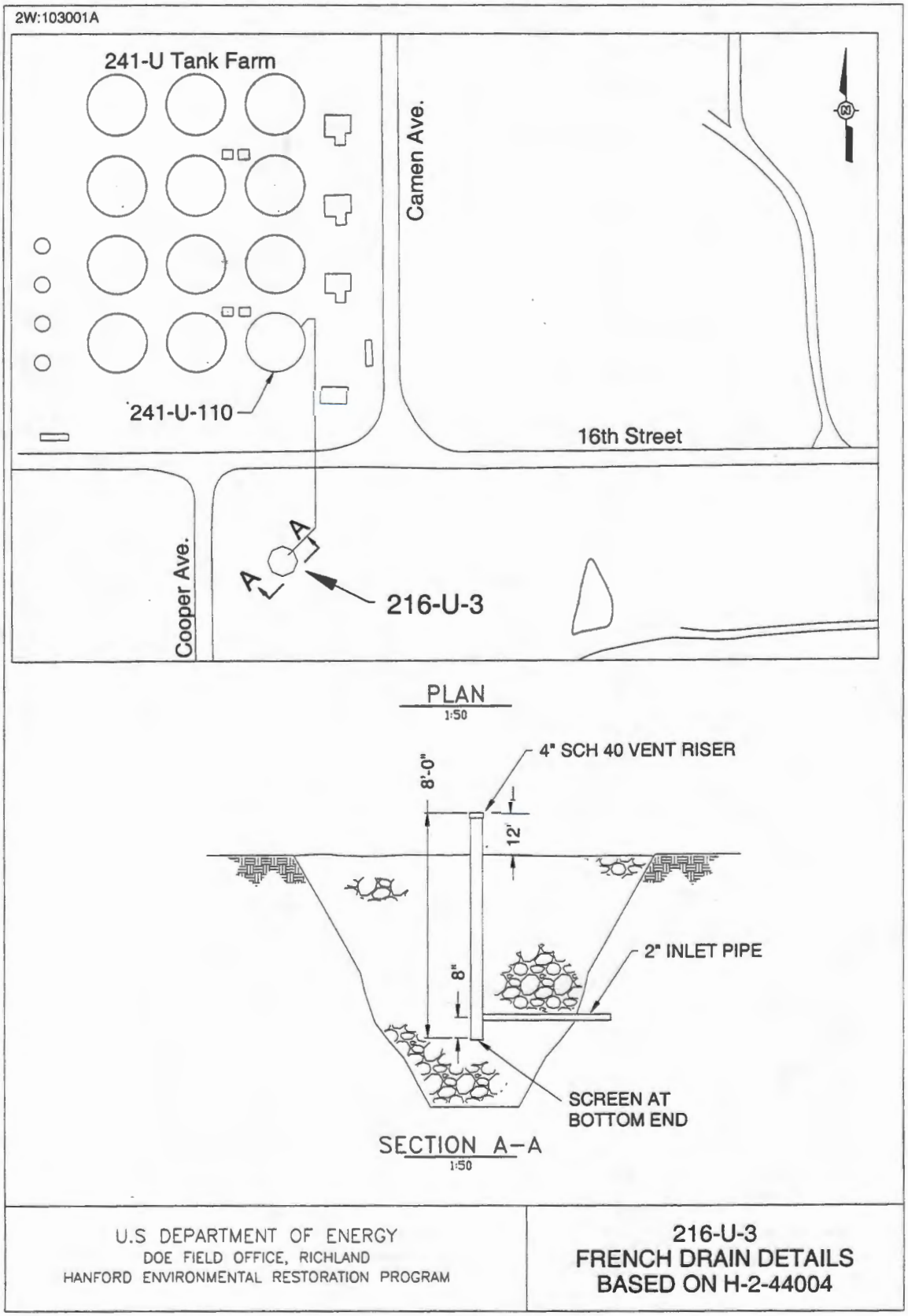


Figure 2-17. 200-E-4 French Drain Construction Diagram.

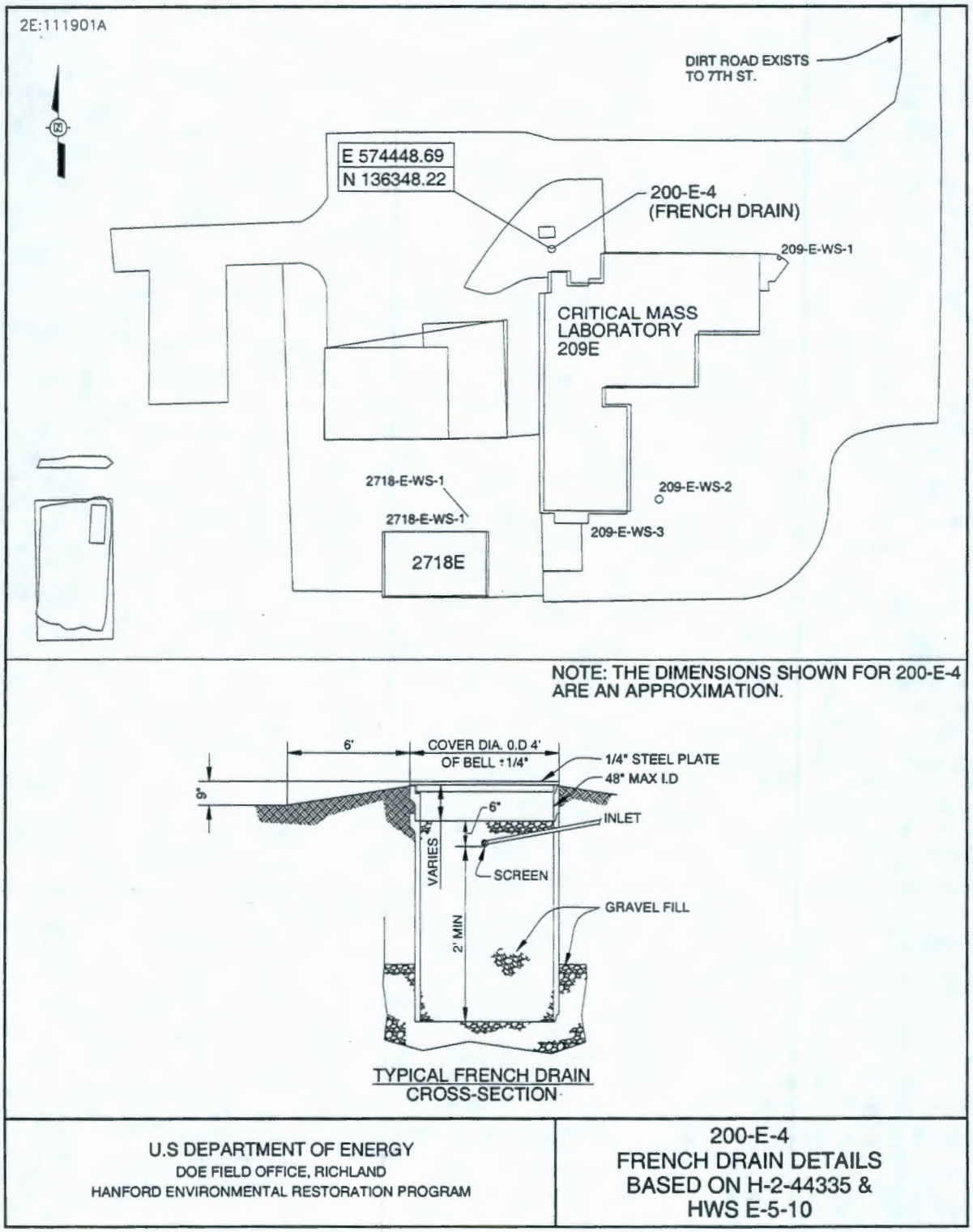


Table 2-1. Summary of Information for the 200-MW-1 Waste Sites Included in this Work Plan. (14 Pages)

Site Code Type	Site Names	Location	Dates of Operation	Source Facility	Contaminant Inventory/ Volume Released	Depth	Waste Site Dimensions	General Description
Process Facility Ventilation Stack and Sand Filter Sources								
216-A-4 Crib **(Rep. Site)**	216-A-4, 216-A-4 Cavern	South of the 202-A Building and east of the 216-A-2, inside the PUREX exclusion fence	1955 to 1958	Laboratory cell drainage from the 202-A Building and 291-A-1 Stack drainage. For a detailed description of this site, see Section 2.2.3.	6,210,000 L with 395 kg U; 140 g Pu; 6.93 Ci Cs-137; 4.39 Ci Sr-90; 300 kg NO_3; 110 Kg $Na_2Cr_2O_7$	5.5 m (18 ft) depth to top of crib, 2.1 m (7 ft) depth of rock bed 0.3 m (1 ft) gravel, sand and Sisal-Kraft paper	6.1 m x 6.1 m (20 ft x 20 ft)	For a detailed description of this site, see Section 2.2.3.
216-A-41 Crib	216-A-41, Crib, 291-AR Stack Drain, 296-A-13 Stack Drain	Northwest of the 296-A-13 Stack, west of Buffalo Ave. and north of the 244-AR Vault facility	1968 to 1974	Drainage from the 296-A-13 Stack. The stack connected to the 291-AR Filter Building.	10,000 L[a]	2 m (7 ft)	3 m x 3 m (10 ft x 10 ft)	The crib contains six 20- x 20- x 41-cm (8- x 8- x 16-in.) bond beam concrete blocks placed end to end to form the dispersion structure 1.2 m (4 ft) below grade. The crib has an inlet pipe from the 296-A-13 Stack and a 20-mil polyethylene barrier separating the gravel from the backfill. The site is not marked in the field and the exact location of this unit has not been confirmed; several temporary buildings are located in the vicinity of the crib at the present time.
216-A-21 Crib	216-A-21, 216-A-21 Crib	South of the 202-A Building inside the PUREX exclusion fence	1957 to 1965	Until June 1958, the site received sump waste from 293-A Building. From June 1958 to December 1958, the site was inactive. From December 1958 to June 1965, the site received the above effluent, laboratory cell drainage from the 202-A Building, and the 291-A-1 Stack drainage.	77,900,000 L[a]	N/A	18 m x 5 m (62 ft x 16 ft)	A 10-cm (4-in.) stainless steel distribution line runs horizontally through the length of the site, 2.1 m (7 ft) below grade. Branching horizontally from this distribution line are four 1.2-m (4-ft) sections of 10-cm (4-in.) tubing. Branching vertically at the same locations are four 2.4-m (8-ft) sections of 10-cm (4-in.) schedule 40 perforated pipe running to the bottom of the site. The excavation is V-shaped in cross-section with a side slope of 1H:1.5V. The excavation has approximately 1.8 m (6 ft) of gravel fill and is backfilled over. The site was surface stabilized in 1999 and posted with Underground Radioactive Material signs.

Table 2-1. Summary of Information for the 200-MW-1 Waste Sites Included in this Work Plan. (14 Pages)

Site Code Type	Site Names	Location	Dates of Operation	Source Facility	Contaminant Inventory/ Volume Released	Depth	Waste Site Dimensions	General Description
216-A-27 Crib	216-A-27, 216-A-27 Crib	South of the PUREX facility, partially inside the double security fence	1965 to 1970	Sump waste from the 293-A Building, the lab cell drainage from the 202-A Building, and the 291-A-1 Stack drainage.	23,200,000 L with 67.5 kg U; 96.5 g Pu; 32.4 Ci Cs-137; 24.5 Ci Sr-90[a]	N/A	61 m x 3 m (200 ft x 10 ft)	A 15-cm (6-in.) perforated pipe is placed horizontally the length of the unit approximately 3 m (10 ft) below grade. The crib also has a 20-cm (8-in.)-diameter well extending from a concrete pad, a 20-cm (8-in.) vent riser with filter, a 41-cm (16-in.) pipe for a recorder, a 3.8-cm (1.5-in.) sensing bulb well, and a polyethylene barrier. The side slope is 1H:1.5V. The crib is covered with gravel and is marked and posted with Underground Radioactive Material signs. The crib was monitored by wells 299-E17-2 and 299-E17-3.
216-S-12 Trench	216-S-12, UPR-200-W-30, 291-S Stack Wash Sump, REDOX Stack Flush Trench	Northeast of the 202-S (REDOX) facility, north of the 291-S Stack	1954	Liquid waste from 291-S Stack flush water.	68,100 L with 5.94 kg U; 1.0 g Pu; 0.43 Ci Cs-137; 0.41 Ci Sr-90	3 m (10 ft)	27 m x 6 m (89 ft x 20 ft)	The unit was constructed in July 1954 to receive flush water containing ammonium nitrate from the 291-S Stack Complex. The trench was retired when the flush of the 291-S-1 Stack was complete, also in July 1954. The trench was deactivated by removing the above-ground piping and then backfilling. The site is surrounded with cement marker posts and chain, posted with Underground Radioactive Material signs.
216-B-13 French Drain	216-B-13, 216-B-13 French Drain, 291-B Crib, 216-B-B, 216-B-13 Crib	South of 221-B and northeast of the 291-B-1 Stack	1945 to 1976	291-B Stack drainage.	21,000 L[a]	6 m (20 ft)	6 m x 1 m (20 ft x 3 ft)	The drain is constructed of two 1.22-m (4-ft)-diameter by 1.53-m (5-ft)-long tile pipes, stacked vertically and filled with crushed limestone. The unit has a plywood cover, located 2.44 m (8 ft) below grade. Two and a half tons (2,270 kg) of limestone were used as a base and to fill the tile pipes. The bottom of the drain is 5.5 m (18 ft) below ground surface. In June 1976, the stack drainage was rerouted to a cell drainage sample tank. A single concrete AC-540 marker is the only site identifier. There is an Underground Radioactive Materials sign attached to the concrete post.
200-E-55 French Drain	200-E-55, Effluent Drain East of 291-B Sand Filter, Misc. Stream #322	East of the east end of the 291-B Sand Filter (WIDS Site Code 200-E-30)	1948 to 1997	Condensate from the B Plant canyon sand filter and rain water that leaked through the sand filter roof.	N/A	1 m (3 ft)	2 m x 1 m (7 ft x 3 ft)	There are no visual surface features for this drain. It has been marked with a single steel post. The drain is below grade and east of the B Plant sand filter.

Table 2-1. Summary of Information for the 200-MW-1 Waste Sites Included in this Work Plan. (14 Pages)

Site Code Type	Site Names	Location	Dates of Operation	Source Facility	Contaminant Inventory/ Volume Released	Depth	Waste Site Dimensions	General Description
216-T-29 French Drain	216-T-29, 291-T Sand Filter Sewer, 216-T-29 French Drain	Adjacent to the north end of the 291-T Sand Filter and northeast of the 221-T Building	1949 to 1964	Canyon air condensate from the 291-T Sand Filter.	74,000 L[a]	1 m (3 ft)	1 m x 0.2 m (3 ft x 0.7 ft)	The site is part of the sand filter construction. In 1964 the sand filter bypass water seal was removed, deactivating the french drain. The sand filter was deactivated because new air filters were installed in each cell of the 221-T Building. The sand filter bypass water seal was removed, allowing the 221-T Building exhaust air to flow directly to the 291-T-1 Stack. The site has a vent riser protruding through the roof of the northwest corner of the sand filter. This is assumed to be the location of the drain. The site is marked and posted as a Contamination Area.
216-T-31 French Drain	216-T-31, 216-T-31 French Drain	West of Camden Ave., near the southeast corner of the 241-TX Tank Farm, on the east side of 241-TX Tank Farm fence	1954 to 1962	Steam condensate from a steam line blowout during efforts to unplug a waste line.	N/A	N/A	1 m (3 ft) diameter	This drain is a registered underground injection well. The unit was in operation in 1954 and abandoned in 1959 after it was contaminated by steam condensate from a steam line blowout during efforts to unplug a waste line. A new steam line was installed in 1959 and a new steam condensate drain was made to replace the contaminated drain. The french drain was exhumed in 1962. The contaminated culvert, gravel and soil were removed and buried in the 200 West Area dry burial ground. The site was released from radiation zone status in February 1962. The site is surrounded by a chainlink fence and is posted with surface contamination warning signs.
216-A-33 French Drain	216-A-33, 216-A-33 Dry Well, 216-A-26B	Inside the PUREX security fence, south of 202-A, and southwest of the 291-A Stack	1955 to 1964	Bearing coolant waste from the 291-A-1 Stack electrical exhaust fans.	N/A	4 m (13 ft)	4 m x 2 m (13 ft x 7 ft)	The site has a 5-cm (2-in.) inlet pipe entering it 1.5 m (5 ft) below grade. Project B-295A constructed the 291-AE Building over the area where this drain was located. The inlet piping was capped and the drain was removed from service in 1964 because water was no longer used as a coolant for electrical fans. The site was deactivated by capping the effluent pipeline to the unit on the south side of the 291-A Fan Plenum.

Table 2-1. Summary of Information for the 200-MW-1 Waste Sites Included in this Work Plan. (14 Pages)

Site Code Type	Site Names	Location	Dates of Operation	Source Facility	Contaminant Inventory/ Volume Released	Depth	Waste Site Dimensions	General Description
216-C-2 Injection/ Reverse Well	216-C-2, 291-C Dry Well, 216-C-2 Dry Well	Inside the 200-E-41 Stabilized Area, south of 7th Street in 200 East Area. Southeast of the former 291-C-1 Stack location, in the Hot Semiworks area	1953 to 1988	291-C Stack drainage and the seal water drainage from the stack ventilation filters. The volume discharged to the unit is unknown.	N/A	12 m (40 ft)	12 m x 0.3 m (39 ft x 0.9 ft)	The dry well was a 30.5-cm (12-in.)-diameter pipe that extended 0.3 m (1 ft) above grade to 12 m (40 ft) below the surface. The bottom 7.6 m (25 ft) of the pipe was perforated. The drain is surrounded by a concrete collar at grade. A 10-cm (4-in.) stainless steel saran-lined inlet pipe connected the unit to the 291-C-1 Stack. A second inlet line constructed of 5.1-cm (2-in.) stainless steel pipe connected to the 291-C-1 Stack Ventilation Filter. The unit was decommissioned in 1988 and buried along with the 291-C-1 Stack during the demolition activities. The reverse well is no longer visible. It is not separately marked or posted from the surrounding stabilized area (200-E-41) that is posted as Underground Radioactive Material.
216-B-4 Injection/ Reverse Well	216-B-4, 216-B-4 French Drain, 216-B-4 Dry Well, 216-B-4 Reverse Well	South of the 221-B Building, east of the 222-B Building and northeast of the 292-B Building	1945 to 1949	Before August 1947, the site received 291-B Stack drainage. After August 1947, the site received floor drainage from the 292-B Building.	10,000 L[a]	N/A	34 m x 0.2 m (112 ft x 0.7 ft)	The top of the well extends 0.6 m (2 ft) above ground. The site is marked with a single concrete AC-540 marker post, with an Underground Radioactive Material sign attached to the post.
Vehicle/Heavy Equipment Facility Decontamination Sources								
216-T-33 Crib **(Rep. Site)**	216-T-33, 216-T-33 Crib	West of 221-T Canyon Building and southwest of 2706-T	1963	Liquid waste from the 2706-T Building.	1,900,000 L with 5.94 kg U; 5.0 g Pu; 0.27 Ci Cs-137; 0.26 Ci Sr-90[f]	3.3 m (10.8 ft) depth to bottom of crib 2 m (6.8 ft) overburden	9 m x 2 m (30 ft x 7 ft)	For a detailed description of this site, see Section 2.2.3.

Table 2-1. Summary of Information for the 200-MW-1 Waste Sites Included in this Work Plan. (14 Pages)

Site Code Type	Site Names	Location	Dates of Operation	Source Facility	Contaminant Inventory/ Volume Released	Depth	Waste Site Dimensions	General Description
216-A-32 Crib	216-A-32, 216-A-32 Crib	Northeast of 202-A, inside the PUREX exclusion fence	1959 to 1972	202-A canyon crane maintenance facility floor, sink, and shower drainage.	4,000 L	4 m (13 ft) depth of crib 2 m (7ft) overburden	21 m x 2 m (69 ft x 7 ft)	The site is constructed of 24 m (77.5 ft) of 15-cm (6-in.) perforated vitrified clay pipe placed horizontally 15 m (5 ft) below grade. Two layers of sisalkraft paper separate the crib gravel from the overlying earthen backfill. The excavation has a side slope of 1H:1.5V, which is filled to 1.5-m (5-ft) depth with 200 m^3 (6,000 ft^3) of gravel fill. The site is currently surrounded with cement posts with Underground Radioactive Material signs. There is an inner area marked with steel posts, chains, and Surface Contamination signs.
Vehicle/Heavy Equipment Field Decontamination Sources								
216-T-11 Trench	216-T-11, Decon. Trenches, Equipment Decon. Area	West of 221-T and southwest of the 216-T-33 Crib	1951 to 1954	Liquid waste disposal of heavy equipment and vehicle decontamination waste.	N/A	2 m (7 ft)	15 m x 3 m (49 ft x 10 ft)	The site consists of a backfilled trench. In 1954, the unit was backfilled, and decontamination operations were transferred to the 269-W garage facility that discharged to the 216-T-13 Trench. In May 1972, the site was exhumed. All contamination was taken to the 200 West Area dry waste burial ground. The 216-T-9, 216-T-10, and 216-T-11 Trenches were then released from radiation zone status. This is no longer marked or posted.
216-T-13 Trench **(Rep. Site)**	216-T-13, 269-W Regulated Garage, 269-W Decon. Pit or Trench, 216-T-12, 269-W Regulated Garage Decon. Pit	North side of the 241-TY Tank Farm, just outside the perimeter fence	1954 to 1964	Vehicle decontamination wastes from the 269-W garage.	N/A	3 m (10 ft)	6.1 m x 6.1 m (20 ft x 20 ft)	For a detailed description of this site, see Section 2.2.3.
216-T-9 Trench	216-T-9, Decon. Trenches, Equipment Decon. Area	West of the 221-T Building and southwest of the 216-T-33 Crib	1951 to 1954	Subsurface liquid disposal of vehicle decontamination waste from heavy equipment and other vehicles.	N/A	2 m (7 ft)	15 m x 3 m (49 ft x 10 ft)	In May 1972, the site was exhumed. All contamination was taken to the 200 West Area dry waste burial ground. The 216-T-9, 216-T-10, and 216-T-11 Trenches were then released from radiation zone status. This site consists of a backfilled trench. The site is no longer marked or posted.

Table 2-1. Summary of Information for the 200-MW-1 Waste Sites Included in this Work Plan. (14 Pages)

Site Code Type	Site Names	Location	Dates of Operation	Source Facility	Contaminant Inventory/ Volume Released	Depth	Waste Site Dimensions	General Description
216-U-13 Trench	216-U-13, 216-U-13 Cribs, 216-U-13, Vehicle Steam Cleaning Pit	West of the 241-U Tank Farm	1952 to 1956	Drainage from equipment steam cleaning and decontamination activities done inside the trenches.	11,400 L with 0.35 kg U; 0.1 g Pu; 4.4×10^{-2} Ci Cs-137; 4.2×10^{-2} Ci Sr-90[f]	6 m (20 ft)	61 m x 6.1 m (200 ft x 20 ft)	The site consisted of two trenches of equal dimensions. It operated as a decontamination pit where vehicles could be driven down to the decontamination station at the bottom. The pits were used mainly to decontaminate trucks and cranes bearing low levels of radioactive contamination. Several large pumps used in the Uranium Recovery process were also cleaned here, but the residue was scraped and taken to the 200 West Area burial grounds. The site was deactivated because the decontamination operations were transferred to the 269-W garage equipment decontamination waste pit (216-T-13). The 216-U-13 Trench was found to be free of surface and subsurface radiological contamination, and the area was released from radiological control in 1982. The two trenches are no longer marked or posted.
216-T-10 Trench	216-T-10, Decon. Trenches, Equipment Decon. Area	West of the 221-T Building and southwest of the 216-T-33 Crib	1951 to 1954	Subsurface liquid disposal of heavy equipment and vehicle decontamination waste.	N/A	2 m (7 ft)	15 m x 3 m (49 ft x 10 ft)	In May 1972, the site was exhumed. All contamination was taken to the 200 West Area dry waste burial ground. The 216-T-9, 216-T-10, and 216-T-11 Trenches were then released from radiation zone status. This site consists of a backfilled trench. The site is no longer marked or posted.
216-S-18 Trench	216-S-18, 241-SX Steam Cleaning Pit, 216-S-14 Steam Cleaning Pit	North of 13th Street, east of 241-S Tank Farms and southwest of 216-S-9 Crib	1954	Contaminated equipment and contaminated soil from the surrounding area.	98,400 L[a]	2 m (7 ft)	38 m x 4.6 m (125 ft x 16 ft)	The trench was built and retired in October 1954. It was active during the month of October 1954 as a vehicle decontamination pit. The unit is L-shaped; the surface is composed of sand and gravel and is 1.2 to 1.8 m (4 to 6 ft) below grade. In 1972, the site was backfilled and released from radiation zone status. During the stabilization of UR-200-W-165 and UPR-200-W-114 in 1995, contamination specks were found in the shallow trench excavation. The area was posted as a radiation area. The source of the contamination is assumed to be contamination specks from the operation of the 241-S Tank Farms. In 1997, a small area of contaminated soil remaining from UPR-200-W-114 was pushed into the 216-S-18 Trench depression. The 216-S-18 Trench area was then covered with clean dirt and posted as an Underground Radioactive Material area.

Table 2-1. Summary of Information for the 200-MW-1 Waste Sites Included in this Work Plan. (14 Pages)

Site Code Type	Site Names	Location	Dates of Operation	Source Facility	Contaminant Inventory/ Volume Released	Depth	Waste Site Dimensions	General Description
200-E-102 Trench	200-E-102, Contaminated Soil Trench	20.7 m (68 ft) south of the south boundary of 216-A-4 Crib	1958	UPR-200-E-15.	N/A	1 m (3 ft)	24 m x 3 m (79 ft x 10 ft)	The trench was used to bury contaminated soil from an unplanned release (WIDS Site UPR-200-E-15). When the 216-A-4 Crib plugged in 1958, it caused the ground between the 216-A-4 Crib and the 291-A Turbine House to flood. The contaminated soil was scraped up and placed into a slit trench near the south end of the crib. The trench was covered with 0.3 m (1 ft) clean dirt. The trench is inside the surface stabilized Underground Radioactive Material area south of PUREX that is known as WIDS site code 200-E-103. The trench is not separately marked or posted.
Low-Level Radioactive process or Steam Condensate Sources								
216-U-3 French Drain **(Rep. Site)**	216-U-3, 216-U-11, 216-U-3 French Drain	South of the 241-U Tank Farm on the south side of 16th Street	1954 to 1955	Condensate from the steam condenser on the 241-U-110 Tank.	791,000 L with 18 kg U; 0.1 g Pu, 0.43 Ci Cs-137; 0.41 Ci Sr-90	3.6 m (11.8 ft)	3.6 x 1.8 m (11.8 x 5.9 ft)	For a detailed description of this site, see Section 2.2.3.
216-U-7 French Drain	216-U-7, 221-U Vessel Vent Blower Pit French Drain	Southeast side of the 221-U Building and of the 241-UX-154 Diversion Box	1952 to 1957	Liquid wastes from a counting box floor drain during the metal recovery program at the 221-U Building.	7,000 L with 1.4×10^{-2} kg U	5 m (16 ft)	5 m x 1 m (16 ft x 3 ft)	The drain is constructed of a gravel-filled 76-cm (30-in.)-diameter concrete pipe set vertically into the ground, extending to a depth of 5 m (16 ft). Gravel fills 1.1 m (3.5 ft) of the pipe. The site was retired when the uranium recovery operations in the 221-U Building were shut down in 1957. In 1998, the contaminated areas on the east side of the 221-U Building were surface stabilized with material from the 200 Area Ash Pit. The area was reposted to Underground Radioactive Material (see UPR-200-W-138 and UPR-200-W-162).

Table 2-1. Summary of Information for the 200-MW-1 Waste Sites Included in this Work Plan. (14 Pages)

Site Code Type	Site Names	Location	Dates of Operation	Source Facility	Contaminant Inventory/ Volume Released	Depth	Waste Site Dimensions	General Description
UPR-200-W-138 Unplanned Release	UPR-200-W-138, 221-U Vessel Vent Blower Pit French Drain, UN-216-W-11, UN-200-W-138, UN-200-W-22, UPR-200-W-22	Southeast corner of the 221-U Building, near the R-3 entrance. Located inside the larger surface stabilized area, UPR-200-W-162	1953 to 1953	The ground surface may have been contaminated through the 216-U-7 French Drain.	An estimated 140 kg (300 lb) of uranium nitrate hexahydrate solution, containing 14 kg (30 lb) of uranium[b]	N/A	N/A	Uranyl nitrate hexahydrate solution overflowed into the 221-U Building Vessel Vent Blower Pit, then onto the ground through the french drain. The site was described as the ground near the R-3 entrance to the 221-U Building. The area has been surface stabilized and posted with Underground Radioactive Material signs. In 1998, the contaminated areas on the east side of 221-U were covered with clean backfill material (see UPR-200-W-162). The area was reposted as Underground Radioactive Material.
Nonradiological Process Steam Condensate Sources with Radionuclide Cross-Contamination								
216-SX-2 Crib	216-SX-2 Crib	East side of Cooper Ave. adjacent to the 241-SXT Tank Farm	1952 to 1965	Waste from the 241-SX-701 Compressor House.	N/A	N/A	19 m x 8 m (62 ft x 26 ft)	The site is a gravel-filled crib topped with a subsurface layer of Sisalkraft paper. In July 2000, the vent risers were sealed as a preventive measure for potential passive radioactive emissions. It is labeled "216-SX-2" on three sides with old-style black and white signs. The crib is currently surrounded by light post and posted with Underground Radioactive Material signs.
2704-C-WS-1 French Drain	2704-C-WS-1, 2704-C French Drain, Gatehouse French Drain	200 East Area at the southwest corner of the 2704-C Building	1949 to 1998	2704C Building steam condensate.	N/A	N/A	N/A	The 2704-C Building was originally built in 1949 to support the Hot Semiworks operations. It was a one-story wooden structure, on a cement slab foundation, which was designated a contaminated facility. The 2704-C Building was demolished in 1998. The area where the building stood is covered with gravel and posted with Underground Radioactive Material signs. The drain is no longer visible at the location described.

Table 2-1. Summary of Information for the 200-MW-1 Waste Sites Included in this Work Plan. (14 Pages)

Site Code Type	Site Names	Location	Dates of Operation	Source Facility	Contaminant Inventory/ Volume Released	Depth	Waste Site Dimensions	General Description
216-Z-13 French Drain	216-Z-13, 234-5 Dry Well #1, 216-Z-13 Dry Well, Misc. Stream 261	Northeast of the 291-Z Stack	1949 to 1999	Steam condensate from the 219-Z Stack ET-8 exhaust fans, and building steam condensate.	N/A	3 m (10 ft) over-burden 5 m (16 ft) depth of drain	5 m x 1 m (16 ft x 3 ft)	The drain is constructed of two 90-cm (36-in.)-diameter tile culverts placed end-to-end in a 4.6-m (15-ft)-deep gravel-backfilled excavation. The site is beneath 2.7 m (9 ft) of gravel. Two pipes discharged to the french drain, but the miscellaneous stream (#261) to it has been eliminated. The site is addressed in the *Miscellaneous Streams Best Management Practices(BMP) Report*[c] as a "b" stream (a stream discharging in a surface contaminated area [SCA]). However, in 2001, the area was not posted as a SCA.
216-Z-14 French Drain	216-Z-14, 234-5 Dry Well #2, 216-Z-14 Dry Well, Misc. Stream #262	Northwest of the 291-Z Stack	1949 to present	Emergency condensate from the ET-9 exhaust fan, and building steam condensate.	N/A	3 m (10 ft) over-burden 5 m (16 ft) depth of drain	5 m x 1 m (15 ft x 3 ft)	The drain is constructed of two 90-cm (36-in.) diameter tile culverts placed end-to-end in a 4.6-m (15-ft)-deep gravel-backfilled excavation. The site is beneath 2.7 m (9 ft) of gravel. Two pipes discharge to the french drain. The site is also addressed in the *Miscellaneous Streams Best Management Practices (BMP) Report*[c] as a "b" stream (a stream discharging in a surface contaminated area). However, in 2001, the area was not posted a SCA. The drain is marked with a single cement marker post.
216-A-11 French Drain	216-A-11 French Drain, Misc. Stream #465	Near the southeast corner of the 202-A Building, south of Trap Pit #1	1956 to 1972	Steam and equipment leakage that drained from the 202-A Building.	100,000 L[a]	9 m (30 ft)	9 m x 1 m (30 ft x 3 ft)	The drain extends 9 m (30 ft) deep into the ground and is 0.8 m (2.6 ft) in diameter. It is constructed of two concrete pipes placed vertically end to end, placed in a 3-m (10-ft)-diameter excavation, which extends 1.5 m (5 ft) below the bottom of the pipe. The unit is composed of two reinforced concrete pipes placed vertically end to end. The site is inside a small area delineated by steel posts and chain. A 0.76-m (2.5-ft)-diameter, circular metal cover is visible. One concrete AC-540 marker identifies the site. It is posted as an Underground Radioactive Material area.

Table 2-1. Summary of Information for the 200-MW-1 Waste Sites Included in this Work Plan. (14 Pages)

Site Code Type	Site Names	Location	Dates of Operation	Source Facility	Contaminant Inventory/ Volume Released	Depth	Waste Site Dimensions	General Description
216-A-12 French Drain	216-A-12, Misc. Stream #463	Center of the south side of the 202-A Building, approximately 23 m (75 ft) from the building	1955 to 1972	Steam condensate, rain water and equipment leakage from the 202-A Building went to a sump in the bottom of Pit #3.	100,000 L[a]	6 m (20 ft)	6 m x 1 m (20 ft x 1 ft)	The unit is composed of two reinforced concrete tile pipes placed vertically end to end in a 3-m (10-ft)-diameter excavation extending 1.5 m (5 ft) below the bottom. Both the drain and the excavation are filled with gravel to the top of the unit and backfilled over. The drain has a side slope of 1H:1V. The site is not marked or posted and cannot be visually located.
216-A-13 French Drain	216-A-13, 216-A-13 French Drain, Misc. Stream #460	Approximately 6 m (20 ft) west and 6 m (20 ft) south of the southwest corner of the 202-A Building	1956 to 1962	Seal water from the air sampler vacuum pumps in the 202-A Building.	10,000 L[a]	6 m (20 ft)	6 m x 1 m (20 ft x 3 ft)	The drain is constructed of two lengths of 1-m (3-ft)-diameter concrete pipe placed vertically end to end to a depth of 5.5 m (18 ft). The waste management unit is filled to a depth of 1 m (3 ft) with 5- to 8-cm (2- to 3-in.)-diameter gravel. The base of the drain was over-excavated by at least 0.3 m (1 ft) in all directions and was filled with a bed of gravel. The line to this french drain was cut and capped in 1962. The effluent was diverted to the 216-A-35 drain. The site is not marked or posted and a 1.2-m (45-in.)-diameter metal cover is visible over the drain.
216-A-35 French Drain	216-A-35 French Drain, 216-A-35 Dry Well	Approximately 9 m (30 ft) south of the west end of the 202-A PUREX Building, south of the 216-A-13 French Drain	1963 to 1966	Seal cooling water from the air sampler vacuum pumps in the 202-A Building. The was is low in salt, neutral to basic, and contains less than 1 Ci total beta activity.	10,000 L[a]	5 m (16 ft)	5 m x 2 m (16 ft x 7 ft)	The site has an inlet pipe located 3.2 m (10.5 ft) below grade. This french drain was a replacement for the 216-A-13 French Drain. Disposal to the site was terminated when the effluent flow rate exceeded the infiltration capacity of the soil. The site was deactivated by capping the effluent pipeline to the unit and rerouting the effluent to the 216-A-29 Ditch via the 202-A Chemical Sewer. The drain is a raised cement structure, painted yellow and surrounded with Underground Radioactive Material signs. The top cover is marked Confined Space.

Table 2-1. Summary of Information for the 200-MW-1 Waste Sites Included in this Work Plan. (14 Pages)

Site Code Type	Site Names	Location	Dates of Operation	Source Facility	Contaminant Inventory/ Volume Released	Depth	Waste Site Dimensions	General Description
216-A-14 French Drain	216-A-14, French Drain-Vacuum Cleaner Filter Pit, Misc. Stream #462	South of the center of the 202-A Building, 5.5 m (18 ft) east of the filter pit	1956 to 1972	Steam condensate, stormwater and equipment leakage from the 202-A Building.	1,000 L[a]	9 m (30 ft)	9 m x 1 m (230 ft x 3 ft)	The unit is composed of two 0.8-m (2.6-ft)-diameter reinforced concrete pipes placed vertically end to end in a 3-m (10-ft)-diameter excavation. The pipes are placed to a depth of 8.8 m (28.8 ft), and the excavation extends below the bottom of the pipe 1.5 m (5 ft). Both the drain and the excavation are filled with 8 cm (3 in.) gravel to the top. A sump is inside the pit and drains through an underground pipe to the buried french drain. The line to this site was cut and capped in 1962. The effluent was diverted to the 216-A-35 drain. The drain is not marked or posted and has no visible surface features.
216-A-26 French Drain	216-A-26, 216-A-26 French Drain, 216-A-26B, Misc. Stream #464	Inside the PUREX security fence, south of the 291-A Control House and approximately 4.57 m (15 ft) south of 216-A-26A French Drain	1965 to 1991	Effluent from floor drains inside the 291-A Fan House.	N/A	5 m (16 ft)	5 m x 1 m (16 ft x 3 ft)	This drain is constructed of three 1.5- x 1.2-m (5- x 4-ft)-diameter clay pipes placed end to end and filled with gravel. It was installed to replace the 216-A-26A French Drain. The drain is accessed by a subsurface feeder pipe. 216-A-26 was removed from service in 1991. There are no visible surface features for this drain.
216-A-26A French Drain	216-A-26A, 216-A-25 Crib, 216-A-26 French Drain, 291-A French Drain	Inside the PUREX security fence, south of the 291-A Building	1959 to 1965	Floor drainage from the 291-A Fan Control Room.	1,000 L[a]	5 m (16 ft)	5 m x 1 m (16 ft x 3 ft)	The construction design of this waste management unit is identical to the 216-A-26 French Drain except the diameter is smaller. In 1965, the site was deactivated by removing the encasement and rerouting the effluent piping to the new 216-A-26 French Drain encasement, located 4.6 m (15 ft) south. There are no surface features for this drain.

Table 2-1. Summary of Information for the 200-MW-1 Waste Sites Included in this Work Plan. (14 Pages)

Site Code Type	Site Names	Location	Dates of Operation	Source Facility	Contaminant Inventory/ Volume Released	Depth	Waste Site Dimensions	General Description
200-E-25 French Drain	200-E-25, 272-BB French Drain, Insulation Shop French Drain, Misc. Stream #659	Approximately 6 m (20 ft) north of the northeast corner of the 272-BB Insulation Shop	1971 to 1991	Possibly material used in the 272-BB Insulation Shop.	Calcium silicate, fiberglass, silicate. Prior to 1988, it is possible that organic chemicals, oils and grease may have been introduced into the french drain.[b]	N/A	3 m x 0.6 m (10 ft x 2 ft)	The building sink and floor drain were connected to the site via a 5.1-cm (2-in.), schedule 40 carbon steel pipe. A 0.4-m (1.5-ft)-diameter grease trap with a removable cover is located on the east side of the 272-BB Building. The floor drain inside the building has been permanently plugged and the sink has been removed. The drain's structure is not visible from the surface. However, the location is marked with an old sign, mounted on two support posts. The sign says "Asbestos Waste Disposal Site - Do Not Excavate."
200-E-4[c] French Drain **(Rep. Site)**	200-E-4, Critical Mass Laboratory Dry Well North, 209-E North Dry Well, Misc. Stream #730	Approximately 7.6 m (25 ft) north of the northeast corner of the 209-E Critical Mass Laboratory Service Building	1958 to 1959	209-E Critical Mass Laboratory via underground piping.	N/A	N/A	1.2 m (4 ft)	For a detailed description of this site, see Section 2.2.3.
216-Z-15 French Drain	216-Z-15, 234-5 Dry Well #3, 216-Z-15 Dry Well, Misc. Stream #263	Adjacent to the southeast corner of the 2731-Z Building and north of the 291-Z Ventilation Building	1949 to 1997	Condensate from the S-12 Evaporator Cooler.	N/A	5 m (16 ft) overburden 7 m (23 ft) depth of drain	7 m x 1 m (23 ft x 3 ft)	Drain consists of two 90-cm (36-in.)-diameter tile culverts stacked on end in a 4.9-m (16-ft)-deep gravel-backfilled excavation. The unit is composed of two sections of vitrified clay pipe in a vertical configuration. There is one inlet pipe. The pipe is filled with cobbles and the upper end is covered with a wood plank. The site is also addressed in the *Miscellaneous Streams Best Management Practices(BMP) Report*[c] as a "b" stream (a stream discharging in a surface contaminated area). The 216-Z French Drain has been inactive and its discharge source has been eliminated, since May 1997. The site is marked with a single concrete marker post that reads "Buried Radioactivity - Do Not Excavate."

Table 2-1. Summary of Information for the 200-MW-1 Waste Sites Included in this Work Plan. (14 Pages)

Site Code Type	Site Names	Location	Dates of Operation	Source Facility	Contaminant Inventory/ Volume Released	Depth	Waste Site Dimensions	General Description
209-E-WS-2 French Drain	209-E-WS-2, Critical Mass Lab French Drain	Southeast corner of the Critical Mass Laboratory (laboratory wing)	N/A	Condensate from the Critical Mass Laboratory HEPA filters and heat exchange system.	N/A	N/A	1 m (3 ft)	The drain is a 1.2-m (4-ft)-diameter drain in a gravel area southeast of the building. The site is associated with the 209-E Critical Mass Laboratory. It is painted with yellow paint and has a metal cover.
299-E24-111 Injection/ Reverse Well	299-E24-111, Experimental Test Well Site, Misc. Stream 803	Southwest of the PUREX facility and west of the 216-A-38-1 Crib	1980 to 2000	Radiological tracers strontium-85 and cesium-134 were delivered for weekly injections and PNNL injected a potassium bromide tracer.	41,580 L with calcium chloride; calcium nitrate; Cs-134 (T ½ =2.05 years); and Sr-85 (T ½=64.85 days).[b]	N/A	20 m x 0.2 m (66 ft x 0.7 ft)	The site is an injection well surrounded by 32 observation wells. It was installed as an experimental test site, constructed to obtain information about radionuclide movement in soil for data modeling and migration forecasting. Strontium-85 and cesium-134 were used as radioactive tracers. The original test start date was September 22, 1980, ending on February 2, 1981. Pacific Northwest National Laboratory scheduled an additional injection experiment at this site in 2000 that added another injection well near the center of the cluster, injected a potassium bromide tracer and collected soil cores. The 299-E24-111 injection well head is located inside a small posted Underground Radioactive Material area. There is a small soil contamination area located southwest of the well.
216-Z-21 Pond	216-Z-21, 216-Z-21 Seepage Basin, PFP Cold Waste Pond	East of the 234-5 Complex (outside the Z Plant security fence) and southeast of the 216-Z-9 Trench	1980 to 1995	Effluent from various sources within Z Plant, including high tank overflow, storm drain runoff, ventilation steam condensate, dry air compressor cooling water, and ventilation air wash spray pans.	N/A	N/A	42 m x 42 m (138 ft x 138 ft)	The site is a large, soil-bermed depression constructed to receive Z Plant noncontact condensate and stormwater runoff. The site is an unlined seepage basin known as the 207-Z Basin. The name created confusion with the 207-Z Retention Basin (located inside the Z Plant security fence). For this reason, the name was officially changed to 216-Z-21 in June 1987. The basin is currently dry and is not radiologically posted.

Table 2-1. Summary of Information for the 200-MW-1 Waste Sites Included in this Work Plan. (14 Pages)

Site Code Type	Site Names	Location	Dates of Operation	Source Facility	Contaminant Inventory/ Volume Released	Depth	Waste Site Dimensions	General Description
216-A-38-1 Crib	216-A-38-1, 216-A-38 Crib	Southwest of 202-A Building north of 1st Street. Located south of the PUREX security fence	Never activated	Intended to receive the 202-A process condensate waste discharged to the 216-A-10 Crib (never used).	N/A	11 m (36 ft) depth 10 m (33 ft) overburden	159 m x 5 m (522 ft x 16 ft)	The site contains a 15-cm (6-in.) perforated steel pipe narrowing to 10 cm (4 in.) placed horizontally 10 cm (33 ft) below grade. The unit also has a 20-cm (8-in.)-diameter inlet pipe, two 8-cm (3-in.) vent risers and filters, two 20-cm (8-in.) gage wells, a membrane barrier, and a 20-cm (8-in.) bypass line paralleling the distribution line in the southern half of the unit. Ancillary equipment include a proportional sampling pit and the 216-A-5 Neutralization Tank. The crib was built to replace the 216-A-10 Crib, but had not been activated when plans for modifying the PUREX head-end process were begun. The planned building addition would have been constructed immediately adjacent to the crib. For this reason, the crib was never activated. The crib was posted as an Underground Radioactive Material area in 1980, due to the fact that underground piping had been installed that connected the crib to the PUREX process. No surface contamination has ever been identified during routine surveillance and no stabilization activities occurred at this crib. The site is surrounded by light posts and a chain.
200-E-67 Injection/ Reverse Well	200-E-67, 202A Building Steam Condensate, Misc. Stream #494	Adjacent to the south wall of 202-A	1996	N/A	N/A	N/A	N/A	The drain is located inside a dome-shaped caisson. The dome-shaped caisson is surrounded by post and chain and posted with Contamination Area signs. The dome is labeled 202-A-417.

[a]DOE-RL, 1997, Waste *Site Grouping for 200 Areas Soil Investigation*, DOE/RL-96-81, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
[b]WIDS.
[c]DOE-RL 1996, *Miscellaneous Streams Best Management Practices (BMP) Report*, DOE/RL-96-40, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
N/A= not available
PNNL = Pacific Northwest National Laboratory

3.0 INITIAL EVALUATION OF REPRESENTATIVE SITES

The purpose of this section is to present the results of previous characterization efforts at the representative waste sites in the 200-MW-1 OU. The contaminant inventory effluent volumes, available soil data, and current understanding of the distribution of contamination are discussed for each representative site.

3.1 KNOWN AND SUSPECTED CONTAMINATION

As discussed in Section 2.0, waste sites in this category received waste from moderate to low-volume vehicle/heavy equipment decontamination and ventilation systems, plus small-volume effluent streams commonly disposed to french drains. The waste was generally disposed to the vadose zone through cribs, french drains, and trenches. The estimated inventory of the primary radionuclides and nonradiological constituents that were discharged to waste sites in the 200-MW-1 OU was obtained from the following sources:

- WIDS
- The aggregate area management study reports for the 200 Areas (e.g., DOE-RL 1993a)
- Implementation Plan (DOE-RL 1999a)
- *Waste Site Grouping for 200 Areas Soil Investigations* (DOE-RL 1997)
- PUREX and REDOX Plant Technical Operating Manuals (WHC 1989, GE 1951a)
- *Uranium Recovery Technical Manual* (U Plant) (GE 1951b)
- *Hanford Engineer Works Technical Manual (T/B Plants)* (GE 1944).

The majority of the radionuclide and nonradiological waste disposed by operations associated with the 200-MW-1 OU waste sites were not documented in historical records. However, rough-order-of-magnitude estimates for some of the waste sites are documented in the Implementation Plan (DOE-RL 1999a) and WIDS based on waste stream analyses for each of the waste sites. When available, these inventories are presented in Table 2-1. The inventories predominantly contained cesium-137, strontium-90, uranium, plutonium, nitrate, and sodium dichromate (DOE-RL 1997).

3.2 ENVIRONMENTAL MONITORING

Current efforts at the Hanford Site focus on environmental cleanup. Prior to recent cleanup efforts, monitoring was performed across the Hanford Site to measure and evaluate long-term trends in the environmental accumulation of radioactive contamination. Risks associated with unacceptable levels of contamination were typically stabilized (covered with soil, concrete, and/or gravel backfill) to minimize impact on human health and the environment.

The accumulation of radioactivity at disposal sites was typically evaluated through sampling and analysis of soil samples. These samples were generally collected less than 0.3 m (1 ft) directly

below the bottom of the receiving sites. Samples were collected on an annual basis; however, the number of samples collected was limited and sample locations were not always documented. Therefore, very little or no information is typically available to evaluate the lateral and vertical extent of contamination in the vadose zone during active periods of discharge. Nonradioactive constituents were not usually analyzed. Scintillation logging was commonly performed in boreholes adjacent to waste sites. The logs were used to determine the extent of radiological contamination in the subsurface; however, these logs are not quantitative and provide only a general indication of the presence of radiological contamination. Groundwater is monitored for some constituents at these sites through RCRA requirements and the sitewide groundwater monitoring program.

Currently, environmental monitoring at the Hanford Site consists of effluent monitoring, groundwater and vadose zone monitoring, and environmental surveillance. The environmental surveillance is conducted for the following media:

- Air
- Surface water and sediments
- Drinking water
- Farm and farm products
- Soil and vegetation
- External radiation.

Air, external radiation, soil, and vegetation are routinely evaluated in the 200 Areas as part of the Hanford Site near-facility and environmental monitoring programs. Results of the near-facility and environmental monitoring programs are presented in annual reports. The most recent of these annual reports are the *Hanford Site Near-Facility Environmental Monitoring Data Report for Calendar Year 1999* (PNNL 2000a) and the *Hanford Site Environmental Report for Calendar Year 2000* (PNNL 2001a). The near-facility document focuses on monitoring activities near facilities that have potential to or have discharged, stored, or disposed of radioactive or hazardous materials, including those facilities within the 200 East and 200 West Areas. The Hanford Site environmental report covers the entire Hanford Site, including those areas not associated with operations (such as the 600 Area). This annual report examines the resources associated with the Hanford Site, including those media listed above as well as groundwater. Results of monitoring efforts pertinent to the 200-MW1 OU waste sites are presented in Section 3.3.7. The potential impacts of 200-MW-1 OU waste site contamination on human health and the environment are discussed in Section 3.3.8.

Groundwater is also routinely monitored sitewide. More than 600 monitoring wells are sampled annually to characterize groundwater flow; groundwater contamination by metals, radionuclides, and nonradiological constituents; and the extent of contamination. Contaminated groundwater ingestion risk and dose are also assessed. Results of groundwater monitoring and remediation are presented in annual reports, the most recent of which is the *Hanford Site Groundwater Monitoring for Fiscal Year 2000* (PNNL 2001b). The groundwater monitoring reports also summarize vadose zone characterization activities conducted on the Hanford Site through other projects.

3.3 NATURE AND EXTENT OF CONTAMINATION

The following sections describe the nature and extent of contamination at the five representative waste sites.

3.3.1 200-E-4 French Drain

Little information is available to evaluate the nature and extent of contamination beneath the 200-E-4 French Drain. The nearest borehole was 299-E27-126, located about 11.6 m (38 ft) to the southwest. The borehole was drilled and decommissioned in December 1980 to identify the lithology in the area. The maximum depth of the boring was 10.7 m (35 ft), and no radiological contamination was detected based on screening the drill cuttings for beta-gamma activity using field survey instruments (Weekes 2001). The nearest groundwater well is 299-E24-8, located about 124.7 m (409 ft) to the southeast. No radiological contamination has been detected in groundwater samples from the well. Boreholes in the vicinity of the french drain are shown in Figure 3-1.

The effluent volume discharged at this site is unknown, but expected to have been very low (DOE-RL 1997). Groundwater plumes in the vicinity of the french drain (Figures 3-2 and 3-3) suggest no impact to the aquifer from this waste site. The current status of groundwater contamination in the vicinity of the 200-E-4 French Drain is described in PNNL (2001b). While iodine-129 levels in the groundwater exceed groundwater protection standards/guidelines in the vicinity of the french drain, based on process knowledge its presence in groundwater is not attributable to this waste site.

3.3.2 216-A-4 Crib

Scintillation probe profiles and spectral gamma-ray log data were used to evaluate the nature and extent of contamination in the vicinity of the 216-A-4 Crib. Spectral gamma profile data and scintillation logs are available from well 299-E24-54 located 2 m (6.6 ft) northeast of the crib. A crib location map is shown in Figure 3-4. Scintillation profiles were collected between 1959 and 1976 and presented in Fecht et al. (1977). Conclusions in this report indicate (1) radioactive contamination was detected from ground surface to the bottom of the borehole 15.2 m (50 ft), (2) waste volume and waste inventory indicated breakthrough to the groundwater has not occurred, and (3) the higher radiation intensity in the upper portion of the borehole was due to the retention of long-lived radionuclides near the point of discharge. The borehole was extended to 100 ft in 1982 to use as a vadose zone monitoring well. Spectral gamma-ray profiles and neutron moisture logs were collected in 1999. Cesium-137 was identified over the depths 0 to 0.9 m (0 to 3 ft), from 7.9 to 10 m (26 to 33 ft), and from 16.5 to 27.1 m (54 to 89 ft). The maximum concentration of cesium-137 occurred at a depth of 19.8 m (65 ft), with a reading of 80 pCi/g. The cesium-137 near ground surface is probably related to UPR-200-E-13 that occurred in 1958 when the crib plugged and caused contaminated liquid to flood the ground surface. The contaminated soil was placed in a trench near the south border of the crib and covered with 0.3 m (1 ft) of soil. The only other radionuclide reported was cobalt-60. Cobalt-60 was identified from 7.9 to 20.7 m (26 to 68 ft). The maximum concentration of cobalt-60 occurred at a depth of 13.4 m (44 ft), with a reading of 3.6 pCi/g.

The effluent volume discharged at this site was greater than the soil pore volume in the soil column beneath the waste site (DOE-RL 1997). This suggests that groundwater may have been impacted by this waste site. The current status of groundwater contamination in the vicinity of the 216-A-4 Crib is described in PNNL (2001b). The report indicates groundwater concentrations of nitrate, iodine-129, and tritium exceeding groundwater protection standards/guidelines in the vicinity of the crib. Based on process knowledge all of these contaminants may be associated with waste disposal practices at the crib. Groundwater plumes in the vicinity of the 200 East Area and the 216-A-4 Crib are shown in Figures 3-2 and 3-3.

3.3.3 216-T-13 Trench

Little information is available to evaluate the nature and extent of contamination beneath the 216-T-13 Trench. Boreholes in the vicinity of the trench are shown in Figure 3-5. Only one well, 299-W10-17, is located in the vicinity of the trench (about 25.9 m [85 ft] to the south). The available data from the borehole consist of scintillation log data collected in 1990. Near-background levels of radioactivity were detected over most of the logged interval (0 to 67.7 m [0 to 222 ft]).

Because the effluent volume discharge to the soil column is far less than the pore volume, liquid waste contaminants with moderate to very low distribution coefficients would be unlikely to impact groundwater at 216-T-13 Trench (DOE-RL 1997). The current status of groundwater contamination in the vicinity of the 216-T-13 Trench is described in PNNL (2001b). The report indicates groundwater concentrations of nitrate, trichloroethylene, and carbon tetrachloride exceed groundwater protection standards/guidelines in the vicinity of the trench. Of these contaminants, only trichloroethylene may have been associated with waste disposal practices at this trench. Groundwater plumes in the 200 West Area and the 216-T-13 Trench are shown in Figures 3-6 and 3-7.

3.3.4 216-T-33 Crib

Little information is available to evaluate the nature and extent of contamination beneath the 216-T-33 Crib. Only well 299-W11-14 is in the vicinity (about 9.1 m [30 ft] to the north). A well location map is shown in Figure 3-8. Scintillation profiles were collected between 1959 and 1976 and presented in Fecht et al. (1977). The conclusions in this report indicate (1) near-background levels of radiation were detected from ground surface to the bottom of the well and (2) breakthrough to the groundwater has not occurred. A scintillation profile was also run in 1987, which suggests that no significant lateral contamination beyond the crib has occurred.

While the effluent volume reportedly discharged at this site was greater than the soil pore volume (DOE-RL 1997), there is uncertainty about the actual volume discharged because the crib was only used for 2 months before it became plugged. The current status of groundwater contamination in the vicinity of the 216-T-33 Crib and 200 West Area is described in PNNL (2001b). The report indicates that nitrate, trichloroethylene, carbon tetrachloride, iodine-129, and tritium groundwater concentrations exceed groundwater protection standards/guidelines in the vicinity of the crib. Of these contaminants, only trichloroethylene may have been associated with waste disposal practices at the crib. Groundwater plumes in the vicinity of the 200 West Area and the 216-T-33 Crib are shown in Figures 3-6 and 3-7.

3.3.5 216-U-3 French Drain

Little information is available to evaluate the nature and extent of contamination beneath the 216-U-3 French Drain. The nearest well is 299-W19-1 (about 36.6 m [120 ft] to the east). A well location map is shown in Figure 3-9. The available data from the borehole consist of scintillation log data collected in 1987, which suggests that no significant lateral contamination beyond the french drain was present.

The effluent volume discharged at this site was greater than the soil pore volume (DOE-RL 1997). The current status of groundwater contamination in the vicinity of the 216-U-3 French Drain is described in PNNL (2001b). The report indicates that the carbon tetrachloride groundwater concentration exceeds groundwater protection standards/guidelines in the vicinity of the crib. Based on process knowledge, this contaminant is not associated with waste disposal practices at this crib. Major groundwater plumes in the vicinity of the 200 West Area and the 216-U-3 French Drain are shown in Figures 3-6 and 3-7.

3.3.6 Conceptual Contaminant Distribution Models

A preliminary conceptual contaminant distribution model was developed for the 200-MW-1 OU in the waste site grouping report (DOE-RL 1997). The preliminary model has been updated with conceptual contaminant distribution models of representative sites in this section. The revised conceptual contaminant distribution models are based on data collected at representative sites and knowledge gained by evaluating other 200 Area waste sites. Because limited data were available to evaluate the nature and extent of contamination beneath the 200-E-4 French Drain, 216-T-13 Trench, 216-T-33 Crib, and 216-U-3 French Drain, conceptual contaminant distribution models for the four sites were developed based on a general understanding of contaminant fate and transport. Conceptual contaminant distribution models are shown in Figures 3-10 through 3-14.

Information pertaining to contaminant sources, release mechanisms, transport media, exposure routes, and receptors have also been incorporated into the discussion of the conceptual contaminant distribution models in this section. The conceptual exposure pathway model is included to facilitate an understanding of potential risks to Hanford Site receptors (Figure 3-15). This information will support an evaluation of potential human health and environmental risk.

The majority of radionuclide and nonradiological inventories disposed by operations associated with the 200-MW-1 OU waste sites were not documented in historical records; however, rough-order-of-magnitude estimates for some of the waste sites are documented in the Implementation Plan and WIDS based on waste stream analyses for the waste sites. These inventories are presented in Table 2-1. In general, the inventories contained varying amounts of cesium–137, strontium-90, uranium, plutonium, nitrate, and sodium dichromate (DOE-RL 1997). The waste streams are characterized by very low concentrations of radionuclides and nonradiological constituents (DOE-RL 1997). The primary contaminant sources were from the following facilities/activities:

- Process facility ventilation stack and sand filter sources. This group also contains the 216-A-4 Crib, which received ventilation as well as PUREX laboratory drainage that was routed through the PUREX canyon U Cell tanks to the crib

- Vehicle/heavy equipment facility decontamination
- Vehicle/heavy equipment field decontamination
- Low-level radioactive process or steam condensate, which was primarily discharged to french drains
- Nonradiological process steam condensate with radiological cross-contamination.

Releases to the environment from the primary contaminant sources have produced contaminated surface soils, subsurface soils, and groundwater beneath waste sites. These secondary sources can impact the environment by infiltration, resuspension of contaminated soil, volatilization, biotic uptake, leaching, and external radiation. During the periods when waste sites received effluent, the dominant mechanism of contaminant transport was infiltration. After effluent disposal ceased, the liquids continued to move through the soil column for an undetermined period of time. Currently, the dominant mechanism of contaminant transport through the vadose zone is assumed to be from residual effluent moisture and natural recharge.

The following general conclusions can be drawn regarding the conceptual contaminant distribution model for these waste streams:

- Effluents discharged to waste sites in the OU consisted of low-level radioactive, low-organic, and low-inorganic concentration solutions. The major radionuclide contaminants of concern (COCs) include cesium-137; plutonium-238, plutonium-239, and plutonium-240; strontium-90; and uranium 234, uranium-235, and uranium-238.
- Some of the OU waste sites received enough effluent to impact groundwater.
- Contamination migrated vertically beneath the waste sites after release. Lateral spreading of liquids and contaminants may have occurred at the bottom of the crib/trench/french drain, at the sand-dominated sequence of the Hanford formation, at the Plio-Pleistocene unit/early Palouse soil, and/or at the upper Ringold Formation, if present.
- Contaminants such as cesium-137 and the plutonium isotopes, for example, normally adsorb strongly onto shallow zone Hanford Site sediments, and therefore have high distribution coefficients (K_d). These less mobile contaminants should be detected near points of release in the vadose zone. Contaminants with low K_d values (e.g., nitrate and tritium) are not readily adsorbed on soil particles and migrate to greater depth within the vadose zone. For example, cesium-137 (K_d > 2,000 mL/g) is likely to concentrate near the point of release; strontium-90 (K_d = 0.4 to 50 mL/g) and uranium (K_d = 2 mL/g) would be expected at greater depths. Tritium with a K_d value equal to 0 will migrate vertically with the wetting moisture front.
- Contaminant mobility may be enhanced at some decontamination waste sites due to complexing agents added to increase the effectiveness of decontamination solutions.

- Immobile contaminants will be detected high above the water table in the vadose zone. The concentration of high K_d contaminants will generally decrease with depth. Mobile contaminants will be detected at very low concentrations throughout the vadose zone, and their concentrations may actually increase with depth.

- Based on existing groundwater data, the contaminants detected above maximum contaminant levels in the groundwater near representative sites are tritium, iodine-129, nitrate, carbon tetrachloride, and trichloroethylene.

- Waste sites in the 200-MW-1 OU no longer receive effluent. Most sites in this OU have been stabilized and covered with clean soil. With the cessation of artificial recharge, the downward flux of moisture through the vadose zone has decreased. Residual moisture should continue to decrease in the vadose zone over time and equilibrate with the natural recharge rate, thus reducing the potential for future impacts to groundwater.

Potential receptors (human and ecological) may be exposed to the affected media through several exposure pathways, including inhalation, ingestion, and direct exposure to external gamma radiation. Potential human receptors include current and future site workers and visitors (occasional users). Potential ecological receptors include terrestrial plants and animals, which are discussed in Section 3.3.7. The conceptual exposure model for the 200-MW-1 OU is shown in Figure 3-15.

Future impacts to humans are largely dependent on prominent exposure pathways indicated by future land uses, which are undetermined at this time. A restricted land-use scenario for the 200 Areas is favored by DOE, EPA, and the Washington State Department of Ecology (Tri-Parties). All the sites within the 200-MW-1 OU are located within the exclusive-use boundary identified in the *Final Comprehensive Land-Use Plan Environmental Impact Statement* (DOE 1999) and the ROD (64 FR 61615).

3.3.7 Environmental Information

A summary of ecological resources for the 200 Areas is provided in Appendix F, Section F8.0 of the Implementation Plan (DOE-RL 1999a). Information on these resources is also included in the annual environmental monitoring reports (e.g., PNNL 2000a, 2001b). This section of the work plan presents available ecological sampling and monitoring data in the vicinity of 200-MW-1 OU waste sites. Sources of data consulted to provide this summary included the following:

- *Historical Records of Radioactive Contamination in Biota at the 200 Areas of the Hanford Site* (Johnson et al. 1994)

- *Hanford Site Near-Facility Environmental Monitoring Data Report for Calendar Year 1999* (PNNL 2000a) (and previous annual reports).

Investigative sampling of soil and biota is conducted as part of the Hanford Site environmental monitoring program to confirm the absence or presence of radioactive and/or radiological contaminants where known or suspected contaminants are present, or to verify radiological conditions at specific project sites. Detection of contamination in wildlife species may indicate that wildlife are entering contaminated areas (e.g., burrowing in waste burial grounds) or that materials are moving out of contaminated areas through blowing dust or food chain transport. Historically, much of the contamination in the 200 Area wildlife was related to contamination in surface-water ponds. Decommissioning the surface water ponds has reduced opportunities for wildlife exposure to radionuclides (Poston and Cooper 1994).

In recent years, the frequency and breadth of biological (wildlife) sampling has significantly diminished. Several radionuclides that were monitored in the past have not been detected in recent samples because they were no longer present in the environment in sufficient amounts to accumulate in wildlife, or did not accumulate in the wildlife tissues of interest (PNNL 2000a). In recent years, sampling in the 200 Areas has been limited to terrestrial biota such as elk and rabbits (PNNL 2000a). Analytes sampled under the radionuclide monitoring program include gamma-emitting radionuclides, strontium isotopes, uranium isotopes, and plutonium isotopes. Media sampled include soil, vegetation, nests (bird, wasp, ant), mammal feces (rabbit, coyote), mammals (mice, bats), and insects (fruit flies). Results of investigative sampling are reported in the annual Hanford Site Environmental Monitoring Report (e.g., PNNL 2000a, 2000b). A large volume of radionuclide data exist as a result of the annual monitoring program; however, nonradiological constituents have not been analyzed under this program.

Wildlife species most commonly associated with uptake of radioactive contamination in the 200 Areas have historically been house mice and deer mice, but other animals such as birds (including waterfowl), coyotes, cottontail rabbits, mule deer, and elk have been sampled (Johnson et al. 1994, PNNL 1999). In 1999, the Pacific Northwest National Laboratory sampled elk, geese, and rabbits for gamma emitters and strontium-90. Samples of elk muscle, bone, liver, heart, kidney, intestine, and feces were collected from animals struck on Hanford Site roadways and from individuals sampled on the 200 Area Plateau. Cesium-137 was undetected in all elk samples. Poston and Cooper (1994) reported a consistent decline in cesium-137 concentration in elk since 1983. Geese were sampled from the Hanford Reach near the Vernita Bridge. Only one of the eight geese sampled showed a cesium-137 concentration above analytical detection. Eight rabbit samples consisting of jackrabbit and cottontail muscle and bone were taken from the 200 Areas in 1999. One of the eight rabbit muscle samples showed a cesium-137 concentration above analytical detection. Strontium-90 was detected in bones of all eight samples; however, according to the *Hanford Site Environmental Report for Calendar Year 1999* (PNNL 2000a), the results from animals sampled near the 200 Areas did not suggest significant exposure attributable to Hanford Site operations.

Plant species may potentially be exposed to contaminated soils present in the 200 Area vadose zone, as they live in direct contact with the soil and can take up contaminants through physical and biological processes. The extent of 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 themselves are generally tolerant of ionizing radiation (IAEA 1982), but present a potential contaminant pathway to wildlife through the consumption of contaminated seeds,

leaves, roots, or stalks. Radionuclide uptake by plants within the 200 Areas was demonstrated by Johnson et al. (1994).

Eighty-five environmental monitoring records of wildlife and vegetation at the 200 East and 200 West Areas collected since 1965 were reviewed and summarized by Johnson et al. (1994). About 4,500 individual cases of monitoring for radionuclide uptake or transport in biota in the 200 Area environs were included in the documents reviewed by Johnson et al. (1994). Approximately 1,900 (42%) of these biota had radionuclide concentrations in excess of 10 pCi/g. These radionuclide transport or uptake cases were distributed among 45 species of animals (mostly small mammals and feces) and 30 species of vegetation.

Wildlife species historically associated with uptake of radioactive contamination in the 200 Areas have been house mice and deer mice. The vegetative species most commonly associated with the contamination was Russian thistle. The largest numbers and levels of radionuclide uptake or transport occurred at several sites unrelated to the 200-MW-1 OU, including the 216-Z Ditches, 216-B-3 Ditches, 216-BC Cribs, 241-B Tank Farm, and 241-BX/BY Tank Farms. Much of the sampling data were collected prior to stabilization activities at the individual waste sites. Noticeable improvements in reducing uptake and transport of radionuclide contaminants by biota were observed in areas where interim stabilization activities have taken place (Johnson et al. 1994).

Only one location near the 200-MW-1 OU waste sites was field surveyed or analytically sampled between 1965 and 1993 (Johnson et al. 1994). Samples of vegetation (cheatgrass and terrestrial composite samples) and rabbit and coyote feces were collected from 1978 to 1988 and analyzed for cesium-137, strontium-90, and plutonium-239. These samples were collected outside of the 221-U Facility, which is located near the 216-U-7 and UPR-200-W-138 sites within the 200-MW-1 OU. All but two samples contained radionuclide concentrations of less than 1.0 pCi/g. The two exceptions were terrestrial vegetation and rabbit feces samples collected in 1982 that contained 1.2 pCi/g and 8.0 pCi/g of cesium-137, respectively (PNL 1983).

In a 1999 sampling effort described in the Hanford Site Environmental Report (PNNL 2000a), 55 soil samples and 48 vegetation samples were collected in the 200/600 Areas. Vegetation and soil samples were collected from one 200-MW-1 waste site (i.e., 216-T-33 Crib) under the Hanford Site Near-Facility Monitoring Program (e.g., PNNL 2000b). Soil and vegetation samples were collected from station D021/V021 located within the 216-T-33 Crib boundary. Soil and vegetation concentrations of radionuclides for the D021/V021 monitoring site are listed in Table 3-1. All soil and vegetation samples contained radionuclide concentrations of less than 1.0 pCi/g.

Biological transport of contamination by ants is also a 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). In a contamination area, ants are capable of bringing radioactive materials to the surface, where they could be susceptible to other means of transport by wind, plant uptake, birds, or mammals. The biological transport of contamination by harvester ants was documented during an annual radiological survey at the UPR-200-E-64 site in 1985. The source of contamination was assumed to be a small-diameter pipe visible on

the west side of the 216-B-64 Retention Basin, near tank 270-E-1 in the 200-SC-1 OU. In 1985, the pipe had a dose rate of 30 mrad/hr. 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 is currently 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 (part of the 200-IS-1 OU) in September 1998.

Based on the lack of ecological data available from previous investigations within the 200-MW-1 OU, additional site-specific ecological data may be required to assess impacts to the environment. However, it is expected that these additional specific ecological data needs for the 200-MW-1 OU will be defined by the overall assessment of ecological impacts for the 200 Areas (DOE-RL 2002b), as discussed in Section 5.2.

3.4 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-MW-1 OU. Information pertaining to contaminant sources, release mechanisms, transport media, exposure routes, and receptors is discussed to develop a conceptual understanding of potential risks and exposure pathways. This information will be used to support an evaluation of potential human health and environmental risk in the RI/FS documents for the 200-MW-1 OU.

3.4.1 Contaminant Sources and Release Mechanisms

As discussed in Section 2.0, the primary sources of contamination at waste sites in this OU were from moderate to low-volume equipment decontamination and ventilation system wastes, plus small-volume waste streams commonly disposed to french drains. The waste was generally disposed to the vadose zone through cribs, french drains, and trenches, where the wastewater infiltrated into the soil. Unplanned releases of contaminants also occurred.

Releases to the environment from primary contaminant sources have resulted in contaminated soils beneath the stabilized waste sites. Secondary releases can occur through infiltration (continued movement of wastewater through the soil), resuspension of contaminated soil (erosion or mechanical disturbances), volatilization (movement of organic chemicals through the soil and into the air), biotic uptake (plant uptake or animal ingestion), leaching (contaminant release from rain or snowmelt exposure), and external radiation (gamma). The dominant mechanism of 200-MW-1 contaminant transport (since direct liquid waste discharges ceased) is from infiltration and leaching, with natural precipitation as driving forces. Residual effluent contamination in the vadose zone beneath the waste sites has the potential to impact groundwater.

3.4.2 Potential Receptors

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

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

Potential human receptors include site workers (current and future) and site visitors (occasional users). Under a restricted future land-use scenario, site worker and visitor exposure pathways would primarily involve incidental soil/sediment ingestion (including dust inhalation), dermal contact with contaminated soils/sediments, and external gamma radiation. Potential ecological receptors include terrestrial plants and animals inhabiting the sites. Site biota exposures would primarily result from incidental soil/sediment ingestion, plant uptake, ingestion of contaminated plant or animals (e.g., grazing or predation), dermal contact with contaminated soils/sediments, and external gamma radiation. The conceptual exposure model for the 200-MW-1 OU is shown in Figure 3-15.

3.4.3 Potential Impacts

Potential contaminant exposures and health impacts to humans are largely dependent on allowable land uses. The land use inside the 200 Area boundary selected by DOE through the *National* Environmental Policy Act of 1969 process (DOE 1999) and documented in a ROD (64 FR 61615) is industrial (exclusive). Outside the 200 Area boundary, the selected land use is conservation (limited mining and grazing by permit only). The 200-MW-1 sites are all located within the 200 Area exclusive-use boundary. Therefore, based on the land-use decision for the 200 Areas, potential impacts from the waste site contaminants within the 200 Area boundary would be to current and future site workers and to terrestrial biota inhabiting the sites.

Identification of ecological receptors and potential impacts to those receptors have been evaluated at waste sites within the 200 Areas (Perkins et al. 2000, Rogers and Rickard 1977, Stegen 1993). The vegetation cover within the 200 Area Plateau is dominantly a rabbitbrush/ cheatgrass and sagebrush/cheatgrass association with incidence of herbaceous and annual species. Many areas are disturbed and nonvegetated, or sparsely vegetated with annuals and weedy species such as Russian thistle. Potential ecological contaminant exposures at the waste sites are minimized due to past site stabilization activities.

Existing soil characterization data plus proposed borehole sampling at representative waste sites are expected to be sufficient to address potential impacts to human health.

Based on the lack of ecological data available from previous investigations within the 200-MW-1 OU, additional site-specific ecological data may be required to assess impacts to the environment. It is expected that these additional specific ecological data needs for the 200-MW-1 OU will be defined by the overall assessment of ecological impacts for the 200 Areas (Section 5.2).

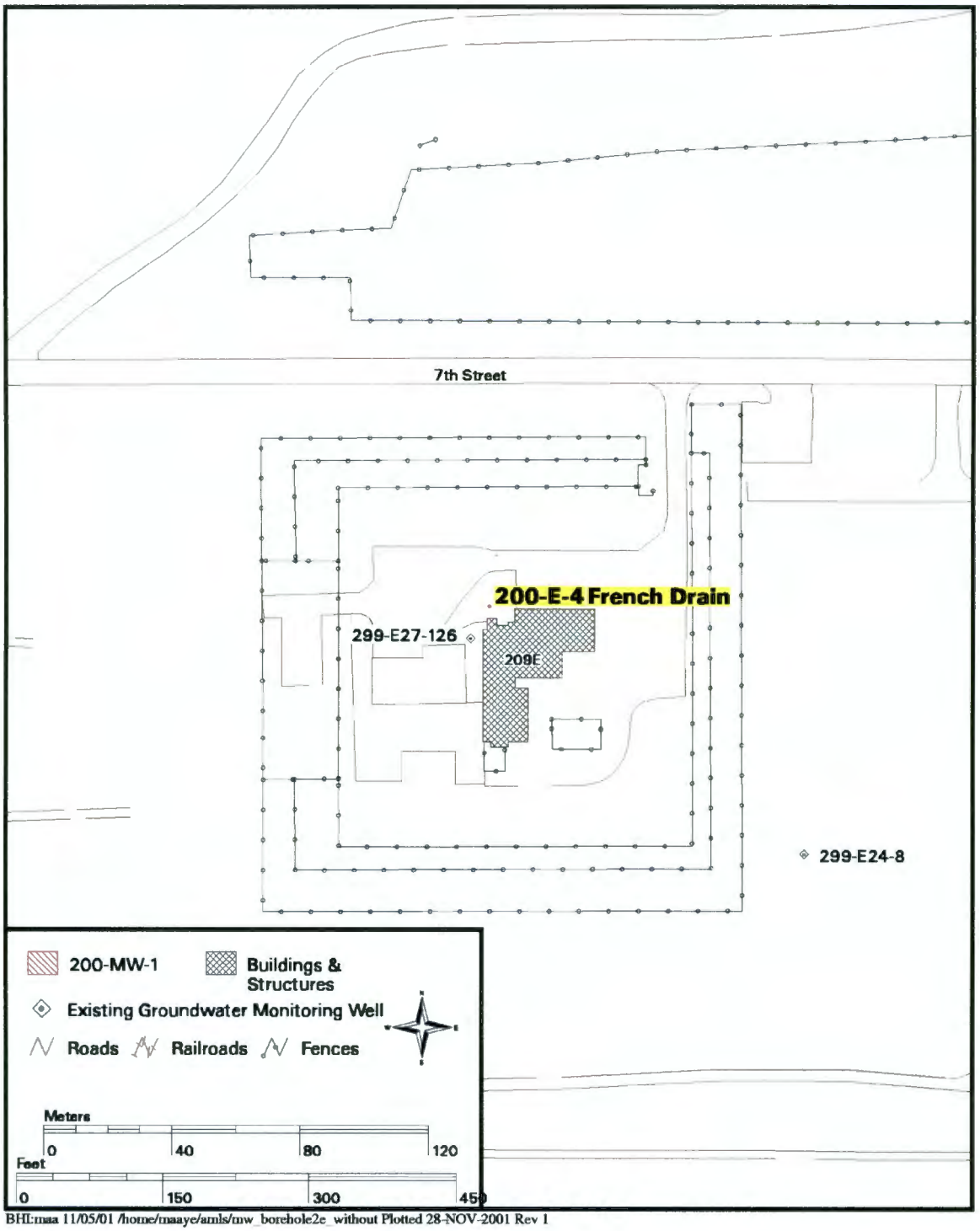
3.5 DEVELOPMENT OF CONTAMINANTS OF CONCERN

The development of the list of COPCs and final list of COCs for this OU were principal objectives of the DQO process. The list of COPCs for the 200-MW-1 OU included the set of all contaminants potentially discharged to this waste group. The final COC list was determined by evaluating the COPCs against a set of exclusion criteria and past sampling/characterization events. Chemical characteristics such as toxicity, persistence, and chemical behavior in the environment were considered. The criteria for exclusion of constituents, as detailed in the DQO summary report (BHI 2002), are as follows:

- Short-lived radionuclides with half-lives less than 3 years
- Radionuclides that constitute less than 1% of the fission product inventory and for which historical sampling indicates nondetection
- Naturally occurring isotopes that were not increased above background levels as a result of Hanford Site operations
- Constituents with atomic mass numbers greater than 242 that represent less than 1% of the actinide activities
- Progeny radionuclides whose ingrowth activity remains insignificant after 50 years 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 minute quantities relative to the bulk production chemicals consumed in the normal processes; these chemicals have no suspected introduction to waste streams except in incidental quantities
- Chemicals that are not persistent in the environment due to biological degradation or other natural mitigating features.

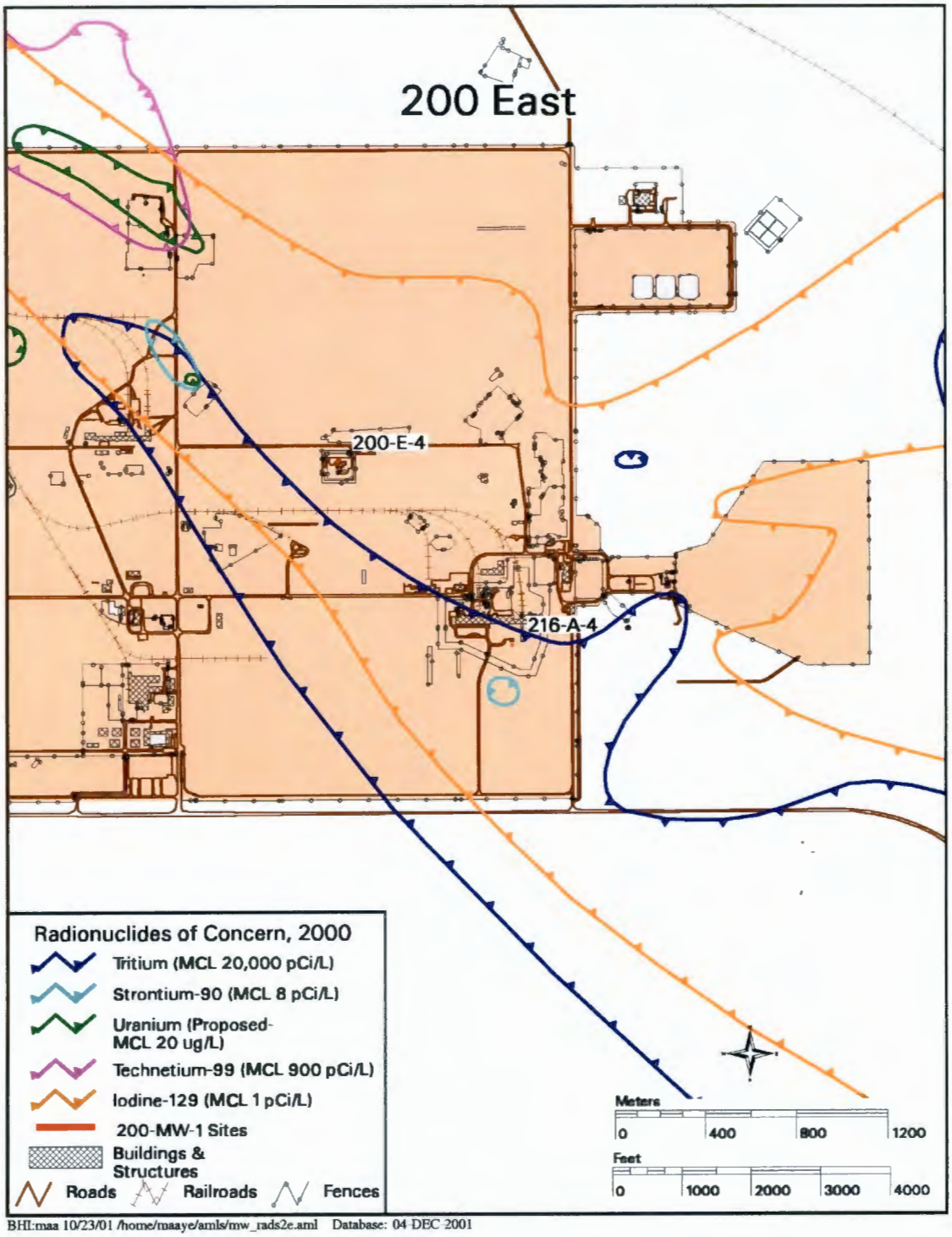
The exclusion process resulted in final lists of COCs for each of the five subgroups in this waste category (see Tables 3-2 through 3-6). The complete list of COPCs, the excluded analytes, and the rationale for exclusion are presented in the DQO summary report (BHI 2002).

Figure 3-1. 200-E-4 French Drain Location Map.



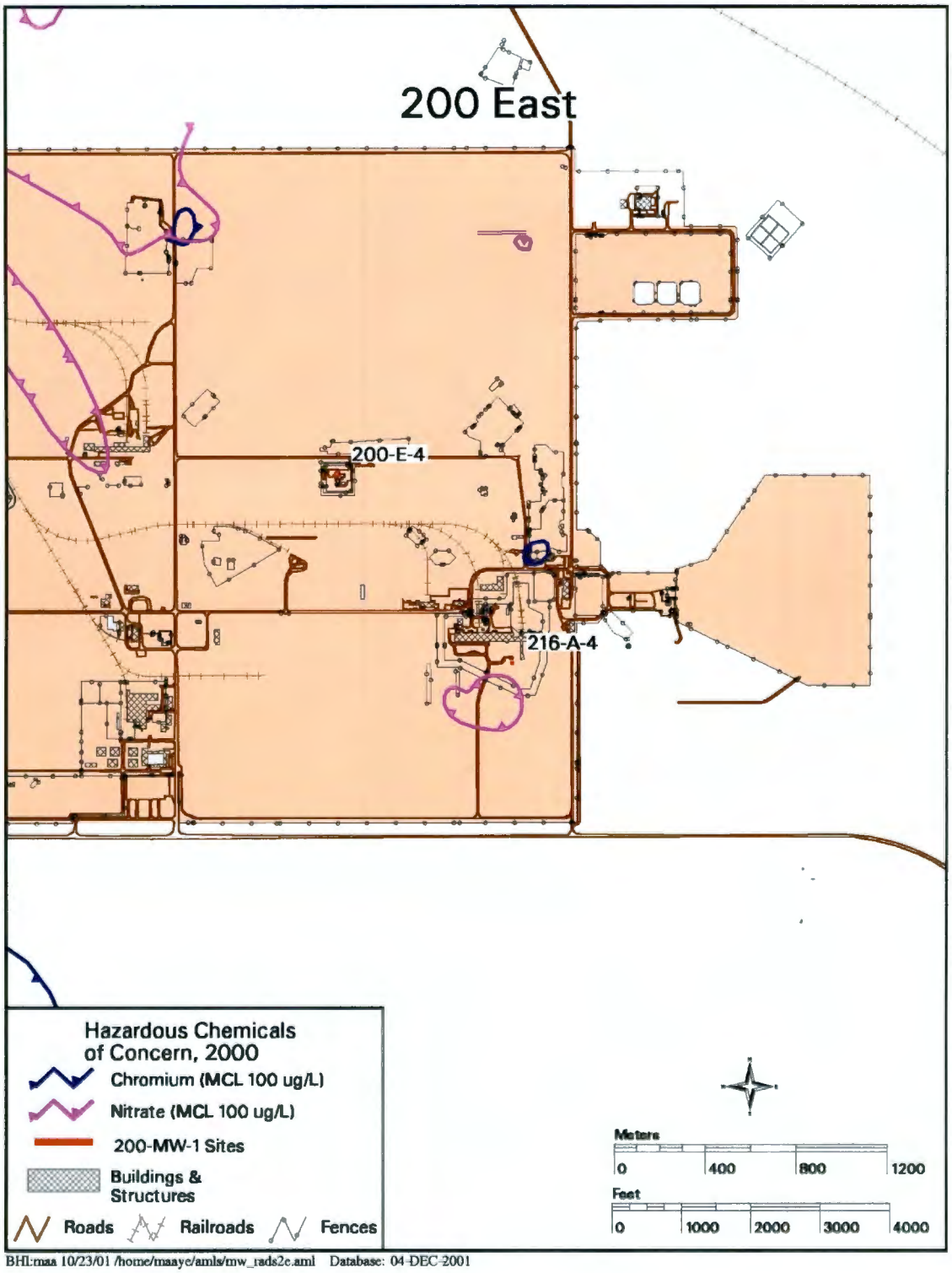
BHI:maa 11/05/01 /home/maaye/amls/mw_borehole2e_without Plotted 28-NOV-2001 Rev 1

Figure 3-2. Major Radiological Groundwater Plumes in the Vicinity of the 200 East Area (Modified from PNNL 2000b).



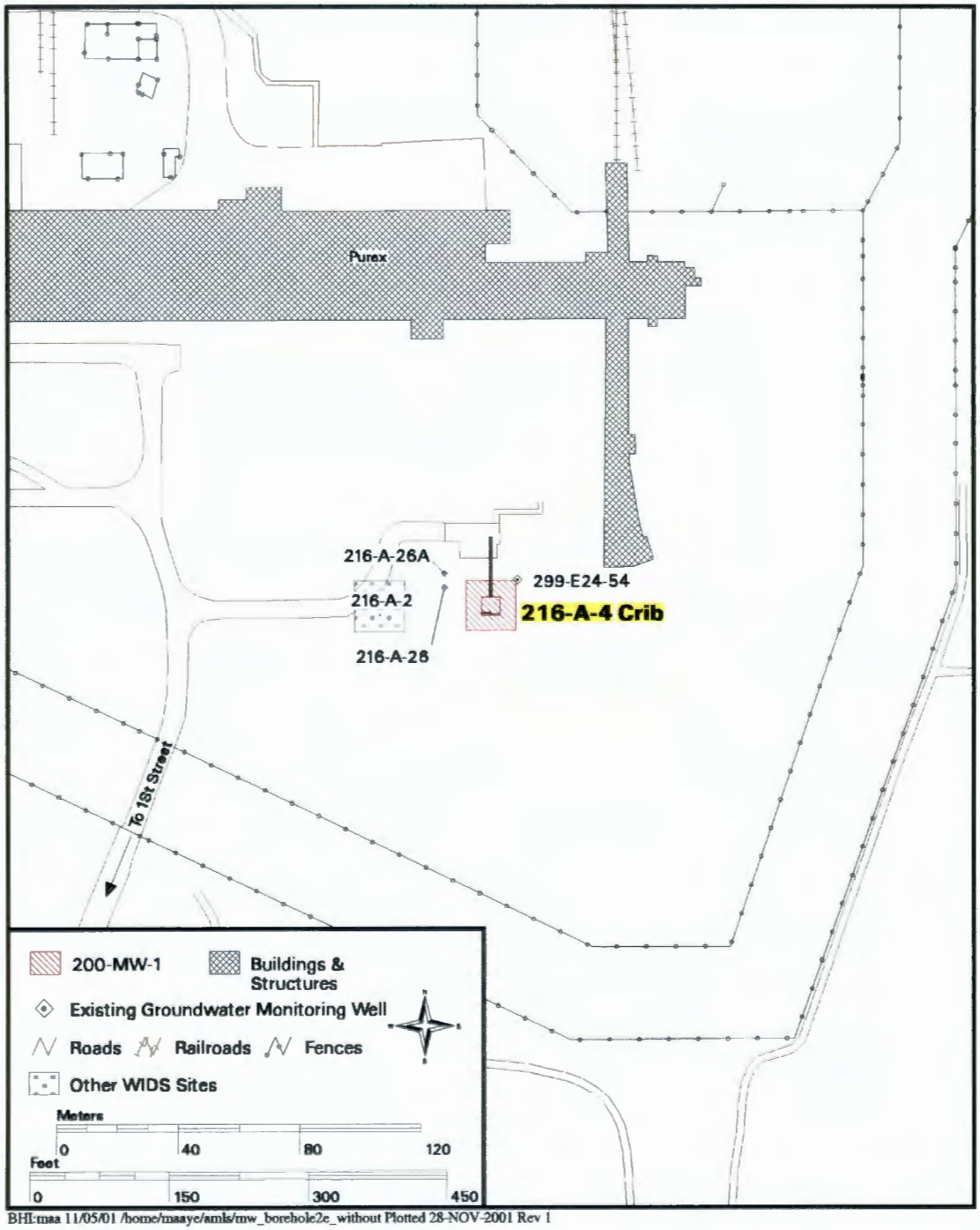
BHI:maa 10/23/01 /home/maaye/amls/mw_rads2e.aml Database: 04-DEC-2001

Figure 3-3. Major Nonradiological Groundwater Plumes in the Vicinity of the 200 East Area (Modified from PNNL 2000b).



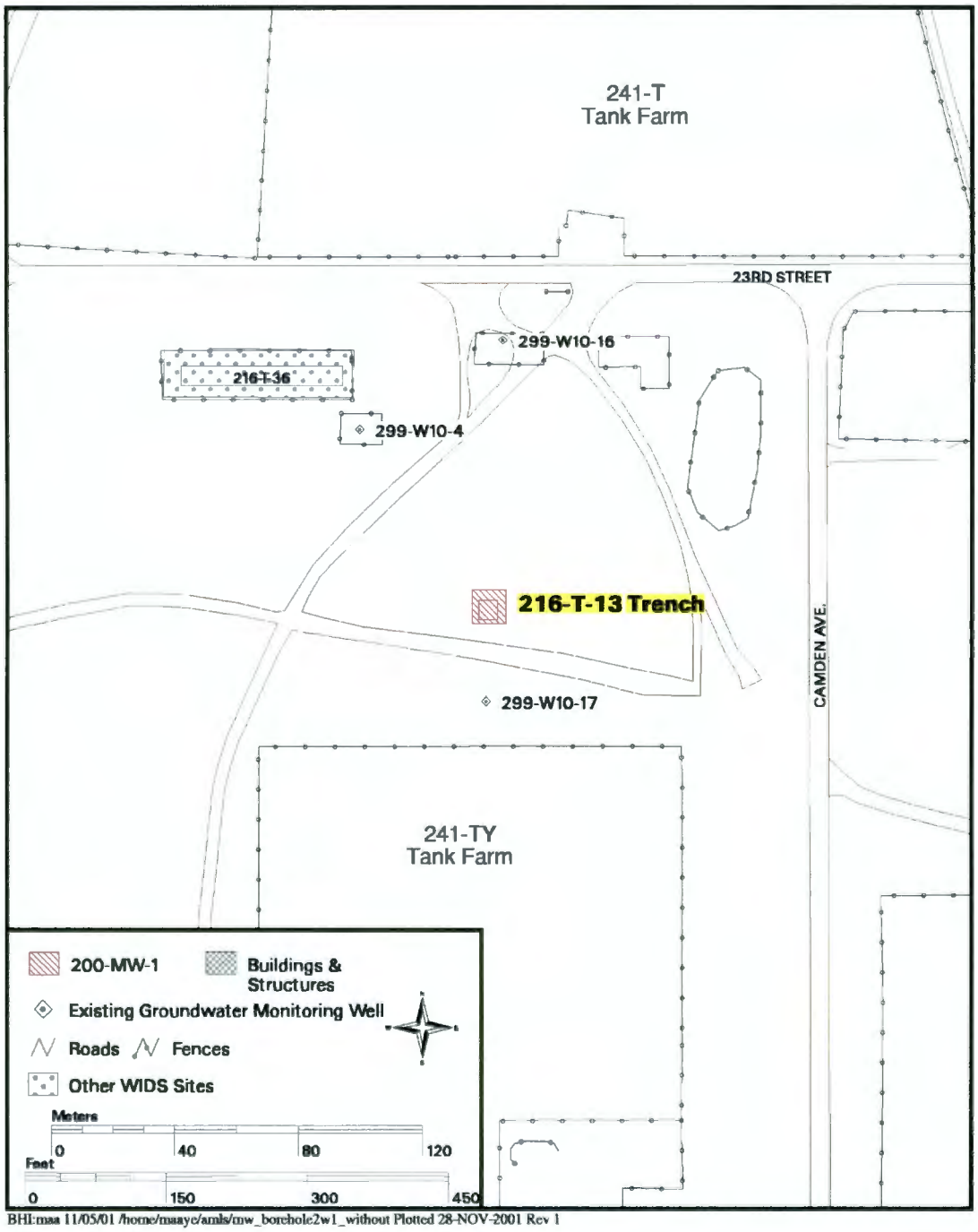
BHI:maa 10/23/01 /home/maaye/amls/mw_rads2c.aml Database: 04-DEC-2001

Figure 3-4. 216-A-4 Crib Location Map.



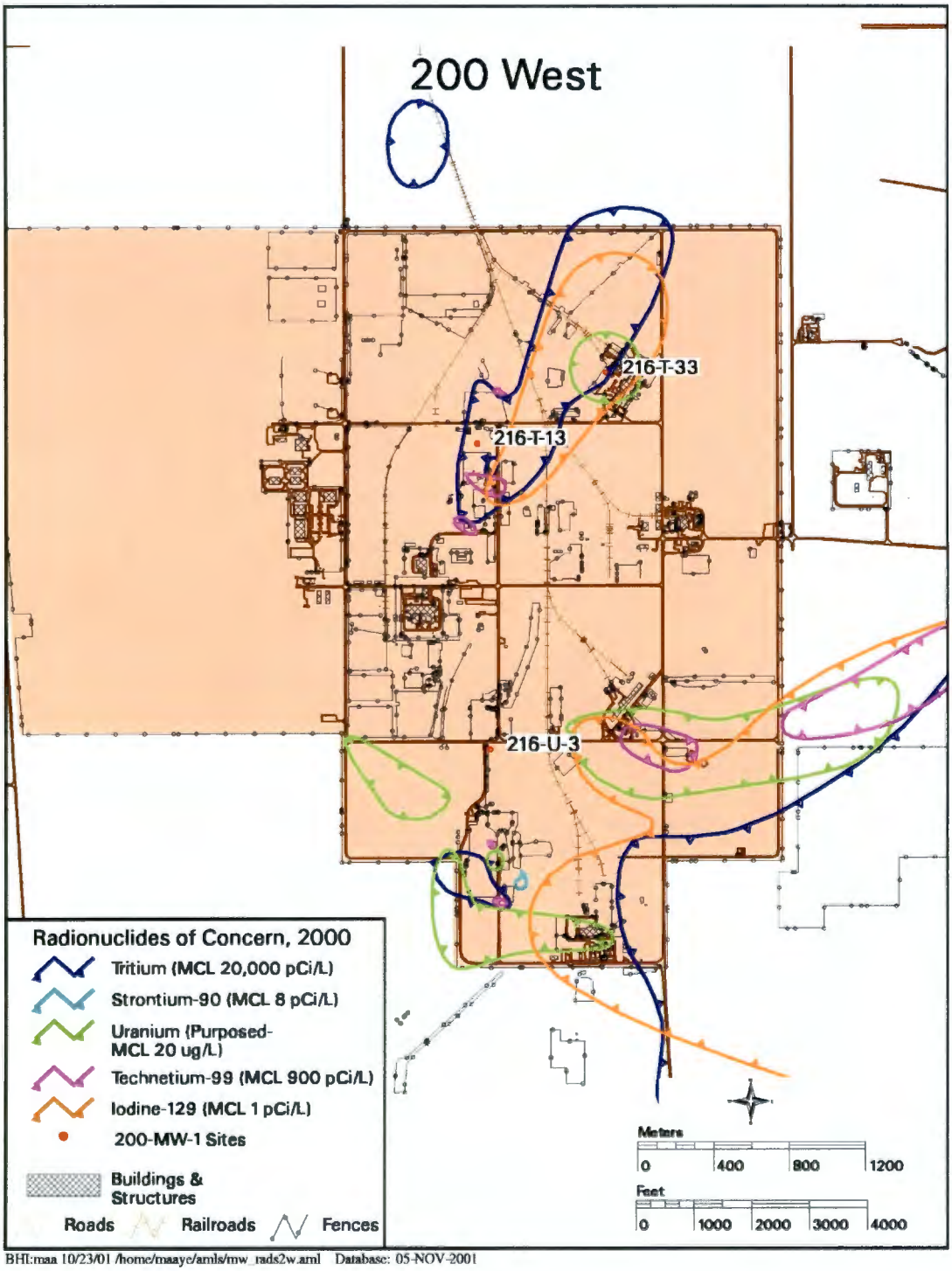
BHI:maa 11/05/01 /home/maaye/amls/mw_borehole2e_without Plotted 28-NOV-2001 Rev 1

Figure 3-5. 216-T-13 Trench Location Map.



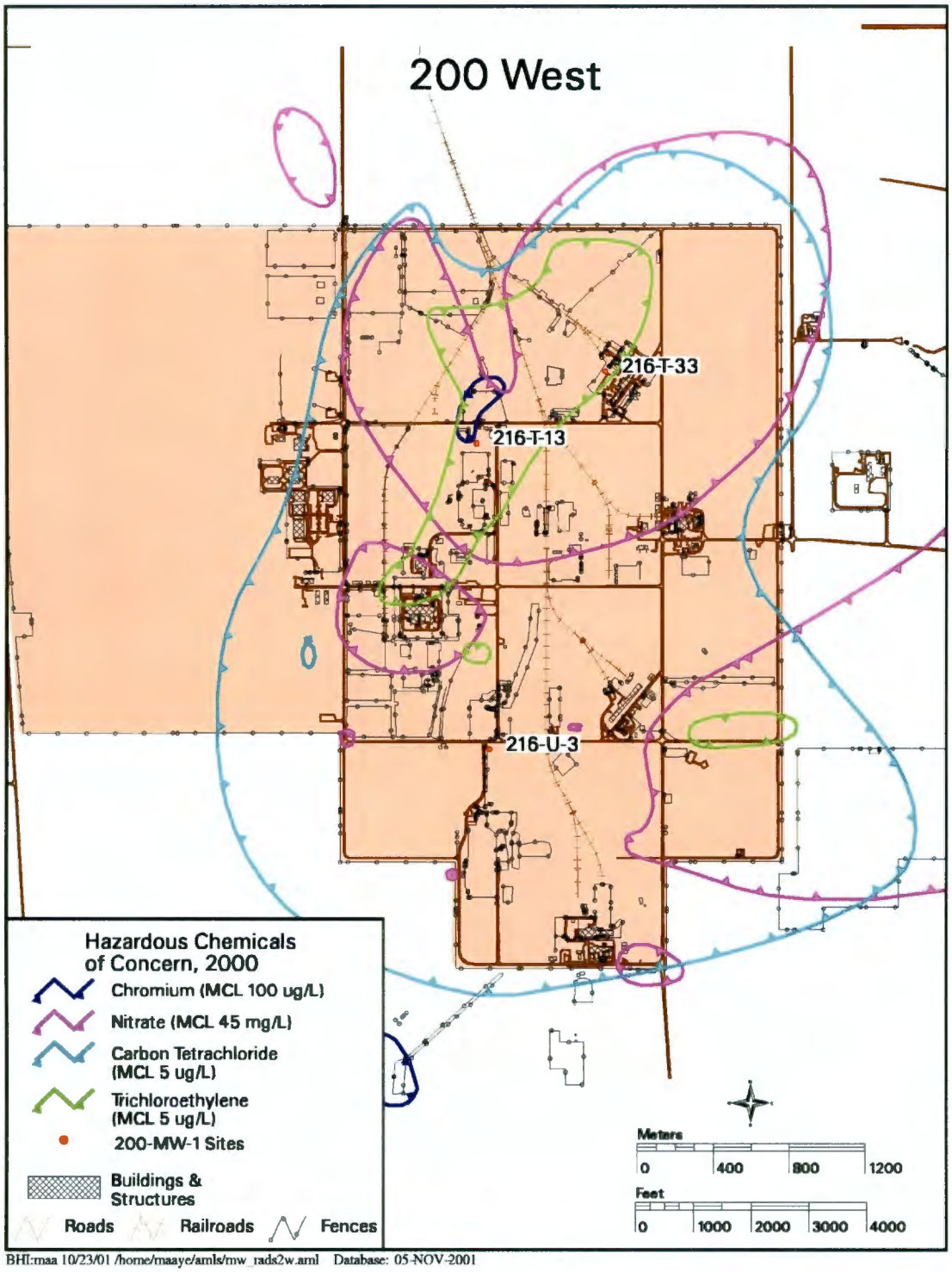
BHI:maa 11/05/01 /home/maaye/amls/mw_borehole2w1_without Plotted 28-NOV-2001 Rev 1

Figure 3-6. Major Radiological Groundwater Plumes in the Vicinity of the 200 West Area (Modified from PNNL 2000b).



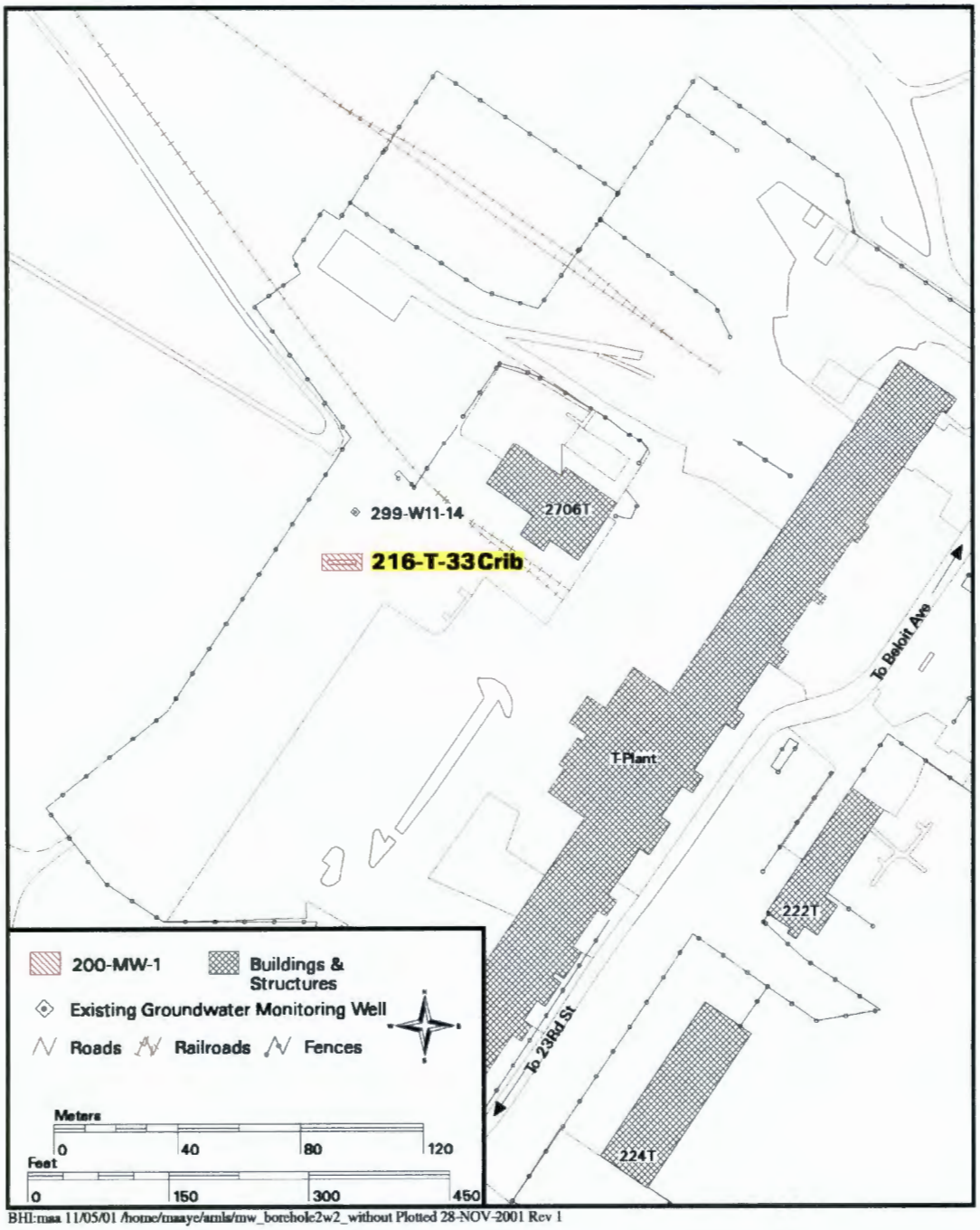
BHI:maa 10/23/01 /home/maaye/amls/mw_rads2w.aml Database: 05-NOV-2001

Figure 3-7. Major Nonradiological Groundwater Plumes in the Vicinity of the 200 West Area (Modified from PNNL 2000b).



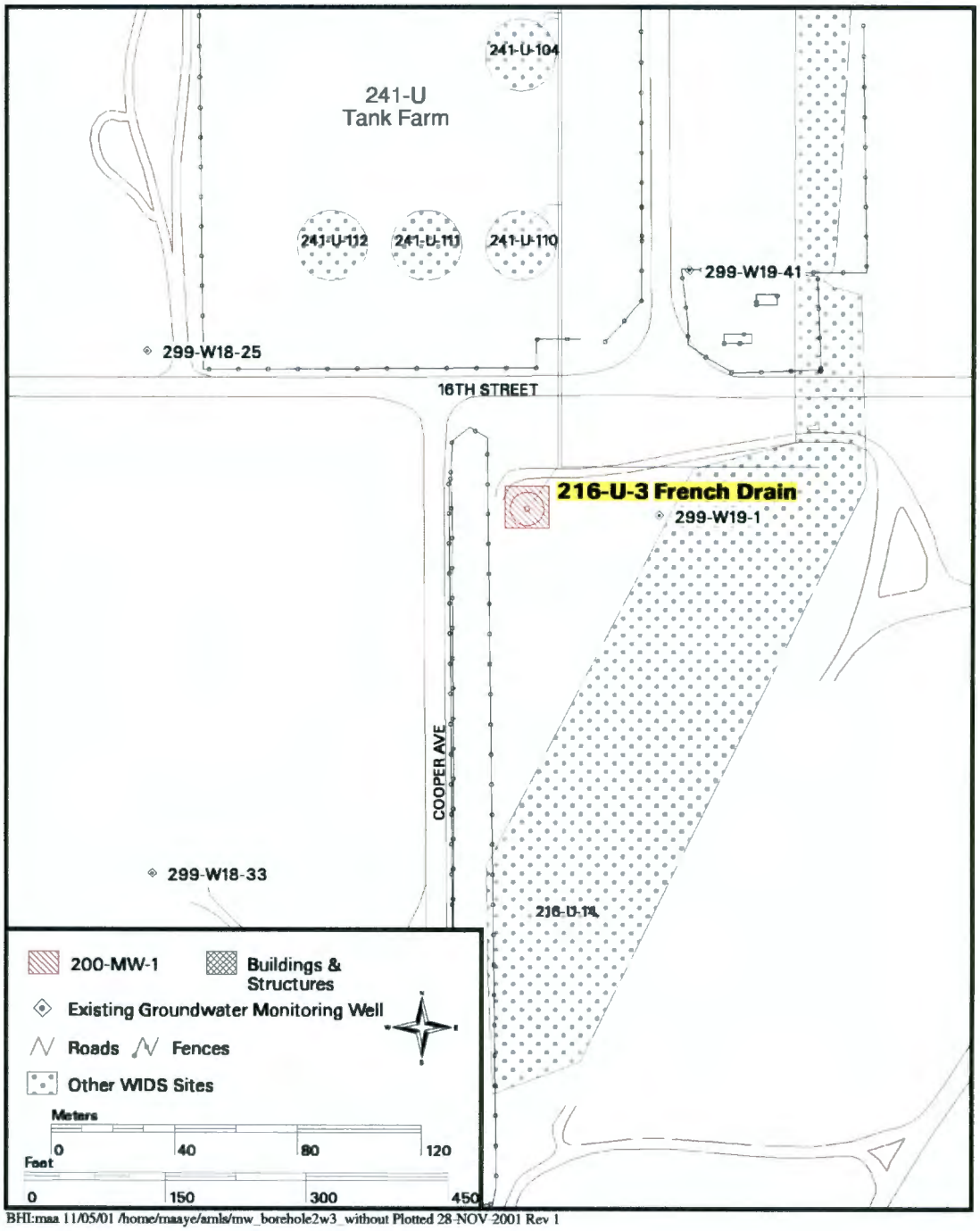
BHI:maa 10/23/01 /home/maaye/amls/mw_rads2w.aml Database: 05-NOV-2001

Figure 3-8. 216-T-33 Crib Location Map.



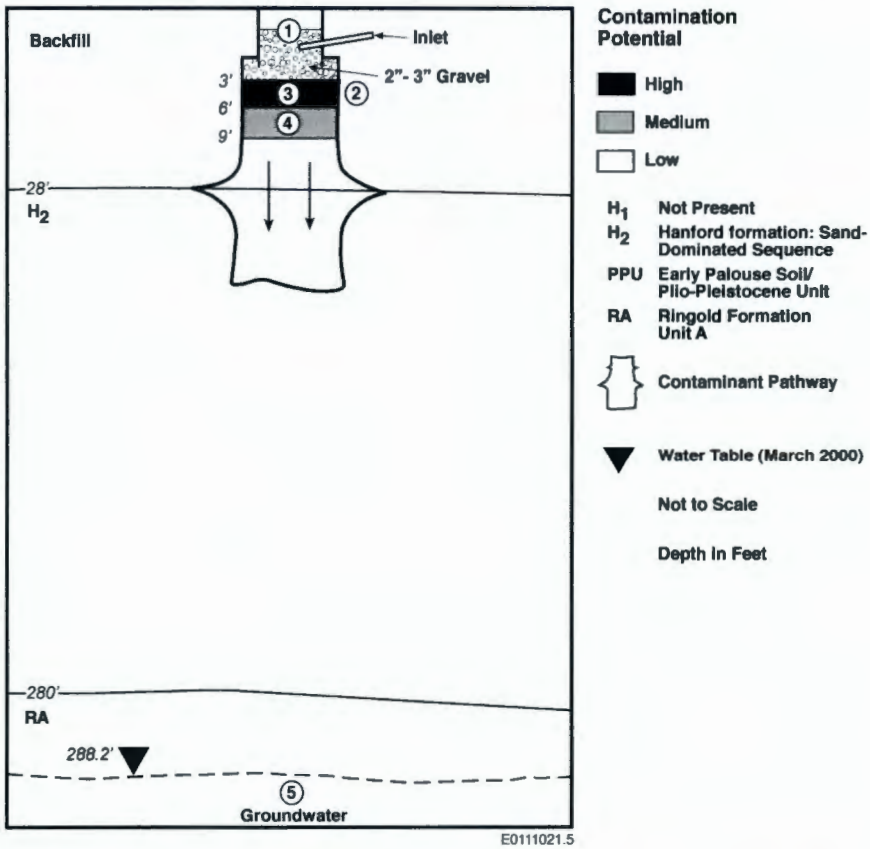
BHI:maa 11/05/01 /home/maaye/arnls/mw_borehole2w2_without Plotted 28-NOV-2001 Rev 1

Figure 3-9. 216-U-3 French Drain Location Map.



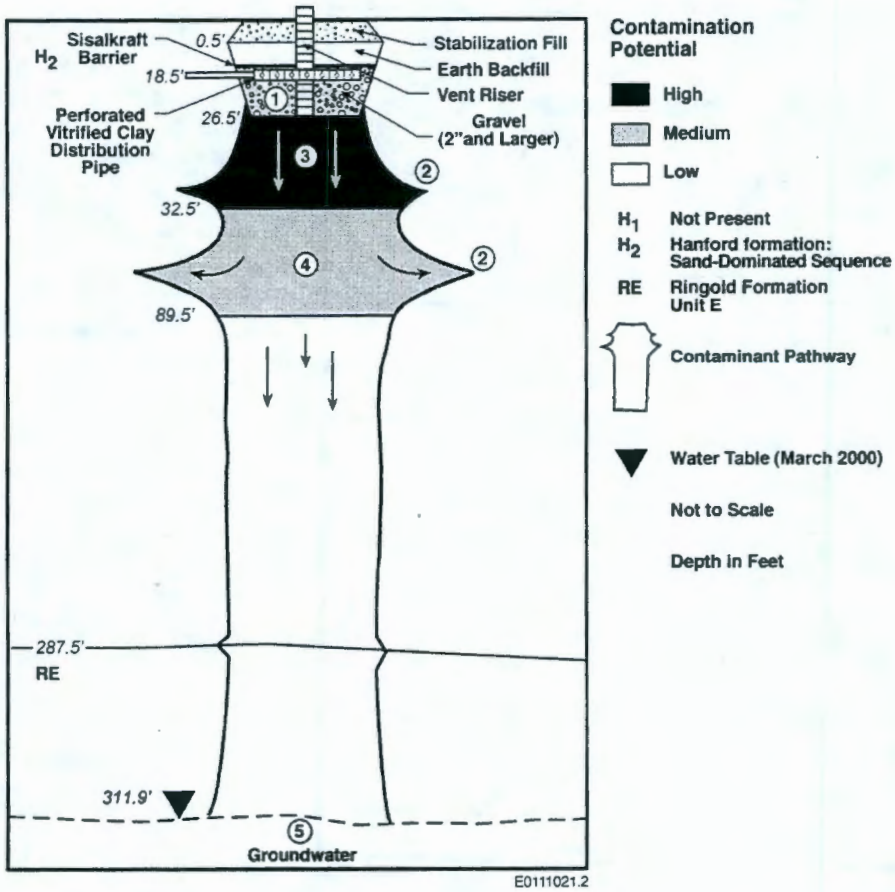
BHI:maa 11/05/01 /home/maaye/arnls/mw_borehole2w3_without Plotted 28-NOV-2001 Rev 1

Figure 3-10. 200-E-4 French Drain Conceptual Contaminant Distribution Model.



1. Low organic low inorganic liquid waste were discharged to the french drain between 1958 and 1983. Any radioactive constituents present are due to cross contamination from other systems. The volume of wastewater received by the french drain is undetermined, but was probably very low because the waste consisted of steam condensate from a valve pit and an equipment room. Very little data is available to evaluate contaminant distribution at this site.
2. Once discharged, wastewater and contaminants migrate vertically downward beneath the french drain within backfill. Little or no lateral spreading occurs, however, the lack of spreading is only partially supported by borehole data. The nearest borehole was 299-E27-126 located about 11.6 m (38 ft) to the southwest. 299-E27-126 was drilled and decommissioned in 1980. No geophysical logging was performed. No contamination was detected above background levels. The nearest groundwater well is 299-E24-8 located about 124.7 m (409 ft) to the southeast.
3. Immobile contaminants, such as cesium-137, normally sorb near the point of release approximately 3 ft bgs. Contaminant concentrations decrease with depth.
4. Mobile contaminants, like nitrate, migrate with the moisture front beneath the french drain.
5. Wastewater and mobile contaminants likely do not impact groundwater since the effluent volume discharge to the soil column is assumed to be less than the soil column pore volume. While iodine-129 exceeds groundwater protection standards beneath the french drain, it is not attributed to this site.

Figure 3-11. 216-A-4 Crib Conceptual Contaminant Distribution Model.



1. Low concentration radioactive and inorganic liquid waste containing uranium, cesium-137, cobalt-60, plutonium-239/240, strontium-90, nitrates, sodium dichromate, and other contaminants was discharged to the crib between 1955 and 1958. The crib received a total volume of 6,210,000 L (1.6 million gal) of liquid waste. In 1958, the crib plugged causing liquid to flood the ground surface and contaminate the surface soil. The site is now located within a large area known as PUREX stabilized area (200-E-103). Only a large green vent riser is visible above the surface.

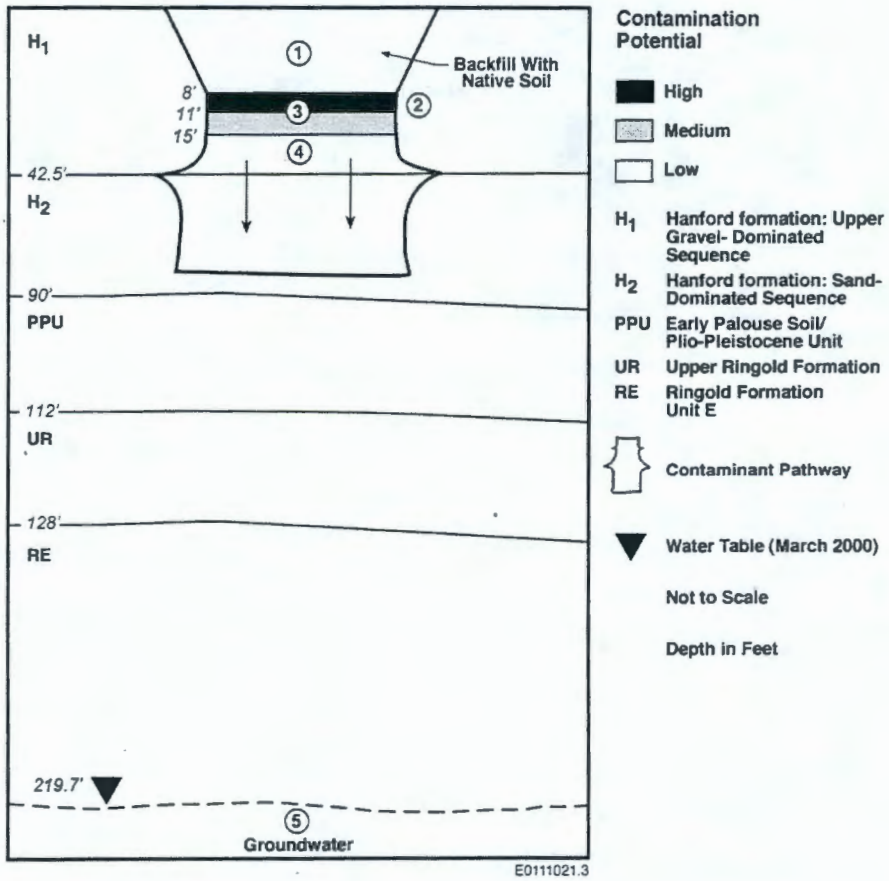
2. Once discharged, wastewater and contaminants migrate vertically down beneath the crib within H_2. There is some lateral spreading. The presence of spreading is supported by geophysical spectral gamma data from well 299-E24-54 located about 2 m (6.6 ft) to the northeast. No distinct lithologic horizons have been identified associated with the spreading.

3. Immobile contaminants, such as cesium-137, normally sorb near the point of release.

4. Mobile contaminants, like nitrate, migrate with the moisture front and may be detected. The activity of cesium-137 decreases with depth; it is not detected greater than 89.5 ft bgs based on spectral gamma data from well 299-E24-54. Cobalt-60 was detected at low concentrations to a maximum depth of 68.5 ft.

5. Wastewater and mobile contaminants likely impact groundwater since the effluent volume discharged to the soil column (6,210 m^3) is greater than the soil column pore volume (948 m^3). Groundwater concentrations of tritium, iodine-129, and nitrate exceed groundwater protection standards beneath the crib. All of these contaminants may be associated with waste disposal practices at this crib.

Figure 3-12. 216-T-13 Trench Conceptual Contaminant Distribution Model.



1. Low concentrated radioactive liquid waste containing uranium, cesium-137, strontium-90, plutonium-239/240, and other organic and inorganic contaminants were discharged to the trench between 1954 and 1964 from the decontamination of vehicles. The trench received a total volume of 98,000 L (26,000 gal) of liquid waste. The site was backfilled with soil in 1964. In 1972, approximately 3.06 m^3 (4 yd^3) were excavated from the trench and backfilled with soil. No direct data is available to evaluate the contaminant distribution at this site.

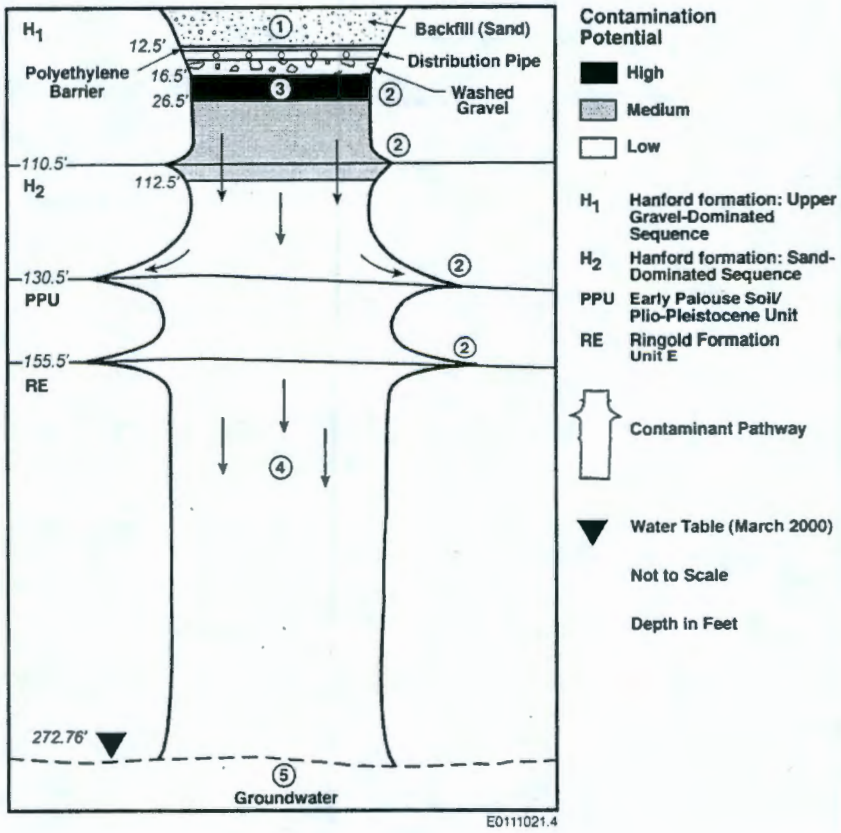
2. Once discharged, wastewater and contaminants migrate vertically downward beneath the trench within H_1. Little or no lateral spreading occurs, however, the lack of spreading is only partially supported by geophysical data from well 299-W10-17 located about 25.9 m (85 ft) to the south. The geophysical data consists of borehole gross gamma logs obtained during drilling in 1990.

3. Immobile contaminants, such as cesium-137, normally sorb near the point of release. Chemicals used to decontaminate equipment may have increased the mobility of contaminants such as cesium-137. Contaminant concentrations decrease with depth.

4. Mobile contaminants, like nitrate, migrate with the moisture front and may be detected to about 80 ft.

5. Wastewater and contaminants from the trench suggest no impact to groundwater since the effluent volume discharged to the soil column (9.8 m^3) is less than the soil column pore volume (716 m^3). While nitrate, trichloroethylene, and carbon tetrachloride exceed groundwater protection standards beneath the trench, only trichloroethylene may have been associated with waste disposal practices at this trench.

Figure 3-13. 216-T-33 Crib Conceptual Contaminant Distribution Model.



1. Low concentration radioactive liquid waste containing uranium, cesium-137, strontium-90, plutonium-239/240 and other organic and inorganic contaminants were discharged to the crib between January 1963 and February 1963. The crib is reported to have received a total volume of 1,900,000 L (500,000 gal) of equipment decontamination liquid waste. No direct data is available to evaluate contaminant distribution at this site.

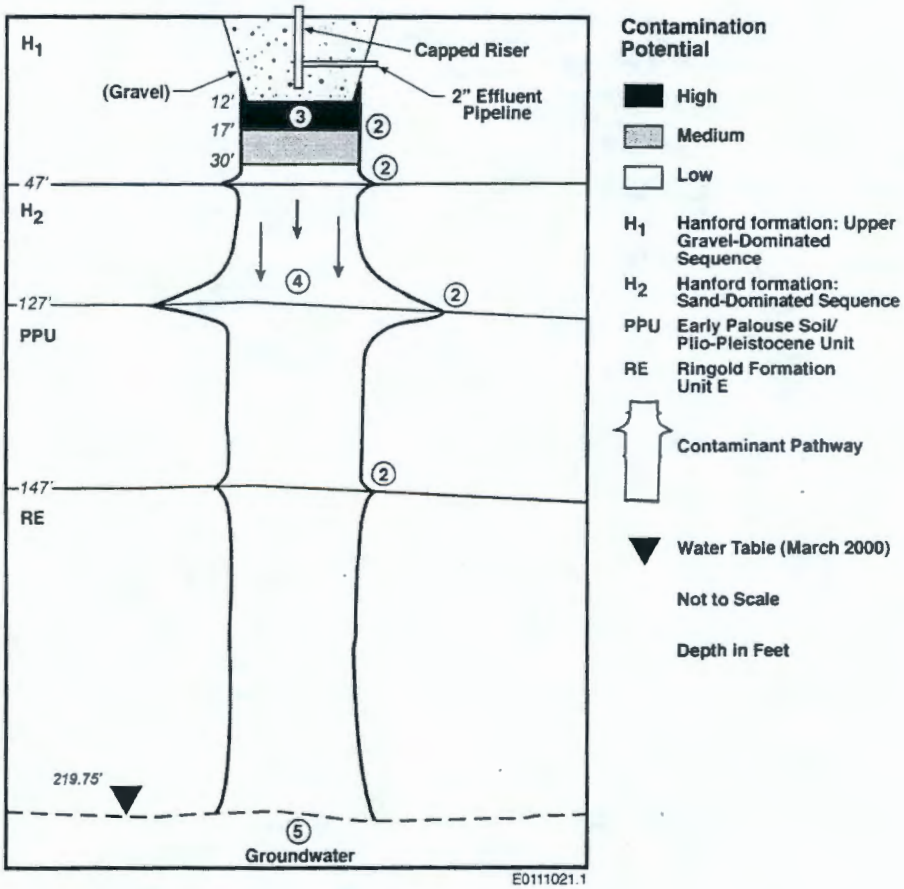
2. Once discharged, liquid wastewater and contaminants migrate vertically downward beneath the crib within H_1. Little or no lateral spreading occurs, however, the lack of spreading is only partially supported by geophysical data from well 299-W11-14 located about 9.1 m (30 ft) to the north. The geophysical data consists of borehole gross gamma logs obtained from the well in 1968, 1976, and 1987. Spectral gamma logging has not been done. Wastewater intersects the H_2 approximately 105 ft bgs. Minor spreading of wastewater contaminants may occur associated with this unit. Waste liquid and more mobile contaminants intersect the PPU approximately 125 ft bgs. Lateral spreading of wastewater and contaminants may occur associated with this unit. If spreading occurs it is to the southeast based on the topography of the PPU. Sorbtion is expected in the PPU. Effluent waste liquid and more mobile contaminants intersect the Ringold Unit E approximately 150 ft bgs. Lateral spreading of wastewater and contaminants may occur associated with this unit.

3. Immobile contaminants, such as cesium-137, normally sorb near the point of release. Chemicals used to decontaminate equipment may have increased the mobility of contaminants such as cesium-137. Contaminant concentrations decreased with depth.

4. Mobile contaminants, like nitrate, migrate with the moisture front beneath the crib and may be detected in low concentrations to the water table.

5. Wastewater and mobile contaminants likely impact groundwater since the effluent volume discharge to the soil column (1,900 m^3) is greater than the soil column pore volume (671 m^3). While nitrate, trichloroethylene, carbon tetrachloride, iodine-129 and tritium exceed groundwater protection standards beneath the crib, only trichloroethylene may have been associated with waste disposal practices at this crib.

Figure 3-14. 216-U-3 French Drain Conceptual Contaminant Distribution Model.



1. Low salt, neutral/basic, low organic radioactive liquid waste containing uranium, cesium-137, strontium-90, plutonium-239/240, and other contaminants were discharged to the french drain between 1954 and 1955. The primary gamma-emitters are uranium and cesium. The french drain received a total volume of 791,000 L (209,000 gal) of wastewater. Very little data is available to evaluate contaminant distribution at this site.

2. Once discharged, wastewater and contaminants migrate vertically downward beneath the french drain within H_1. Little or no lateral spreading occurs, however, the lack of spreading is only partially supported by borehole data. The nearest well is 299-W19-1 located about 36.6 m (120 ft) to the east. The geophysical data consists of gross gamma logs obtained in 1987. No spectral gamma logs have been run. Wastewater intersects the H_2 approximately 47 ft bgs. Minor spreading of wastewater contaminants may occur associated with this unit. Effluent and more mobile contaminants intersect the PPU approximately 127 ft bgs. Lateral spreading of wastewater and contaminants may occur associated with this unit. If spreading occurs it is to the southeast based on the topography of the PPU. Sorbtion is expected in the PPU. Effluent and more mobile contaminants intersect the Ringold Unit E approximately 147 ft bgs. Lateral spreading of wastewater and contaminants may occur associated with this unit.

3. Immobile contaminants, such as cesium-137, normally sorb near the point of release. Contaminant concentrations decrease with depth.

4. Mobile contaminants, like nitrate, migrate with the moisture front beneath the french drain and may be detected in low concentrations to the water table.

5. Wastewater and contaminants likely impact groundwater since the effluent volume discharge to the soil column (791 m^3) is greater than the soil column pore volume (39 m^3). While carbon tetrachloride exceeds groundwater protection standards beneath the french drain, it is not attributed to this waste site.

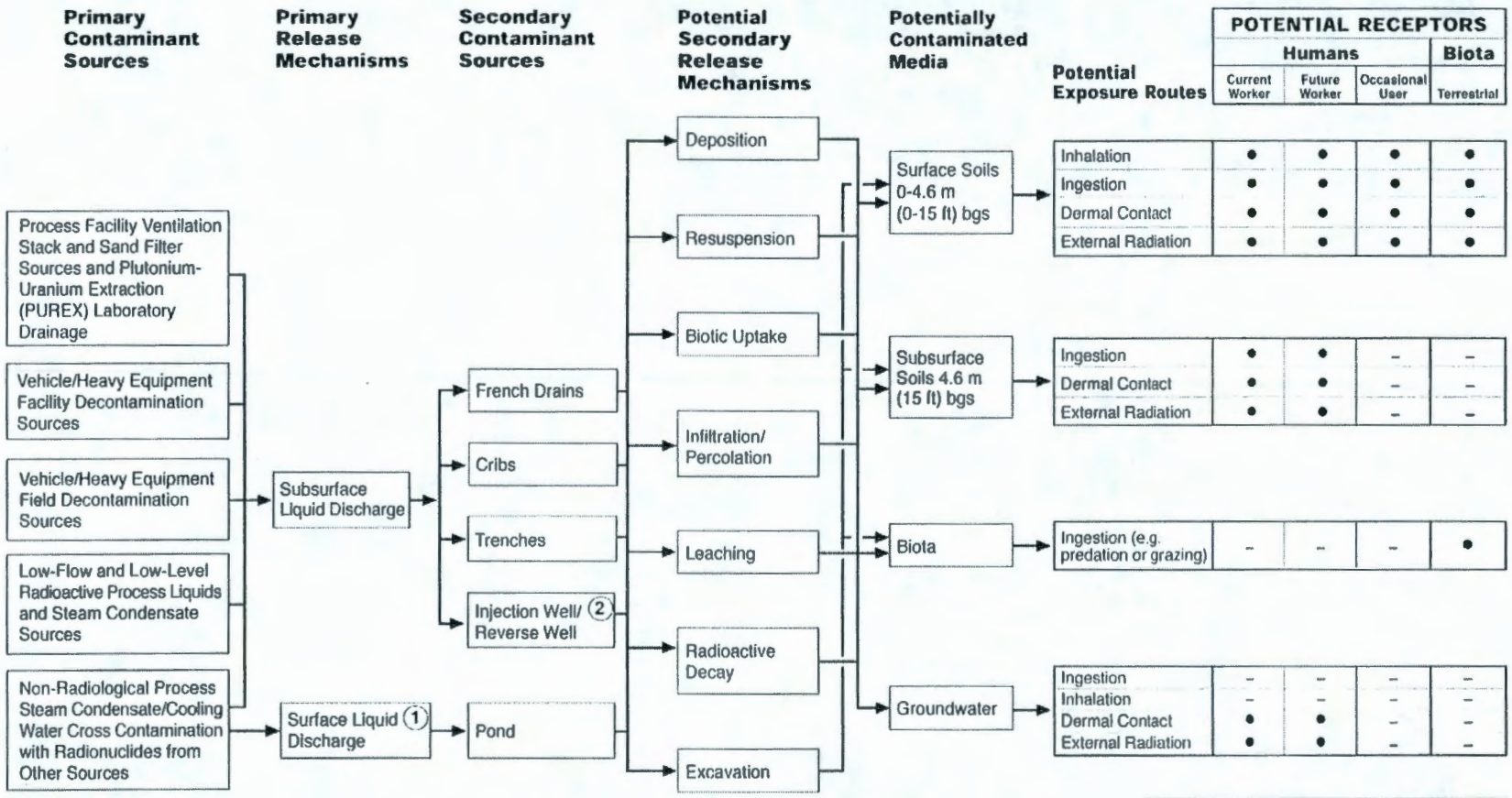


Figure 3-15. Conceptual Exposure Pathway Model.

Table 3-1. 1999 Soil and Vegetation Environmental Surveillance Data (pCi/g) for the 216-T-33 Site in the 200-MW-1 Operable Unit.

Isotope	216-T-33 Crib	
	Soil (D021)	Vegetation (V021)
Ce-144	-4.3E-03[a]	5.9E-02
Co-60	5.3E-03	1.8E-02
Cs-134	2.5 E-02	-1.3E-02[a]
Cs-137	2.1E-01	9.2E-03
Eu-152	-2.6E-02[a]	3.7E-02
Eu-154	6.8E-03	-1.7E-02[a]
Eu-155	5.0E-02	7.1E-03
Pu-238	-9.6E-02[a]	6.4E-03
Pu-239/240	2.0E-02	3.7E-03
Ru-103	-7.6E-03[a]	1.9E-02
Ru-106	5.2E-02	4.2E-03
Sb-125	2.9E-03	1.5E-02
Sn-113	-9.5E-03[a]	-5.3E-02[a]
Sr-90	1.9E-01	4.7E-01
U-234	1.9E-01	2.0E-02
U-235	3.5E-02	3.8E-03
U-238	1.7E-01	1.3E-02
Zn-65	-5.2E-03[a]	7.0E-02

Source: *Hanford Site Near Facility Environmental Monitoring Data Report for Calendar Year 1999* (PNNL 2000a).
[a]The value represents the actual result when sample results are subtracted from background.

Table 3-2. 200-MW-1 Operable Unit Final COC List Process Facility Ventilation Stack and Sand Filter Sources. (2 Pages)

CAS #	Final COCs	Rationale for Inclusion
Radiological Constituents		
14596-10-2	Americium-241	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
10045-97-3	Cesium-137	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
10198-40-0	Cobalt-60	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
14683-23-9	Europium-152	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
15585-10-1	Europium-154	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
14391-16-3	Europium-155	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
15046-84-1	Iodine-129	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
13981-16-3	Plutonium-238	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
15117-48-3	Plutonium-239	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
14119-33-6	Plutonium-240	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
10098-97-2	Strontium-90	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
14133-76-7	Technetium-99	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
10028-17-8	Tritium	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
13966-29-5	Uranium-233/234	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
15117-96-1	Uranium-235/236	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
13982-70-2	Uranium-238	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
Nonradiological Constituents – Metals		
7440-43-9	Cadmium	Analytical results from sediment samples collected in 200 Areas (Rohay 1994).
7440-47-3	Chromium	Due to sodium/potassium dichromate added during first- and second-cycle decontamination and concentration operations of bismuth-phosphate process (GE 1944 [Section C], WHC 1990a).
7440-47-3	Chromium (VI)	Due to sodium/potassium dichromate added during first- and second-cycle decontamination and concentration operations of bismuth-phosphate process (GE 1944 [Section C], WHC 1990a).
7440-50-8	Copper	Associated with ventilation and cooling systems.
7439-92-1	Lead	Metal used in lead-dipped cladding and cladding waste stream (1952 to 1956) (GE 1944 [Section A]).
7429-90-5	Silver	Associated with ventilation system silver reactors (Agnew et al. 1997).
7439-97-6	Mercury	Several uses in bismuth-phosphate campaign including addition to cladding and metal waste streams to prevent gaseous generations and miscellaneous laboratory uses (Agnew et al. 1997).
Nonradiological Constituents – General Inorganics		
57-12-5	Cyanide	Extensive use (1954 to 1958) as nickel ferro/ferric cyanide during scavenging and recovery processes. Listed as a result of tank farm integration (Agnew et al. 1997, Borsheim and Simpson 1991, GE 1951b).
16984-48-8	Fluoride	Several compounds contained fluoride. The most widely used included lanthanum-fluoride (which was used during the concentration operations of the bismuth-phosphate process) and ammonium silica fluoride (which was used as a cleaning and decontamination compound based on ability to dissolve metals and fission products) (GE 1944 [Section C], 1951a; HEW 1945).
N02-N03-N	Nitrate/nitrite	Several compounds contained nitrates/nitrites. The most widely used included sodium nitrite, a salting agent during the cladding removal; nitric acid, used throughout the bismuth-phosphate process and Uranium Reclamation Process (URP); and bismuth subnitrate, which was used to create the bismuth-phosphate/plutonium solid during the first and second decontamination cycles (GE 1944 [Section C], 1951a; HEW 1945).
14265-44-2	Phosphate	Several compounds contained phosphate. The most widely used included phosphoric acid, which was used throughout bismuth-phosphate process (GE 1944 [Section C], HEW 1945).

Table 3-2. 200-MW-1 Operable Unit Final COC List Process Facility Ventilation Stack and Sand Filter Sources. (2 Pages)

CAS #	Final COCs	Rationale for Inclusion
14808-79-8	Sulfate	Several compounds contained sulfate. The most widely used included sulfuric acid, which was used in dissolving the fuel rods during the bismuth-phosphate process (GE 1944 [Section C], 1951a; HEW 1945). Other sulfate complexes were used as carriers for various metals.
Volatile Organics		
75-34-3	1,1-dichloroethane (DCA)	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
107-06-2	1,2-dichloroethane (DCA)	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
71-55-6	1,1,1-trichloroethane (TCA)	Listed waste associated with B Plant operations-F001 (WHC 1996).
67-19-7	Acetone	Listed waste associated with PUREX Plant operations-F003 (WHC 1996).
71-43-2	Benzene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
156-59-2	cis-1,2-dichloroethylene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
100-41-4	Ethylbenzene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
108-10-1	Methyl isobutyl ketone	Listed waste associated with B Plant operations-F002 (WHC 1996).
156-60-5	trans-1,2-dichloroethylene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
78-93-3	Methyl ethyl ketone	Listed waste associated with B Plant operations-F005 (WHC 1996).
75-09-2	Methylene chloride	Listed waste associated with B Plant operations-F002 (WHC 1996).
71-63-3	n-butyl alcohol	Listed waste associated with PUREX Plant operations-F003 (WHC 1996).
104-51-8	n-butyl benzene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
127-18-4	Tetrachloroethylene (PCE)	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
79-01-6	Trichloroethylene (TCE)	TCE is a degradation product of carbon tetrachloride. Analytical results and measurements have illustrated that this contaminant is prevalent throughout the vadose zone and has impacted groundwater (Rohay 1994).
108-88-3	Toluene	Listed waste associated with PUREX Plant operations-F005 (WHC 1996).
1330-20-7	Xylene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
Semi-Volatile Organics		
8008-20-6	Normal paraffins[a]	Extensive use (1953 to 1957) in solvent extraction operation as the dilutant for TBP in URPs (GE 1951a).
1336-36-3	Polychlorinated biphenyls (PCBs)	Various types of normal paraffins were used as milling, cutting, and washing solutions during the production of plutonium buttons/rods. These solutions usually contained PCBs (discussions/publications with David A. Dodd, Plutonium Finishing Plant chemist [Mandis 2001]). Analytical results from sediment samples collected within tank 241-Z-361 (FH 2000).
126-73-8	Tributyl phosphate and derivatives (mono, bi)	Extensive use in the extraction of plutonium and uranium in the PUREX process and of uranium in the uranium recovery process (GE 1951b, 1955).

[a]Analyzed as kerosene by nonhalogenated volatile organic analytes via 8015 Method; total petroleum hydrocarbons, diesel to oil ranges; or total petroleum hydrocarbons, gasoline range.
CAS = Chemical Abstract Services

Table 3-3. 200-MW-1 Operable Unit Final COC List Vehicle/Heavy Equipment Facility Decontamination Sources. (2 Pages)

CAS #	Final COCs	Rationale for Inclusion
Radiological Constituents		
14596-10-2	Americium-241	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
10045-97-3	Cesium-137	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
10198-40-0	Cobalt-60	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
14683-23-9	Europium-152	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
15585-10-1	Europium-154	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
14391-16-3	Europium-155	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
13981-16-3	Plutonium-238	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
15117-48-3	Plutonium-239	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
14119-33-6	Plutonium-240	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
10098-97-2	Strontium-90	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
14133-76-7	Technetium-99	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
13966-29-5	Uranium-233/234	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
15117-96-1	Uranium-235/236	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
13982-70-2	Uranium-238	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
Nonradiological Constituents – Metals		
7439-92-1	Lead	Metal used in lead-dipped cladding and cladding waste stream (1952 to 1956) (GE 1944 [Section A]).
7440-43-9	Cadmium	Expected to be present from contaminants/engine wear in oil/grease and pigments in paint.
7440-47-3	Chromium	Expected to be present from contaminants/engine wear in oil/grease and pigments in paint.
Nonradiological Constituents – General Inorganics		
14265-44-2	Phosphate	Several compounds contained phosphate. The most widely used included phosphoric acid, which was used throughout bismuth-phosphate process (GE 1944 [Section C], HEW 1945).
14808-79-8	Sulfate	Several compounds contained sulfate. The most widely used included sulfuric acid, which was used in dissolving the fuel rods during the bismuth-phosphate process (GE 1944 [Section C], 1951a; HEW 1945). Other sulfate complexes were used as carriers for various metals.
Volatile Organics		
75-34-3	1,1-dichloroethane (DCA)	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
107-06-2	1,2-dichloroethane (DCA)	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
71-55-6	1,1,1-trichloroethane (TCA)	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
67-19-7	Acetone	Listed waste associated with T Plant operations-F003 (WHC 1996).
71-43-2	Benzene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
156-59-2	cis-1,2-dichloroethylene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
100-41-4	Ethylbenzene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
75-09-2	Methylene chloride	Listed waste associated with T Plant operations-F002

Table 3-3. 200-MW-1 Operable Unit Final COC List Vehicle/Heavy Equipment Facility Decontamination Sources. (2 Pages)

CAS #	Final COCs	Rationale for Inclusion
71-63-3	n-butyl alcohol	Associated with T Plant heavy equipment decontamination operations-F003 (WHC 1990a).
104-51-8	n-butyl benzene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
127-18-4	Tetrachloroethylene (PCE)	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
156-60-5	trans-1,2-dichloroethylene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
79-01-6	Trichloroethylene (TCE)	TCE is a degradation product of carbon tetrachloride. Analytical results and measurements have illustrated that this contaminant is prevalent throughout the vadose zone and has impacted groundwater (Rohay 1994).
108-88-3	Toluene	Listed waste associated with PUREX Plant operations-F005 (WHC 1996).
1330-20-7	Xylene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
Semi-Volatile Organics		
8008-20-6	Normal paraffins[a]	Expected from vehicle oil and grease removed during decontamination.
1336-36-3	Polychlorinated biphenyls (PCBs)	Expected from vehicle oil and grease removed during decontamination.

[a]Analyzed as kerosene by nonhalogenated volatile organic analytes via 8015 Method; total petroleum hydrocarbons, diesel to oil ranges; or total petroleum hydrocarbons, gasoline range.

Table 3-4. 200-MW-1 Operable Unit Final COC List Vehicle/Heavy Equipment Field Decontamination Source. (2 Pages)

CAS #	Final COCs	Rationale for Inclusion
Radiological Constituents		
14596-10-2	Americium-241	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
10045-97-3	Cesium-137	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
10198-40-0	Cobalt-60	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
14683-23-9	Europium-152	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
15585-10-1	Europium-154	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
14391-16-3	Europium-155	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
13981-16-3	Plutonium-238	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
15117-48-3	Plutonium-239	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
14119-33-6	Plutonium-240	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
10098-97-2	Strontium-90	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
14133-76-7	Technetium-99	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
13966-29-5	Uranium-233/234	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
15117-96-1	Uranium-235/236	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
13982-70-2	Uranium-238	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
Nonradiological Constituents – Metals		
7439-92-1	Lead	Expected to be present from contaminants/engine wear in oil/grease and pigments in paint.
7440-43-9	Cadmium	Expected to be present from contaminants/engine wear in oil/grease and pigments in paint.
7440-47-3	Chromium	Expected to be present from contaminants/engine wear in oil/grease and pigments in paint.
Nonradiological Constituents – General Inorganics		
14265-44-2	Phosphate	Several compounds contained phosphate. The most widely used included phosphoric acid, which was used throughout bismuth-phosphate process (GE 1944 [Section C], HEW 1945).
14808-79-8	Sulfate	Several compounds contained sulfate. The most widely used included sulfuric acid, which was used in dissolving the fuel rods during the bismuth-phosphate process (GE 1944 [Section C], 1951a; HEW 1945). Other sulfate complexes were used as carriers for various metals.
Volatile Organics		
75-34-3	1,1-dichloroethane (DCA)	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
107-06-2	1,2-dichloroethane (DCA)	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
71-55-6	1,1,1-trichloroethane (TCA)	Listed waste associated with B Plant operations-F001 (WHC 1996).
67-19-7	Acetone	Listed waste associated with PUREX Plant operations-F003 (WHC 1996).
71-43-2	Benzene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
156-59-2	cis-1,2-dichloroethylene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
108-10-1	Methyl isobutyl ketone	Listed waste associated with B Plant operations-F002 (WHC 1996).
78-93-3	Methyl ethyl ketone	Listed waste associated with B Plant operations-F005 (WHC 1996).
75-09-2	Methylene chloride	Listed waste associated with B Plant operations-F002.

Table 3-4. 200-MW-1 Operable Unit Final COC List Vehicle/Heavy Equipment Field Decontamination Source. (2 Pages)

CAS #	Final COCs	Rationale for Inclusion
71-63-3	n-butyl alcohol	Listed waste associated with PUREX Plant operations-F003 (WHC 1996).
127-18-4	Tetrachloroethylene (PCE)	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
156-60-5	trans-1,2-dichloroethylene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
79-01-6	Trichloroethylene (TCE)	TCE is a degradation product of carbon tetrachloride. Analytical results and measurements have illustrated that this contaminant is prevalent throughout the vadose zone and has impacted groundwater (Rohay 1994).
108-88-3	Toluene	Listed waste associated with PUREX Plant operations-F005 (WHC 1996).
1330-20-7	Xylene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
Semi-Volatile Organics		
8008-20-6	Normal paraffins (greases and oils)	Expected from vehicle oil and grease removed during decontamination.
1336-36-3	Polychlorinated biphenyls (PCBs)	Expected from vehicle oil and grease removed during decontamination.

Table 3-5. 200-MW-1 Operable Unit Final COC List Low-Level Radioactive Process or Steam Condensate Source. (2 Pages)

CAS #	Final COCs	Rationale for Inclusion
Radiological Constituents		
14596-10-2	Americium-241	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997)..
10045-97-3	Cesium-137	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
10198-40-0	Cobalt-60	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
14683-23-9	Europium-152	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
15585-10-1	Europium-154	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
14391-16-3	Europium-155	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
13981-16-3	Plutonium-238	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
15117-48-3	Plutonium-239	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
14119-33-6	Plutonium-240	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
10098-97-2	Strontium-90	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
14133-76-7	Technetium-99	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
10028-17-8	Tritium	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
13966-29-5	Uranium-234	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
15117-96-1	Uranium-235	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
13982-70-2	Uranium-238	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
Nonradiological Constituents – Metals		
7440-43-9	Cadmium	Analytical results from sediment samples collected in 200 Areas (Rohay 1994).
7440-47-3	Chromium	Due to sodium/potassium dichromate added during first- and second-cycle decontamination and concentration operations of bismuth-phosphate process (GE 1944 [Section C], WHC 1990a).
7440-47-3	Chromium (VI)	Due to sodium/potassium dichromate added during first- and second-cycle decontamination and concentration operations of bismuth-phosphate process (GE 1944 [Section C], WHC 1990a).
7440-50-8	Copper	Associated with ventilation and cooling systems.
7439-92-1	Lead	Metal used in lead-dipped cladding and cladding waste stream (1952 to 1956) (GE 1944 [Section A]).
7439-97-6	Mercury	Several uses in bismuth-phosphate campaign including addition to cladding and metal waste streams to prevent gaseous generations and miscellaneous laboratory uses (Agnew et al. 1997).
Nonradiological Constituents – General Inorganics		
57-12-5	Cyanide	Extensive use (1954 to 1958) as nickel ferro/ferric cyanide during scavenging and recovery processes. Listed as a result of tank farm integration (Agnew et al. 1997, Borsheim and Simpson 1991, GE 1951a).
16984-48-8	Fluoride	Several compounds contained fluoride. The most widely used included lanthanum-fluoride (which was used during the concentration operations of the bismuth-phosphate process) and ammonium silica fluoride (which was used as a cleaning and decontamination compound based on ability to dissolve metals and fission products) (GE 1944 [Section C], 1951a; HEW 1945).
N02+N03-N	Nitrate/nitrite	Several compounds contained nitrates/nitrites. The most widely used included sodium nitrite, a salting agent during the cladding removal; nitric acid, used throughout the bismuth-phosphate process and URP; and bismuth subnitrate, which was used to create the bismuth-phosphate/plutonium solid during the first and second decontamination cycles (GE 1944 [Section C], 1951a; HEW 1945).

Table 3-5. 200-MW-1 Operable Unit Final COC List Low-Level Radioactive Process or Steam Condensate Source. (2 Pages)

CAS #	Final COCs	Rationale for Inclusion
14265-44-2	Phosphate	Several compounds contained phosphate. The most widely used included phosphoric acid, which was used throughout bismuth-phosphate process (GE 1944 [Section C], HEW 1945).
14808-79-8	Sulfate	Several compounds contained sulfate. The most widely used included sulfuric acid, which was used in dissolving the fuel rods during the bismuth-phosphate process (GE 1944 [Section C], 1951a; HEW 1945). Other sulfate complexes were used as carriers for various metals.
Volatile Organics		
75-34-3	1,1-dichloroethane (DCA)	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
107-06-2	1,2-dichloroethane (DCA)	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
71-55-6	1,1,1-trichloroethane (TCA)	Listed waste associated with B Plant operations-F001 (WHC 1996).
67-19-7	Acetone	Listed waste associated with PUREX Plant operations-F003 (WHC 1996).
71-43-2	Benzene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
156-59-2	cis-1,2-dichloroethylene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
100-41-4	Ethylbenzene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
108-10-1	Methyl isobutyl ketone	Listed waste associated with B Plant operations-F002 (WHC 1996).
78-93-3	Methyl ethyl ketone	Listed waste associated with B Plant operations-F005 (WHC 1996).
75-09-2	Methylene chloride	Listed waste associated with B Plant operations-F002.
71-63-3	n-butyl alcohol	Listed waste associated with PUREX Plant operations-F003 (WHC 1996).
104-51-8	n-butyl benzene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
127-18-4	Tetrachloroethylene (PCE)	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
156-60-5	trans-1,2-dichloroethylene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
79-01-6	Trichloroethylene (TCE)	TCE is a degradation product of carbon tetrachloride. Analytical results and measurements have illustrated that this contaminant is prevalent throughout the vadose zone and has impacted groundwater (Rohay 1994).
108-88-3	Toluene	Listed waste associated with PUREX Plant operations-F005 (WHC 1996).
1330-20-7	Xylene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
Semi-Volatile Organics		
8008-20-6	Normal paraffins[a]	Extensive use (1953 to 1957) in solvent extraction operation as the dilutant for TBP in URPs (GE 1951a).
1336-36-3	Polychlorinated biphenyls (PCBs)	Various types of normal paraffins were used as milling, cutting, and washing solutions during the production of plutonium buttons/rods. These solutions usually contained PCBs (discussions/publications with David A. Dodd, PFP chemist [Mandis 2001]). Analytical results from sediment samples collected within the 241-Z-361 tank (FH 2000).
126-73-8	Tributyl phosphate and derivatives (mono, bi)	Extensive use in the extraction of plutonium and uranium in the PUREX process and of uranium in the uranium recovery process (GE 1951b, 1955).

[a]Analyzed as kerosene by nonhalogenated volatile organic analytes via 8015 Method; total petroleum hydrocarbons, diesel to oil ranges; or total petroleum hydrocarbons, gasoline range.

Table 3-6. 200-MW-1 Operable Unit Final COC List Nonradiological Process Steam Condensate with Radiological Cross Contamination. (2 Pages)

CAS #	Final COCs	Rationale for Inclusion
Radiological Constituents		
14596-10-2	Americium-241	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
10045-97-3	Cesium-137	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
10198-40-0	Cobalt-60	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
14683-23-9	Europium-152	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
15585-10-1	Europium-154	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
14391-16-3	Europium-155	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
13981-16-3	Plutonium-238	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
15117-48-3	Plutonium-239	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
14119-33-6	Plutonium-240	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
10098-97-2	Strontium-90	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
14133-76-7	Technetium-99	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
13966-29-5	Uranium-233/234	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
15117-96-1	Uranium-235/236	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
13982-70-2	Uranium-238	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
Nonradiological Constituents – Metals		
7440-50-8	Copper	Associated with ventilation and cooling systems.
7439-92-1	Lead	Metal used in lead-dipped cladding and cladding waste stream (1952 to 1956) (GE 1944 [Section A]).
Nonradiological Constituents – General Inorganics		
N02+N03-N	Nitrate/nitrite	Several compounds contained nitrates/nitrites. The most widely used included sodium nitrite, a salting agent during the cladding removal; nitric acid, used throughout the bismuth-phosphate process and URP; and bismuth subnitrate, which was used to create the bismuth-phosphate/plutonium solid during the first and second decontamination cycles (GE 1944 [Section C], 1951a; HEW 1945).
14265-44-2	Phosphate	Several compounds contained phosphate. The most widely used included phosphoric acid, which was used throughout bismuth-phosphate process (GE 1944 [Section C], HEW 1945).
14808-79-8	Sulfate	Several compounds contained sulfate. The most widely used included sulfuric acid, which was used in dissolving the fuel rods during the bismuth-phosphate process (GE 1944 [Section C], 1951a; HEW 1945). Other sulfate complexes were used as carriers for various metals.
Volatile Organics		
71-55-6	1,1,1-trichloroethane (TCA)	Listed waste associated with B Plant operations-F001 (WHC 1996).
67-19-7	Acetone	Listed waste associated with PUREX Plant operations-F003 (WHC 1996).
156-59-2	cis-1,2-dichloroethylene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
108-10-1	Methyl isobutyl ketone	Listed waste associated with B Plant operations-F002 (WHC 1996).
78-93-3	Methyl ethyl ketone	Listed waste associated with B Plant operations-F005 (WHC 1996).
75-09-2	Methylene chloride	Listed waste associated with B Plant operations-F002.

Table 3-6. 200-MW-1 Operable Unit Final COC List Nonradiological Process Steam Condensate with Radiological Cross Contamination. (2 Pages)

CAS #	Final COCs	Rationale for Inclusion
71-63-3	n-butyl alcohol	Listed waste associated with PUREX Plant operations-F003 (WHC 1996).
108-88-3	Toluene	Listed waste associated with PUREX Plant operations-F005 (WHC 1996).
Semi-Volatile Organics		
8008-20-6	Normal paraffins[a]	Extensive use (1953 to 1957) in solvent extraction operation as the dilutant for TBP in URPS (GE 1951a).
1336-36-3	Polychlorinated biphenyls (PCBs)	Various types of normal paraffins were used as milling, cutting, and washing solutions during the production of plutonium buttons/rods. These solutions usually contained PCBs (discussions/publications with David A. Dodd, PFP chemist [Mandis 2001]). Analytical results from sediment samples collected within the 241-Z-361 tank (FH 2000).
126-73-8	Tributyl phosphate and derivatives (mono, bi)	Extensive use in the extraction of plutonium and uranium in the PUREX process and of uranium in the uranium recovery process (GE 1951b, 1955).

[a]Analyzed as kerosene by nonhalogenated volatile organic analytes via 8015 Method; total petroleum hydrocarbons, diesel to oil ranges; or total petroleum hydrocarbons, gasoline range.

4.0 WORK PLAN APPROACH AND RATIONALE

4.1 SUMMARY OF DATA QUALITY OBJECTIVE PROCESS

The RI needs for the 200-MW-1 OU were developed in accordance with the DQO process (EPA 1994; BHI-EE-01, *Environmental Investigations Procedures*, Procedure 1.2). The DQO process is a seven-step planning approach that is used to develop data collection strategies consistent with data uses and needs. The DQO goals for the 200-MW-1 OU were to provide the data needed to refine the preliminary conceptual contaminant distribution model and to support remedial decisions.

The DQO process was implemented by a team of subject matter experts and key decision makers. Subject matter experts provided input on regulatory issues, the history and physical condition of the sites, and sampling and analysis methods. Key decision makers from DOE 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 provides a high degree of confidence that the right type and quality of data are collected to fulfill informational needs of the 200-MW-1 decisional process. Results of the DQO process for characterization of the representative sites in the 200-MW-1 OU are presented in the *Remedial Investigation Data Quality Objectives Summary Report for the 200-MW-1 Operable Unit* (BHI 2002). During the DQO process, the three representative sites from the 200-MW-1 OU that were identified in the waste site grouping report (DOE-RL 1997) were reviewed and determined to be appropriate for representing the waste sites in this OU. During the DQO waste site review, two additional sites from the 200-MW-1 OU were included as representative waste sites to better addresss the range of waste sites under the OU. Section 4.1.1 outlines the process for selecting the 200-E-4 French Drain, the 216-A-4 Crib, the 216-T-13 Trench, the 216-T-33 Crib, and the 216-U-3 French Drain as representative sites.

The nature of the waste sites to be investigated in the RI support the use of focused sampling as identified in *Washington State Department of Ecology Toxics Cleanup Program Guidance on Sampling and Data Analysis Methods* (Ecology 1995). This guidance document defines focused sampling as selective sampling of areas where potential or suspected soil contamination can reliably be expected if a release of a hazardous substance has occurred. The relatively small crib, french drain, or trench structures to be investigated released contaminants in a point-source fashion. Contaminants released through a small crib would likely impact the soil immediately beneath the crib, french drain, and trench with minimal lateral spread; therefore, focusing the RI sampling through the crib, french drain, or trench will ensure collection of the area of greatest impact associated with the discharge. Contaminant distributions are expected to follow relatively predictable patterns based on process knowledge and existing environmental data.

4.1.1 Representative Site Selection Process

Because the 200-MW-1 OU consisted of the remaining radioactive liquid waste disposal sites that did not fit within other well defined waste site groupings (DOE-RL 1997, 1999a) and additional waste sites have since been added to the OU (as part of the process defined in the *Tri-Party Agreement Handbook Management Procedures*, Guideline Number TPA-MP-14, "Maintenance of the Waste Information Data System [WIDS]" [DOE-RL 1998]), it was necessary to review all the WIDS sites currently identified with the 200-MW-1 OU prior to selecting representative sites for the OU. The selection approach was designed to ensure that waste sites added to the 200-MW-1 OU in the future fit into the subgroups for which representative sites have been selected. Figure 4-1 shows the site review flow diagram.

Five WIDS categories were identified that represent the 200-MW-1 OU waste sites. These various WIDS categories are listed below.

The sites were sorted according to the following WIDS-defined categories:

- WIDS Classification Status Rejected Sites (Appendix B, Table B-1)
- WIDS Classification Status Proposed Rejected Sites (Appendix B, Table B-2)
- WIDS Reclassification Status Rejected Sites (Appendix B, Table B-3)
- WIDS Classification Status 216/218 Regulatory Authority Sites (Appendix B, Table B-4)

  NOTE: The "216/218 Regulatory Authority Sites" are steam condensate surface discharge sites. The steam condensate consisted of sanitary water that had been sent through a water softener system to remove minerals (calcium and magnesium), which was then introduced into boilers to produce steam. This steam was superheated before distribution to facilities for heating and process use. Steam condensate from the steam distribution lines was released to these sites. When used for heating purposes, this was a seasonal discharge. In addition to sanitary water, the condensate contained nonregulated chemicals that were added to dechlorinate the water, prevent scale, and control corrosion of the boilers.

- WIDS Classification Status 200-MW-1 Operable Unit CPP Waste Sites (Appendix B, Table B-5).

The results of this sorting, which was based on the WIDS status as of November 8, 2001, are shown in Appendix B, Tables B-1 through B-5.

Table B-5 was reviewed to remove waste sites not technically appropriate for the 200-MW-1 OU based on the intent of the waste site grouping report (DOE-RL 1997) and Implementation Plan (DOE-RL 1999a). The waste sites removed are assigned to an appropriate waste group OU in Table B-6.

The CPP sites identified for this work plan (Table 2-1) were then reviewed based on their configuration for receiving waste, source of the waste stream, and expected contaminants to identify appropriate subgroups of sites from which representative sites would be selected for characterization.

Waste sites within the 200-MW-1 OU mainly include cribs, french drains, and trenches. While a few waste sites are identified as injection/reverse wells, their construction is similar to a french drain. Only one pond is included in the 200-MW-1 OU. It received condensate from Z Plant ventilation equipment and was comparable in footprint to the cribs within the OU. It therefore is not considered as a significantly different waste receiving structure.

After reviewing the process history for each waste site, the following subgroups were developed based on the types and amount of waste received:

- Process facility ventilation stack and sand filter sources. This group also contains the 216-A-4 Crib, which received ventilation as well as PUREX laboratory drainage that was routed through the PUREX canyon U cell tanks to the crib
- Vehicle/heavy equipment facility decontamination sources
- Vehicle/heavy equipment field decontamination source
- Low-level radioactive process or steam condensate sources, which were primarily discharged to french drains
- Nonradiological process steam condensate with radiological contaminants from cross contamination from other sources.

Table B-7 presents the results from this waste site sorting. The representative sites were then selected from each subgroup based on the approach outlined in the Implementation Plan (DOE-RL 1999a). The following representative sites were selected:

- 200-E-4 French Drain for the nonradiological process steam condensate with cross contamination sources
- 216-A-4 Crib for process facility ventilation stack and sand filter source
- 216-T-13 Trench for vehicle/heavy equipment field decontamination source
- 216-T-33 Crib for vehicle/heavy equipment facility decontamination sources
- 216-U-3 French Drain for low-level radioactive process or steam condensate sources.

The representative sites originally identified for the 200-MW-1 OU in the waste site grouping report (DOE-RL 1997) (216-A-4 Crib, 216-T-33 Crib, and 216-U-3 French Drain) were all selected to remain as representative sites for this work plan.

4.1.2 Data Uses

Data generated during characterization of the representative sites will consist mainly of soil contamination data. These data will be used to define the nature and vertical extent of radiological and nonradiological contamination, support an initial evaluation of potential human health risks, and assist in the evaluation and selection of a remedial alternative. By defining the type and vertical distribution of contamination, the conceptual model for contaminant distribution can be verified or refined. The lateral extent of contamination is assumed to be confined within each site boundary, but may be evaluated further through geophysical logging results or test pits. Additional evaluation of the lateral extent of contamination will be performed during the confirmatory sampling phase as necessary to support remedial design. Verification of the current conceptual contaminant distribution models will direct the application of the analogous site concept at the remaining 200-MW-1 waste sites. A limited amount of data will be collected to characterize the physical properties of soils that will be used to support an initial assessment of risk dose model (e.g., RESidual RADioactivity [RESRAD] or other risk modeling) and fate and transport modeling, as required. Contaminant and soil property data will be obtained by sampling and analyzing soils.

4.1.3 Data Needs

A considerable amount of information has been presented in Sections 2.0 and 3.0 of this work plan regarding the 200-MW-1 representative waste sites. Some existing data are available for the representative waste sites; however, these data are insufficient to develop individual conceptual contaminant distribution models for the sites. The most pertinent existing information was used to develop site-specific conceptual contaminant distribution models for the 200-E-4 French Drain, the 216-A-4 Crib, the 216-T-13 Trench, the 216-T-33 Crib, and the 216-U-3 French Drain representative sites; additional information is provided by reference. For the representative waste sites (and the other waste sites in the OU in general), information is available regarding location, construction design, and major types of waste disposed. However, the data needed to verify and/or refine the site conceptual models and to develop conceptual contaminant distribution models are limited. These data are needed to support remedial decision making at these sites and any analogous sites. As defined by the DQO process, the focus of the 200-MW-1 RI is to determine the nature and vertical extent of contamination in the vadose zone within the boundary of the representative waste sites. Specifically, determinations of the type, concentration (particularly the highest concentration), and vertical distribution of radiological and nonradiological contamination in the vadose zone at all five of the representative waste sites are the major data needs. Data are also required to determine the physical properties of soils; these data will provide additional inputs to support a risk evaluation through the use of models for fate and transport of contaminants through the vadose zone to groundwater, exposure to radionuclides, and exposure to chemicals.

4.1.4 Data Quality

Data quality was addressed during the DQO process. Data quality and quantity were determined to be insufficient to support the RI/FS process for the OU; therefore, additional data collection is needed through the RI process.

The process of identifying the final list of COCs is summarized in Section 3.5. Analytical performance criteria were established by evaluating potential ARARs and preliminary remediation goals (PRGs), which are regulatory thresholds and/or standards or derived risk-based thresholds. These potential ARARs and PRGs represent chemical-, location-, and action-specific requirements that are protective of human health and the environment. Regulatory thresholds and/or standards or preliminary action levels provide the basis for establishing cleanup levels and dictate analytical performance levels (i.e., laboratory detection limit requirements). Detection limit requirements and standards for precision and accuracy are used to define data quality.

To provide the necessary data quality, detection limits should be lower than preliminary action levels. Additional data quality is gained by establishing specific policies and procedures for the generation of analytical data and field quality assurance/quality control requirements. These requirements are discussed in detail in the SAP (Appendix A). Analytical performance requirements are specified in Table 3-6 of the DQO summary report (BHI 2002). The potential ARARs and PRGs for 200 Area waste sites are discussed in Sections 4.0 and 5.0 of the Implementation Plan (DOE-RL 1999a).

4.1.5 Data Quantity

Data quantity refers to the number of samples collected. The number of samples needed to refine the site conceptual model and make remedial decisions is based on a biased sampling approach. Biased sampling is the intentional location of a sampling point within a waste site based on process knowledge of the waste stream and expected behavior of the potential COC(s). It is the preferred sampling approach as defined in Section 6.2.2 of the Implementation Plan (DOE-RL 1999a) for the RI phase. Using this approach, sampling locations can be selected that increase the chance of encountering the highest contamination in the local soil column.

Sample locations at the representative sites were selected based on the preliminary conceptual models of contaminant distribution presented in the DQO summary report (BHI 2002). Five locations in five representative sites were selected for sampling. The locations were selected with the goal of intersecting the areas of highest potential for contamination and to determine the type and vertical extent of contamination at the representative sites. Because the 200-E-4 French Drain, 216-A-4 Crib, 216-T-13 Trench, 216-T-33 Crib, and 216-U-3 French Drain cover only relatively small areas, lateral extent of contamination within the site boundaries is not considered necessary for remedial decision making. Soil samples will be taken at each representative site from a borehole (either to the Plio-Pleistocene unit or to near the groundwater table) or test pit and will be collected from different depths beneath the waste site to evaluate the vertical extent of contamination. Extra soil samples may be collected as warranted by observations such as changes in lithology, visual indications of contamination, and field screening results. This biased sampling approach was designed to provide the data needed to meet DQOs for this phase of the RI/FS process.

4.2 CHARACTERIZATION APPROACH

This section provides an overview of characterization activities that are planned to collect the required data identified in the DQO process. These activities include ground-penetrating radar and electromagnetic induction surveys, borehole drilling, excavation of test pits, and sampling and geophysical logging using spectral gamma and neutron moisture tools. Sample analysis will be conducted by an offsite laboratory under a contract-required quality program. The sampling strategy is designed to provide access to potentially contaminated subsurface areas. Sample collection will be guided by field screening conducted during the RI and a sampling scheme that identifies critical sampling depths.

The sample taken just above the water table is intended to represent deep contaminants in the vadose zone that could potentially impact groundwater. The sample intervals are also significant at the 4.6- and 7.6-m (15- and 25-ft) depth to define contamination profiles for remedial designs. For excavation and disposal sites, the decision-making depth is 4.6 m (15 ft), as directed by *Model Toxics Control Act* direct exposure requirements.

Three boreholes will be drilled for the investigation, one borehole each at the 216-A-4 Crib, 216-T-33 Trench, and 216-U-3 French Drain. The 200-E-4 French Drain and 216-T-13 Trench will each have a test pit excavated.

4.2.1 Ground-Penetrating Radar and Electromagnetic Induction

Ground-penetrating radar and electromagnetic induction will be performed at each representative site in support of the excavation permit process. Additional ground-penetrating radar and electromagnetic induction is planned at the 216-T-13 Trench to confirm the trench location and to determine the trench bottom profile.

4.2.2 Drilling and Sampling

For waste sites requiring boreholes for characterization, the depth of drilling and associated soil sampling will be based on site-specific conditions. When available information indicates the presence of deep vadose zone contamination or that groundwater has been impacted by a waste site, soil sampling to the water table will be performed. For waste sites where deep contamination has not been observed or no information exists, sampling to groundwater may not be necessary. In this case, the drilling and sampling depths will be determined based on the observational approach. As a minimum, samples will be collected to the deepest significant confining geological unit such as the Plio-Pleistocene unit, if present, and as a maximum, to the water table. The Plio-Pleistocene unit is expected to be a zone of higher moisture content and where contaminants would tend to concentrate. Decisions to collect samples past the Plio-Pleistocene unit will be based on soil samples or drill cuttings screened for radioactive contamination.

As shown in the conceptual contaminant distribution models (Figures 3-11, 3-13, and 3-14), liquid waste discharged to the 216-U-3 French Drain and 216-T-33 Crib is not expected to have significantly impacted the vadose zone below the Plio-Pleistocene unit, while the 216-A-4 Crib

is expected to have significantly impacted the deep vadose zone. Therefore, this observational approach to borehole sampling would apply to the 216-U-3 French Drain and 216-T-33 Crib.

The 216-A-4 Crib borehole will be drilled and sampled from a location near the area of maximum expected contamination of the crib (Figure 4-2) to a depth just above the groundwater table. This location was chosen to target the areas of maximum contamination within the site.

The 216-T-33 Crib and 216-U-3 French Drain boreholes will be located near the area of maximum expected contamination within the site, respectively (Figures 4-4 and 4-5). At these two sites, uranium and cesium-137, which are gamma-emitting radionuclides that are detectable in the field, are the primary contaminants based on inventory records (DOE-RL 1997, Appendix A). As a result, soil samples will be collected down to and within the Plio-Pleistocene unit. The soil samples/drill cutting from the Plio-Pleistocene unit will be screened using a hand-held rate meter with a gamma detector. If contamination is three times greater than background, drilling and sampling will resume, as specified in the SAP (Appendix A), to the next sample interval until contamination is less than three times background. The three times greater than background criterion is considered appropriate to minimize the potential for a false-positive. If contamination is less than three times background, the borehole will be logged with the spectral gamma-ray logging (SGL) system to confirm that significant contamination is not present prior to abandoning the borehole. These decisions will be made in the field by the site geologist.

The sample collection strategy outlined above has been designed to thoroughly characterize the vadose zone materials beneath the sites to the Plio-Pleistocene unit or to the top of the groundwater table, as appropriate. Sampling will generally begin at the first sign of radiological contamination, as determined by field measurements. Significant contamination is expected to begin at the historic bottom of the site (i.e., crib or trench bottom), but if contamination is detected in backfill materials above the waste site bottom, the backfill materials will also be sampled. Borehole samples will typically be collected at smaller intervals from the point of release point (i.e., the bottom of the crib or trench), and then at larger intervals with depth. Samples that were identified as critical during the DQO process were from 4.6 m (15 ft) bgs and 7.6 m (25 ft) bgs. In addition to these samples identified in the SAP, samples may be collected at the discretion of the geologist/sampler based on field screening and geologic information (e.g., changes in lithology). A detailed sample location profile for each borehole is presented in the SAP (Appendix A).

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

Likely drilling methods for this project include cable tool, sonic, and diesel hammer. The drilling method must allow the use of a 13-cm (5-in.) outside-diameter split-spoon sampler. Use of a split-spoon sampler will necessitate compositing the sample over at least 0.3 m (1 ft) to obtain enough sample for analysis. The drilling method must not use any system that circulates air or water. Air-based drilling methods may compromise the sample collection and data quality for volatile constituents through the introduction of air to the soils. In addition, the air circulated in these methods may dry the formation and negatively impact moisture logging activities.

The presence of water-saturated soils will indicate the water table has been contacted as determined by the site geologist. Up to three strings of casing may be telescoped to the proposed depth to minimize the transport of contaminants in the vadose zone from the drilling operations. The casings will be of sufficient size to accommodate a split-spoon sampler to the bottom of the borehole. Downsizing of the casing will be commensurate with the expected decrease in contamination levels with decreasing depth. Actual conditions during drilling may warrant changes; the changes may be implemented after consultation with and the approval by the task lead and the subcontract technical representative. All casings will be removed from the boreholes when drilling and sampling are completed. If required to support Hanford Site groundwater monitoring needs, boreholes may be completed as groundwater wells. Otherwise, the borehole will be backfilled and decommissioned in accordance with *Washington Administrative Code* 173-160, "Minimum Standards for Construction and Maintenance of Wells."

4.2.3 Test Pit Excavation and Sampling

The 200-E-4 French Drain and 216-T-13 Trench each will have a test pit excavated and sampled from a location near the center of the waste site. The test pit locations were chosen to target the accessible areas of maximum potential for contamination within the site. Therefore, the soils collected close to the bottom of the site should provide a worst-case scenario for maximum contamination levels.

The sample collection strategy has been designed to characterize the vadose zone materials directly beneath the sites (see Figures 3-10 and 3-12). Sampling will generally begin at the first sign of radiological contamination, as determined by field measurements. This contamination is expected to begin at the historic bottom of the site (i.e., french drain or trench bottom), but if contamination is detected in backfill materials above the waste site bottom, the backfill materials will also be sampled. Samples will typically be collected at smaller intervals near the release point (i.e., the bottom of the french drain or trench), and at larger intervals with increasing depth. Samples that were identified as critical during the DQO process will be collected at 4.6 m (15 ft) bgs and 7.6 m (25 ft). In addition to the specific sample intervals in the SAP, a detailed sample location profile for each test pit is also presented in the SAP (Appendix A). Additional samples may be collected at the discretion of the geologist/sampler based on field screening and geologic information (e.g., changes in lithology). At the 216-T-13 Trench, the potential exists for significant contamination below the 7.6-m (25-ft) depth of a standard test pit due to the disposal of mobility-enhancing chemicals. Therefore, assessing the contamination at a depth greater than 7.6 m (25 ft) may be required. The assessment approach is discussed in Section 4.3.2 and the SAP (Appendix A).

All test pits will be conducted per BHI-EE-01, Procedure 5.2, "Test Pit Excavation in Contaminated Areas." The excavator generally will require a 5-m (16-ft)-wide access road. Cleaning and decontamination requirements will also be performed according to BHI-approved procedures.

4.2.4 Field Screening

All samples and/or cuttings from the boreholes or excavated from test pits will be field screened for evidence of radionuclides. Except for critical samples, soil radioactivity screening will assist in defining the sampling intervals identified in the SAP.

4.2.5 Analysis of Soil

Soil samples will be collected for analysis of radiological and nonradiological constituents and the determination of select soil properties. The list of analytes for this investigation was developed based on an evaluation of all potential contamination that was discharged to the waste sites. Development of this list of COCs is presented in Section 3.4, Tables 3-2 through 3-6, and in the DQO summary report (BHI 2002). Tables A-7 and A-8 of the SAP list details of the analytical methods, holding times, and quality assurance and quality control procedures for each contaminant. A limited number of samples will also be analyzed to determine soil physical properties, such as moisture content and particle size.

4.3 GEOPHYSICAL LOGGING

Geophysical logging is planned for boreholes and direct push drive casing.

4.3.1 Borehole Geophysics

The three boreholes (described in Section 4.2.2) will be logged with a high-resolution SGL system to provide continuous vertical logs of gamma-emitting radionuclides and with a neutron moisture-logging system to identify moisture changes. In addition to the logging performed on the new borings, SGL is proposed in existing boreholes near the representative waste sites. The SGL of existing boreholes in the vicinity of a waste site can be a cost-effective method of providing supplemental data on the vertical and lateral distribution of gamma-emitting radionuclides, provided that the boreholes are located sufficiently close to the waste site and are appropriately constructed (e.g., single borehole casing in contact with the formation).

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

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

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

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

Logging runs will be made prior to changing casing sizes and at the total depth of the borehole. The downhole tools and cable will be subject to the same rules as the drill rig and equipment. The downhole tools and cable will be decontaminated and surveyed between boreholes.

4.3.2 Geophysical Logging Through Direct Push Casing

The 216-T-13 Trench has the potential for contamination below the planned 7.6-m (25-ft) depth limitation of a standard test pit due to the disposal of chemicals that enhanced mobility. Therefore, assessment of the radioactive contamination, which also would be an indicator of nonradiological contamination, at a depth greater than 7.6 m (25 ft) may be required. Based on process knowledge, the radioactive contamination is expected to be represented by gamma emitters (e.g., cesium-137). One direct push (e.g., Geoprobe®, cone penetrometer, or drive casings) hole will be installed and logged with a gamma logging tool (gross gamma tool for Geoprobe or cone penetrometer and high-resolution SGL system). The depth of a direct push casing is limited by the subsurface conditions (i.e., cobbles, gravel). The hole will be pushed as deep as possible, but a maximum depth of approximately 18 m (60 ft) bgs is anticipated for investigation planning. If at the maximum direct push depth radioactive contamination is greater than three times background, a borehole may be required. The sampling interval for this borehole would be similar to the intervals for the 216-T-33 Crib below 7.6 m (25 ft).

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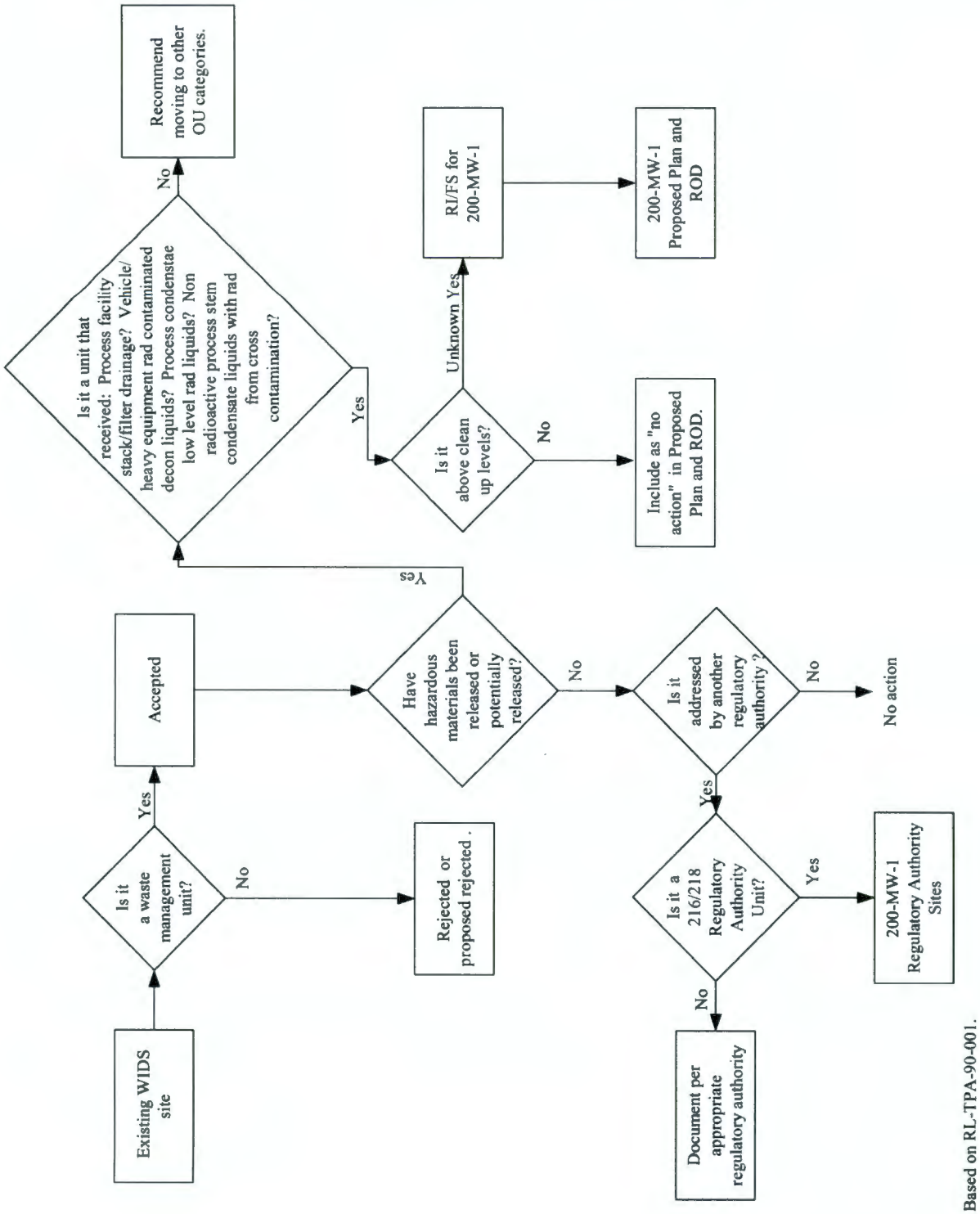
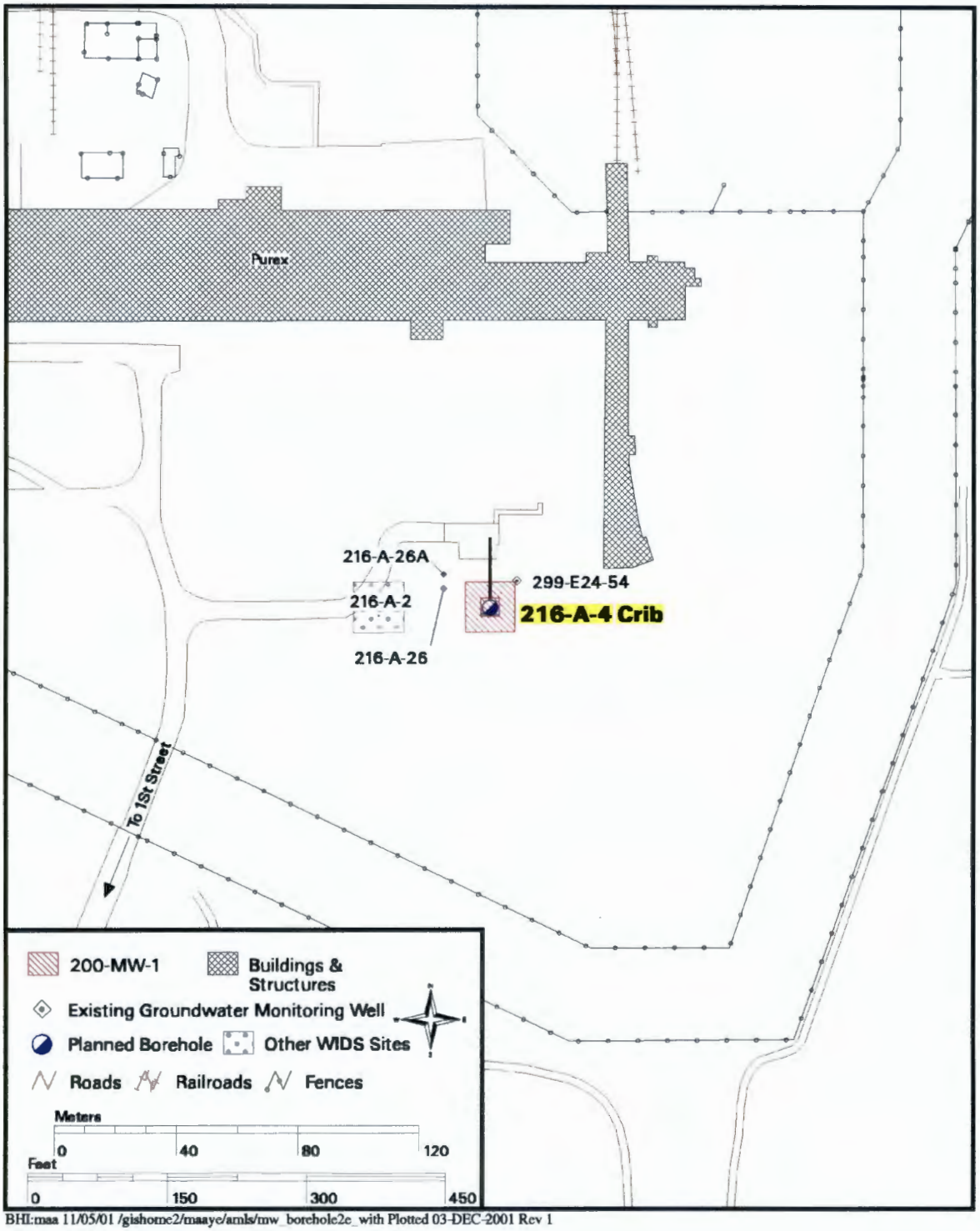
Figure 4-1. 200-MW-1 Waste Site Review Flow Diagram.



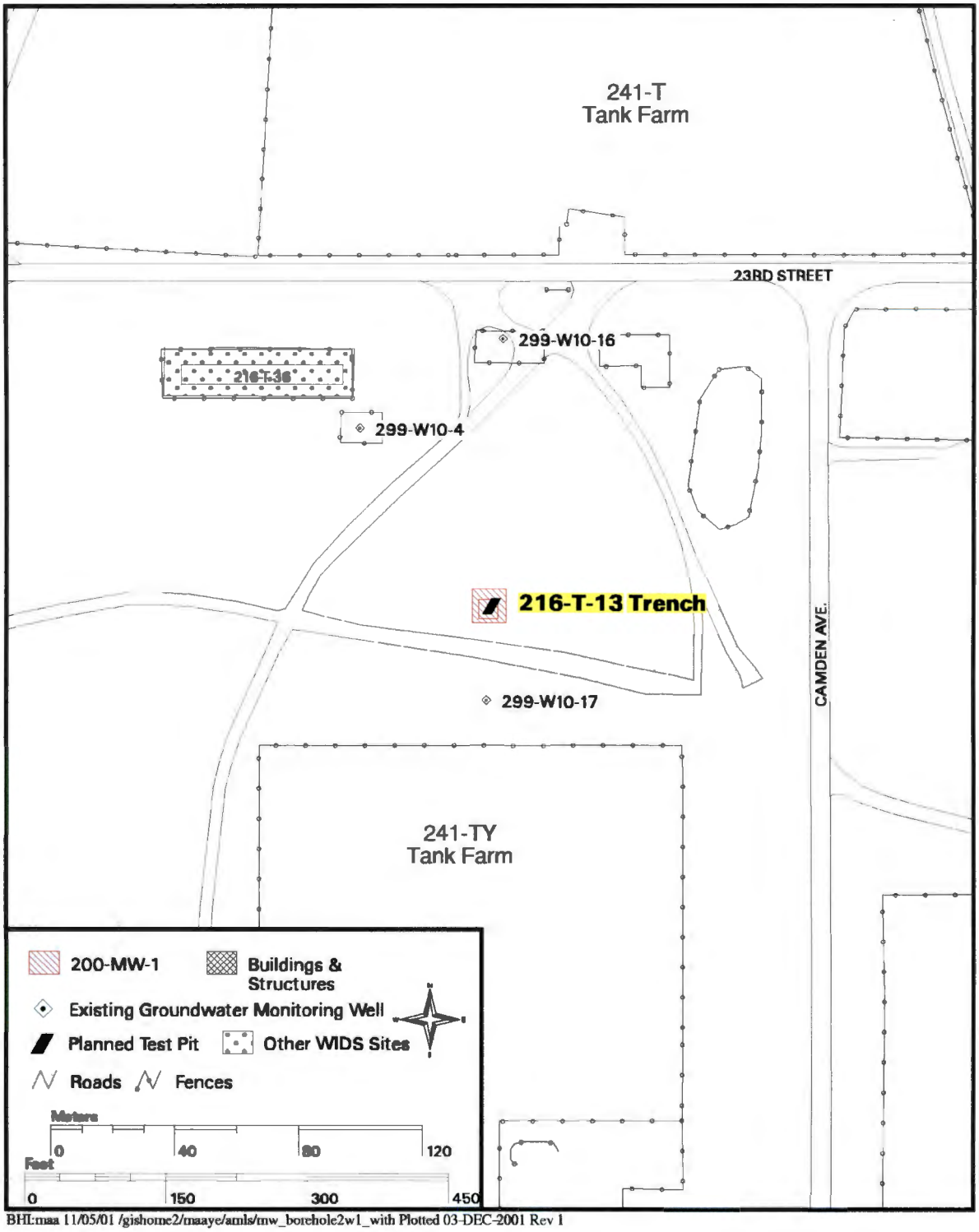
[a] Based on RL-TPA-90-001.

Figure 4-2. Location of Planned and Existing Boreholes at the 216-A-4 Crib.



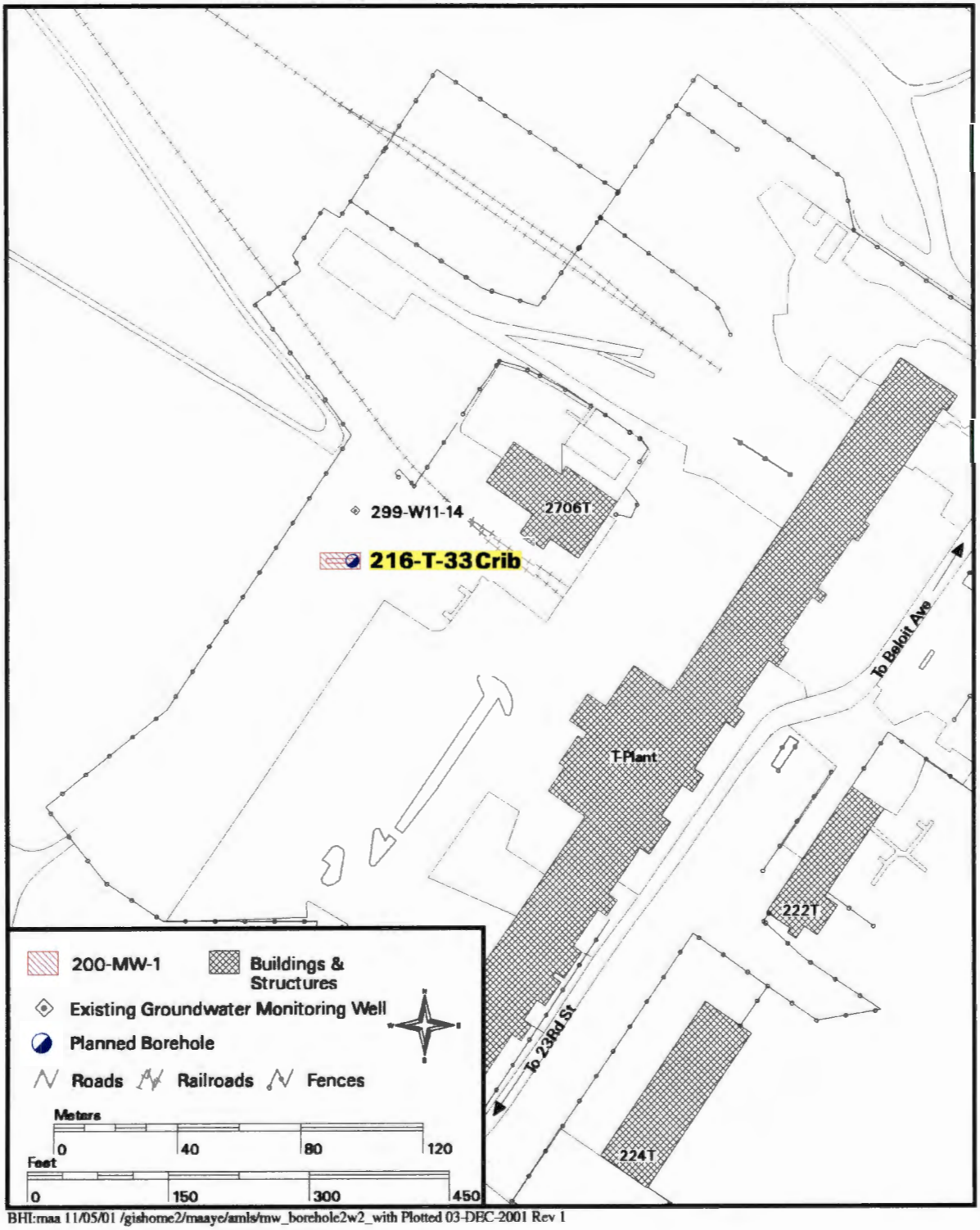
BHI:maa 11/05/01 /gishome2/maaye/amls/mw_borehole2e_with Plotted 03-DEC-2001 Rev 1

Figure 4-3. Location of Planned Test Pit and Existing Boreholes at the 216-T-13 Trench.



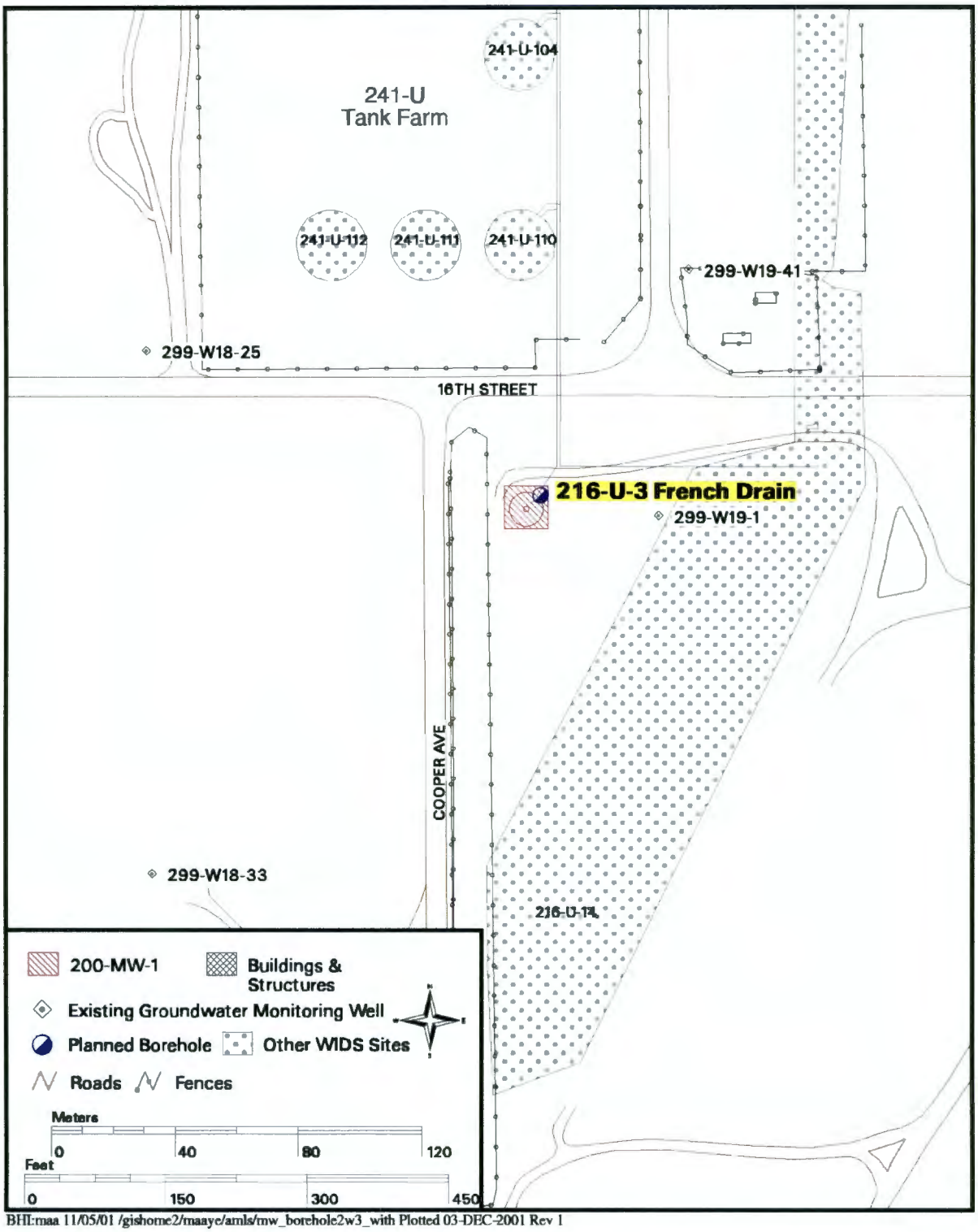
BHI:maa 11/05/01 /gishome2/maaye/amls/mw_borehole2w1_with Plotted 03-DEC-2001 Rev 1

Figure 4-4. Location of Planned and Existing Boreholes at the 216-T-33 Crib.



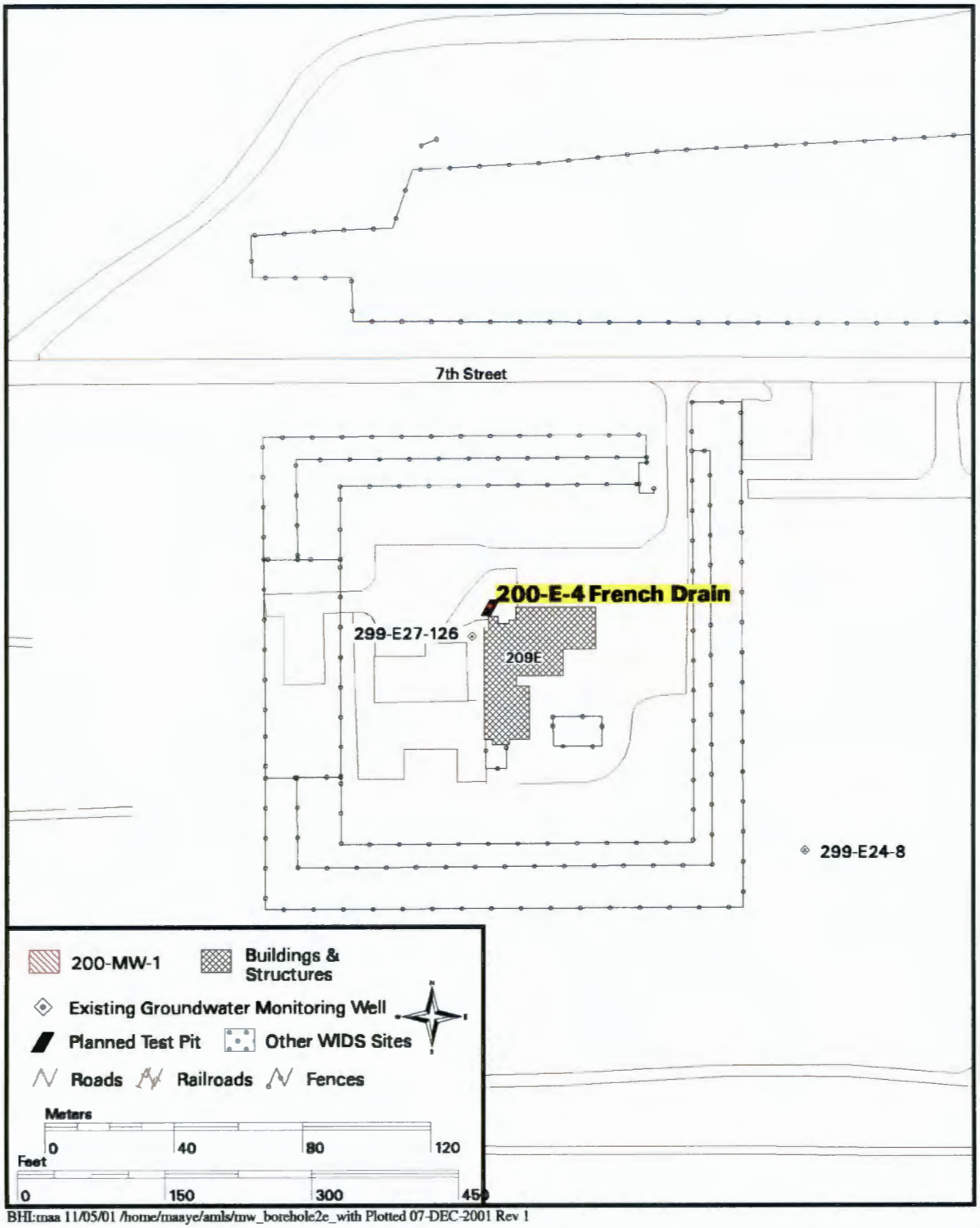
BHI:maa 11/05/01 /gishome2/maaye/amls/mw_borehole2w2_with Plotted 03-DEC-2001 Rev 1

Figure 4-5. Location of Planned and Existing Boreholes at the 216-U-3 French Drain.



BHI:maa 11/05/01 /gishome2/maaye/amls/mw_borehole2w3_with Plotted 03-DEC-2001 Rev 1

Figure 4-6. Location of Planned Test Pit and Existing Boreholes at the 200-E-4 French Drain.



BHI:maa 11/05/01 /home/maaye/amls/mw_borehole2e_with Plotted 07-DEC-2001 Rev 1

5.0 REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROCESS

This section describes the RI/FS (assessment) process for the 200-MW-1 OU. The development of and rationale for this process provided in the Implementation Plan (DOE-RL 1999a) are summarized in Section 1.0 and Figure 1-1. The process follows the CERCLA process that is summarized in Section 5.1. A strategy to address ecological impacts in the 200 Areas is discussed in Section 5.2.

Section 5.3 outlines the tasks to be completed during the RI phase, including planning and conducting field sampling activities and preparation of the RI report. These tasks are designed to effectively manage the work, satisfy the DQOs identified in Section 4.0, document the results of the investigation, and manage waste generated during field activities. The general purpose of the RI is to characterize the nature, the vertical extent, and in some cases the lateral extent within the confines of the waste site; concentration; and potential transport of contaminants and to provide data to determine the need for and type of remediation. The information that will be collected to carry out these tasks is described in the SAP (Appendix A). Tasks to be completed following the RI include an FS (Section 5.4), a proposed plan/ROD (Section 5.5), and post-ROD activities (Section 5.6).

Project management occurs throughout the RI/FS process. Project management is used to direct and document project activities so that objectives of the work plan are met and the project remains within budget and on schedule. The initial project management activity will be to assign individuals according to roles established in Section 7.2 of the Implementation Plan (DOE-RL 1999a). Other project management activities include day-to-day supervision of and communication with project staff and support personnel; meetings; control of cost, schedule, and work; records management; progress and final reports; quality assurance; health and safety; and community relations.

Appendix A of the Implementation Plan (DOE-RL 1999a) provides the overall quality assurance framework that was used to prepare an OU-specific quality assurance project plan for the RI (Appendix A, Section A.2). Appendix B of the Implementation Plan includes a review of data management activities that are applicable to the investigation activities at this OU and describes the process for the collection/control of data, records, documents, correspondence, and other information associated with OU activities.

5.1 REGULATORY PROCESS

The characterization process for the 200-MW-1 OU uses this work plan in combination with the Implementation Plan (DOE-RL 1999a) to satisfy the requirements for an RI/FS work plan. General facility background information, potential ARARs, preliminary RAOs, and preliminary remedial technologies developed in the Implementation Plan are incorporated by reference into this work plan. Following the completion of the work plan, an RI limited to the investigation of representative 200-MW-1 waste sites will be performed and summarized in an RI report.

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

The decision-making process for the 200-MW-1 OU will be based on the use of a proposed plan and a ROD. Based on the FS, a proposed plan will be prepared that identifies the preferred remedial alternative for waste sites within the OU. The proposed plan will be issued for a 45-day public review and comment period. Supporting documents, including the FS, will also be made available to the public at this time. A combined public meeting/public hearing may be held during the comment period to provide information on the proposed action and to solicit public comment. After the public review, EPA will respond to comments and make a final decision on the proposed action that will be documented in a ROD.

Additional guidance on the regulatory process is provided in Section 2.4 of the Implementation Plan (DOE-RL 1999a).

5.2 ECOLOGICAL EVALUATION PROCESS

A strategy to address ecological impacts has been developed and is being implemented in the 200 Areas (DOE-RL 2002b). The 200 Area ecological evaluation approach is intended to support the RI/FS process implemented at the OU level as illustrated in Figure 5-1. Phase I includes the compilation, evaluation (Step A in Figure 5-1), and reporting (Step B in Figure 5-1) of existing data describing known ecological conditions (200-MW-1 specific data are presented in Section 3.3.7). The Phase I ecological report (Step B in Figure 5-1) will also be used as the foundation for the Phase II effort. If needed, Phase II is intended to refine the ecological risk assessment methodology and address additional data needs using the DQO development process (Step C in Figure 5-1). Depending on the nature of the DQOs (e.g., COC, media type, location), data collection would be accomplished as part of an OU RI or as part of a 200 Area-wide ecological monitoring program. Soil sampling at specific waste sites will be performed as part of the OU RI (Step D in Figure 5-1). Soil sampling at locations other than waste sites and all biological sampling are expected to be performed as part of a general 200 Area monitoring program (Step E in Figure 5-1). The 200 Area program would focus on meeting sampling needs that are geographic in nature (e.g., 200 National Priorities List scale) and not associated with any one waste site or OU (Step E in Figure 5-1). As such, the program does not have direct ties to the OU RI/FS process and is currently planned to be accomplished under current and future site environmental monitoring programs.

The Phase I report (Step B in Figure 5-1) and Phase II DQO process (Step C in Figure 5-1) can provide input to the RI/FS process as a source of compiled ecological data and by identifying waste site-specific data needs. The 200 Area Remedial Action Project has been preparing and implementing RI/FS work plans since 1999. As a result, the timing and nature of the input will be OU specific and a function of the current stage the OU has reached in the RI/FS process. For OUs where a work plan has not been prepared (Step F in Figure 5-1), the Phase I report provides a source of ecological information needed to describe environmental conditions, and the Phase II

DQO process serves to identify soil sampling and analysis requirements that would typically be met under the remedial investigation. If a work plan has already been prepared and approved (Step G in Figure 5-1), waste site-specific sampling could be performed under a task-specific SAP (Step I in Figure 5-1) as part of the RI or deferred to a later stage of sampling (Step J in Figure 5-1), depending on the timing. All efforts should be made to collect representative waste data (Step H in Figure 5-1) prior to the completion of the FS, as the information is generally needed to complete the task. If additional analogous waste site data are required, the data can be collected during a later stage of sampling referred to as confirmatory sampling (Step J in Figure 5-1).

The specific path for the 200-MW-1 OU is shown in the shaded boxes in Figure 5-1.

5.3 REMEDIAL INVESTIGATION ACTIVITIES

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

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

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

5.3.1 Planning

The planning subtask includes activities and documentation that must be completed before field activities can begin. These include the preparation of a site-specific health and safety plan (HASP), according to 29 *Code of Federal Regulations* (CFR) 1910.120, and a preliminary hazard classification. If required, a final hazard classification and safety analysis will be performed in accordance with BHI procedures. Radiological work permits, excavation permits and supporting surveys (e.g., cultural, radiological, wildlife, and utilities), work instructions, personnel training, and the procurement of materials and services (e.g., drilling and geophysical logging services) will also be required. In addition, three boreholes and two test pits identified in Figures 4-2 through 4-6 will be located using a Global Positioning Satellite system.

Appendix B of the Implementation Plan (DOE-RL 1999a) provides a general HASP that outlines health and safety requirements for RI activities. A site-specific HASP will be prepared for drilling activities, following requirements of the general HASP. Initial surface radiological surveys will be performed to document any radiological surface contamination and background levels in and around the sampling locations. This information will be used to document initial site conditions.

5.3.2 Field Investigation

The field investigation task involves data-gathering activities performed in the field that are required to satisfy the project DQOs. The field characterization approach is summarized in Section 4.2 and detailed in the SAP provided in Appendix A of this work plan. The scope includes soil sampling and analysis to characterize the vadose zone at the 200-MW-1 OU representative waste sites (200-E-4 French Drain, 216-A-4 Crib, 216-T-13 Trench, 216-T-33 Crib, and 216-U-3 French Drain). Major subtasks associated with the field investigation include the following:

- Borehole drilling, soil sampling, and collection of data from geophysical logging
- Test pit excavation and soil sampling
- Preparation of a field report.

5.3.2.1 Borehole Drilling and Soil Sampling. This subtask involves the drilling of boreholes for the purpose of collecting soil samples and geophysical logging. For the 200-MW-1 OU, three boreholes are planned to collect samples down to the top of the groundwater table.

Samples will be collected with split-spoon samplers and packaged for shipment to an offsite laboratory if radiation levels permit. Otherwise, samples will be shipped to an onsite laboratory. At the completion of sampling, the boreholes will be abandoned and initial site conditions reestablished. Alternatively, the boreholes may be completed as groundwater monitoring wells, if needed by the Hanford Site groundwater monitoring program. Other activities include work zone setup, mobilization/demobilization of equipment, equipment decontamination, and field analyses. Planned field analyses include radiological field screening, geologic logging, and geophysical logging of boreholes.

All samples and drill cuttings will be field screened for radionuclides to provide additional characterization data, to assist in the selection of sample intervals (e.g., hot spots) and in establishing radiation control measures, and to ensure worker health and safety.

Geophysical logging will be used to gather in situ radiological and physical data from the borehole and from existing wells (specified in Table A-16 of the SAP). High-resolution SGL will be performed to assess the distribution of gamma-emitting radionuclides. Neutron logging will be also performed for moisture content distribution over the borehole or well interval.

5.3.2.2 Test Pit Excavation and Soil Sampling. This subtask involves the excavation of test pits for the purpose of collecting soil and sediment samples and characterizing the geology of the shallow vadose zone. Samples will be collected from two test pits to a maximum depth of 7.6 m (25 ft) using an excavator. Samples will be collected from the bucket of the excavator and will be packaged for shipment to an offsite laboratory. At the completion of sampling, the test pit will be backfilled and initial site conditions will be reestablished. Other activities include work zone setup, mobilization/demobilization of equipment, equipment decontamination, and field analyses.

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

5.3.2.3 Preparation of Field Report. At the completion of the field investigation, a field report will be prepared to summarize activities performed and information collected in the field. The report will include survey data for borehole locations, the number and types of samples collected and associated Hanford Environmental Information System numbers, inventory of IDW containers, geological logs, field screening results, and geophysical logging results.

5.3.3 Management of Investigation-Derived Waste

A waste designation DQO effort will be performed before the initiation of the characterization activities to ensure that the proper information is collected during the field effort to support the designation of all project IDW. During the IDW DQO effort, any listed waste issues will also be resolved. Any additional sampling requirements or analytes needed to support designation activities will be identified and implemented through the waste designation DQO summary report that will be prepared at that time.

Waste generated during the RI will be managed in accordance with a waste control plan to be prepared for the OU. Appendix E of the Implementation Plan (DOE-RL 1999a) provides general waste management processes and requirements for this IDW and forms the basis for activity-specific waste control plans. The site-specific waste control plan addresses the handling, storage, and disposal of IDW generated during the pre-ROD phase. Furthermore, the plan identifies governing Environmental Restoration Contractor procedures and discusses types of waste expected to be generated, the waste designation process, and the final disposal location. The IDW management task begins when IDW is first generated at the start of the field investigation, through waste designation and disposal.

5.3.4 Laboratory Analysis and Data Validation

Soil samples collected via boreholes will be analyzed for a suite of radiological and nonradiological constituents identified as COCs during the DQO, and for select physical properties based on established DQOs and as defined in the SAP. The list of analytes, methods, and associated target detection limits are provided in Tables A-7 and A-8 of the SAP. This task includes the laboratory analysis of samples, the compilation of laboratory results in data packages, and the validation of a representative number of laboratory data packages.

5.3.5 Remedial Investigation Report

This section summarizes data evaluation and interpretation subtasks leading to the production of an RI report. The primary activities include a data quality assessment (DQA); evaluating the nature, extent, and concentration of contaminants based on sampling results; assessing

contaminant fate and transport; refining the site conceptual models; and evaluating risks through a qualitative risk assessment (QRA). These activities will be performed as part of the RI report preparation task.

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

5.3.5.2 Data Evaluation and Conceptual Model Refinement. This task will include evaluating the information collected during the investigation. The nonradiological and radiological data obtained from the boreholes will be compiled, tabulated, and statistically evaluated to gain as much information as possible to satisfy data needs. Data evaluation tasks may include the following:

- Graphically evaluating the data for vertical distribution of contamination within each borehole

- Stratifying the data and computing basic statistical parameters such as mean and standard deviation for individual levels (when sufficient data are available). This evaluation can provide an indication of contaminant distribution

- Constructing contour diagrams and variograms to evaluate spatial correlations within each stratum. This evaluation will indicate whether or not contamination is concentrated in a particular area (e.g., near the influent end for trenches)

- Performing statistical tests on the data to evaluate the presence or absence of contamination. There are many facets to this step, including determining the distribution of the data and selecting the appropriate statistical tests. The initial screening for contamination should evaluate the data with respect to background, by using simple comparisons of an upper bound of the data to background concentrations (e.g., *Model Toxics Control Act* tests), or through more complex comparisons, such as nonparametric hypothesis tests (e.g., Wilcoxon Rank Sum Test). These tests may also compare the data to appropriate cleanup levels.

All of these statistical evaluations will aid in refining the conceptual model for this OU and selecting the remedial alternative. However, because the sites within the 200-MW-1 OU represent point-source types of releases, statistical analysis may not always be possible. Single boreholes are planned at the representative sites, and if the resulting data are not sufficient for statistical analysis, maximum or average concentrations will be used in the data evaluation process.

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

of the soil type and soil moisture will allow the determination of unsaturated hydraulic conductivity, which will be used as needed in modeling flow and transport (see Section 5.3.5.3).

The combined chemical, physical, and geophysical data for the 200-MW-1 representative sites will be used for correlating subsurface data, for further refinement of the preliminary conceptual contaminant distribution models, and as inputs to a QRA.

5.3.5.3 Qualitative Risk Assessment. The application of risk assessment in the characterization and remediation of the 200 Areas will follow a graded approach as described in Section 5.5 of the Implementation Plan. A QRA will be performed as part of the RI report and FS. Once additional data are available for all the sites in the 200-MW-1 OU, a more quantitative risk assessment may be performed. A quantitative, cumulative risk assessment will be used to evaluate remedial actions and to close out the sites in the 200 Areas.

QRAs will be prepared to evaluate risk to human receptors from potential exposure to contaminants in accessible surface and shallow subsurface soils. The QRAs will also evaluate the impact to groundwater that may result from contaminants migrating to the water table through the vadose zone underlying wastes sites in this OU.

As discussed in Section 5.2, the 200 Area ecological evaluation approach (DOE-RL 2002b) is intended to support the RI/FS process implemented at the OU level. Initial ecological risk screening-level assessment of contaminants provided in DOE-RL (2002b) will be refined in the RI report using information in DOE-RL (2002b) and supplemental data collected during the OU RI. Contaminants identified from the OU RI that exceed the screening level analysis may require a more detailed evaluation based on site-specific conditions. This type of site-specific evaluation would be performed in the RI report and/or in the FS based on the presence of site-specific contaminants and exposure conditions (e.g., depth of contaminants, habitat type, future land use), as well as EPA guidance and MTCA requirements.

The computer program RESRAD will be used to model radionuclide dose at the surface. The STOMP model will be used to evaluate potential impacts to groundwater from contaminants. The physical characterization data obtained in this study will be used in RESRAD along with input parameters appropriate to the land use. Land-use options and exposure scenario(s) within the exclusive-use boundary are being developed by the Tri-Parties Central Plateau Risk Framework Workshops. The results of these workshops are expected to be finalized in a document to be issued in December 2002. These results will serve as the framework for performance of the QRAs for waste sites in this OU.

5.4 FEASIBILITY STUDY

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

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

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

- No action alternative (no institutional controls)
- Engineered multimedia barrier
- Excavation and disposal of waste
- In situ vitrification of soil
- In situ grouting or stabilization
- Monitored natural attenuation (with institutional controls).

During the detailed analysis, each alternative will be evaluated against the following CERCLA criteria (40 CFR 300.430):

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

- Cost
- State acceptance.

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

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

The FS will also include supporting information needed to complete the detailed analysis and meet regulatory integration needs, including the following:

- Summarize the RI, including the nature and extent of contamination, the contaminant distribution models, and an assessment of the risks to help establish the need for remediation and to estimate the volume of contaminated media

- Refine the conceptual exposure pathway model to identify pathways that may need to be addressed by remedial action

- Provide a detailed evaluation of ARARs, starting with potential ARARs identified in the Implementation Plan (Section 4.0, DOE-RL 1999a)

- Refine potential RAOs and PRGs identified in the Implementation Plan (Section 5.0, DOE-RL 1999a) based on the results of the RI, ARAR evaluation, and current land-use considerations

- Refine the list of remedial alternatives identified in the Implementation Plan (Appendix D, DOE-RL 1999a) based on the RI.

5.5 PROPOSED PLAN

The decision-making process for the 200-MW-1 OU will be based on the use of a proposed plan and a ROD. Following the completion of the FS, a proposed plan will be prepared that identifies the preferred remedial alternative(s) for the waste sites within the OU. In addition to identifying the preferred alternative, the proposed plan will:

- Provide a summary of the completed RI/FS

- Provide criteria by which analogous waste sites within the OU not previously characterized will be evaluated after the ROD to confirm that the contaminant distribution model for the site is consistent with the preferred alternative. Contingencies to allow transfer of waste sites to a more appropriate waste group will also be developed.

- Identify ARARs applicable to the OU.

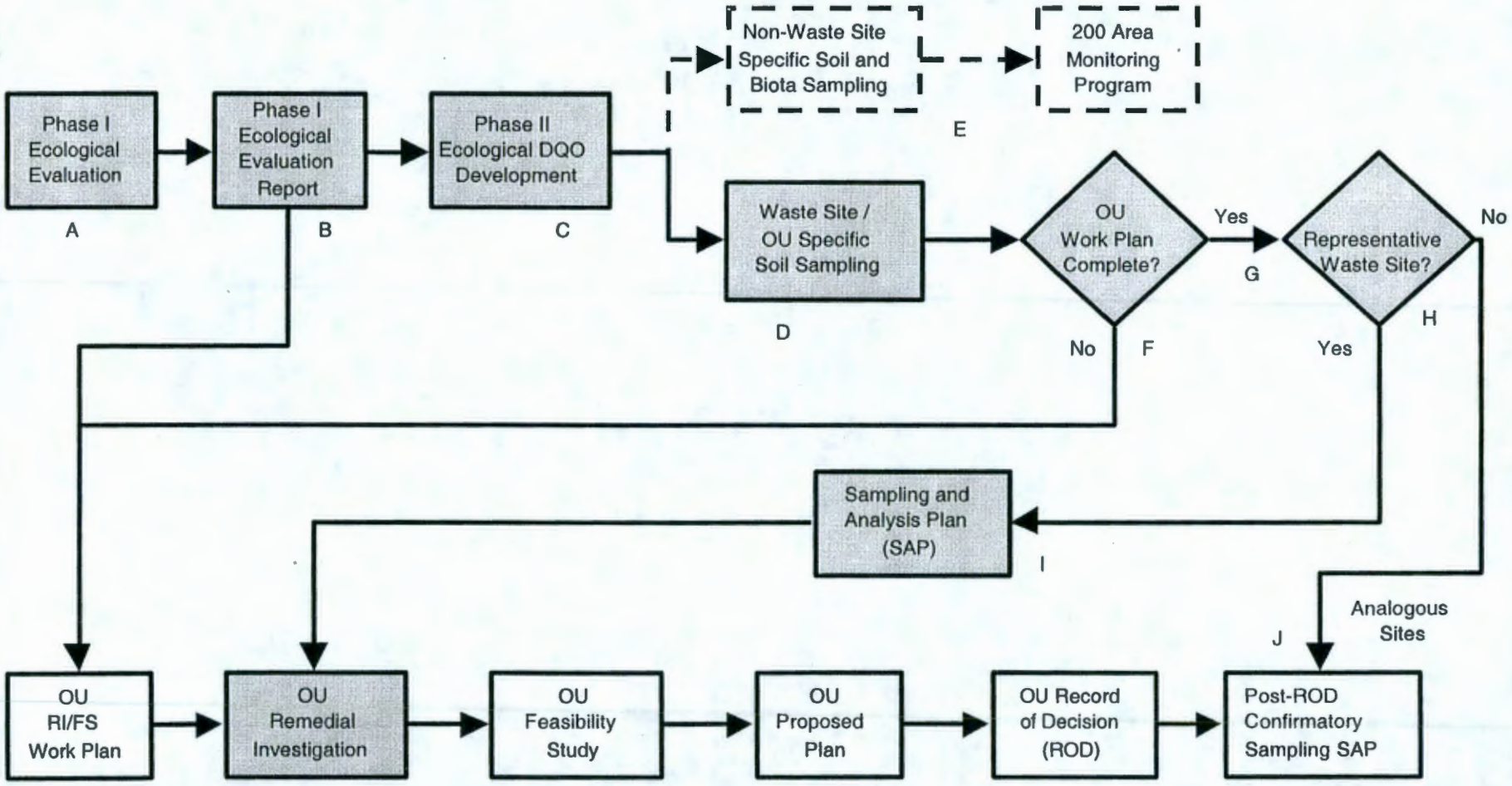
After the public review process is complete, EPA, as the lead regulatory agency for the 200-MW-1 OU, will make decisions on the preferred remedial action that will be documented in a ROD.

5.6 POST-ROD ACTIVITIES

After the ROD has been issued, a remedial design report (RDR) and remedial action work plan (RAWP) will be prepared to detail the scope of the remedial action. As part of this activity, DQOs will be established and SAPs prepared to direct confirmatory and verification sampling and analysis efforts. Prior to the start of remediation, confirmatory sampling will be performed to ensure that sufficient characterization data are available to confirm that the selected remedies are appropriate for all waste sites within the 200-MW-1 OU, to collect data necessary for the remedial design, such as lateral extent of contamination or additional ecological sampling, and to support future risk assessments, if needed. Sites that are not appropriate to the remedy will be reassigned to another, more appropriate OU. Verification sampling will be performed after the remedial action is complete to determine if ROD requirements have been met and if the remedy was effective. Additional guidance for confirmatory and verification sampling is provided in Section 6.2 of the Implementation Plan (DOE-RL 1999a).

The RDR/RAWP will include an integrated schedule of remedial activities for the OU. The OU-specific schedules will be developed considering closure/corrective action activities associated with the tank farms so that the 200-MW-1 OU and tank farm activities can be integrated as appropriate. Following the completion of the remediation effort, closeout activities will be performed as specified in the ROD and RDR/RAWP.

Figure 5-1. 200-MW-1 Operable Unit RI/FS and Ecological Evaluation Integration.



6.0 PROJECT SCHEDULE

The schedule for activities discussed in this work plan, including field activities; the preparation, review, and issuance of the RI report, the FS, and the proposed plan; and preparation of a ROD, is shown in Figure 6-1. This schedule will serve as the baseline for the work planning process and will be used to measure the progress of the implementation of this process.

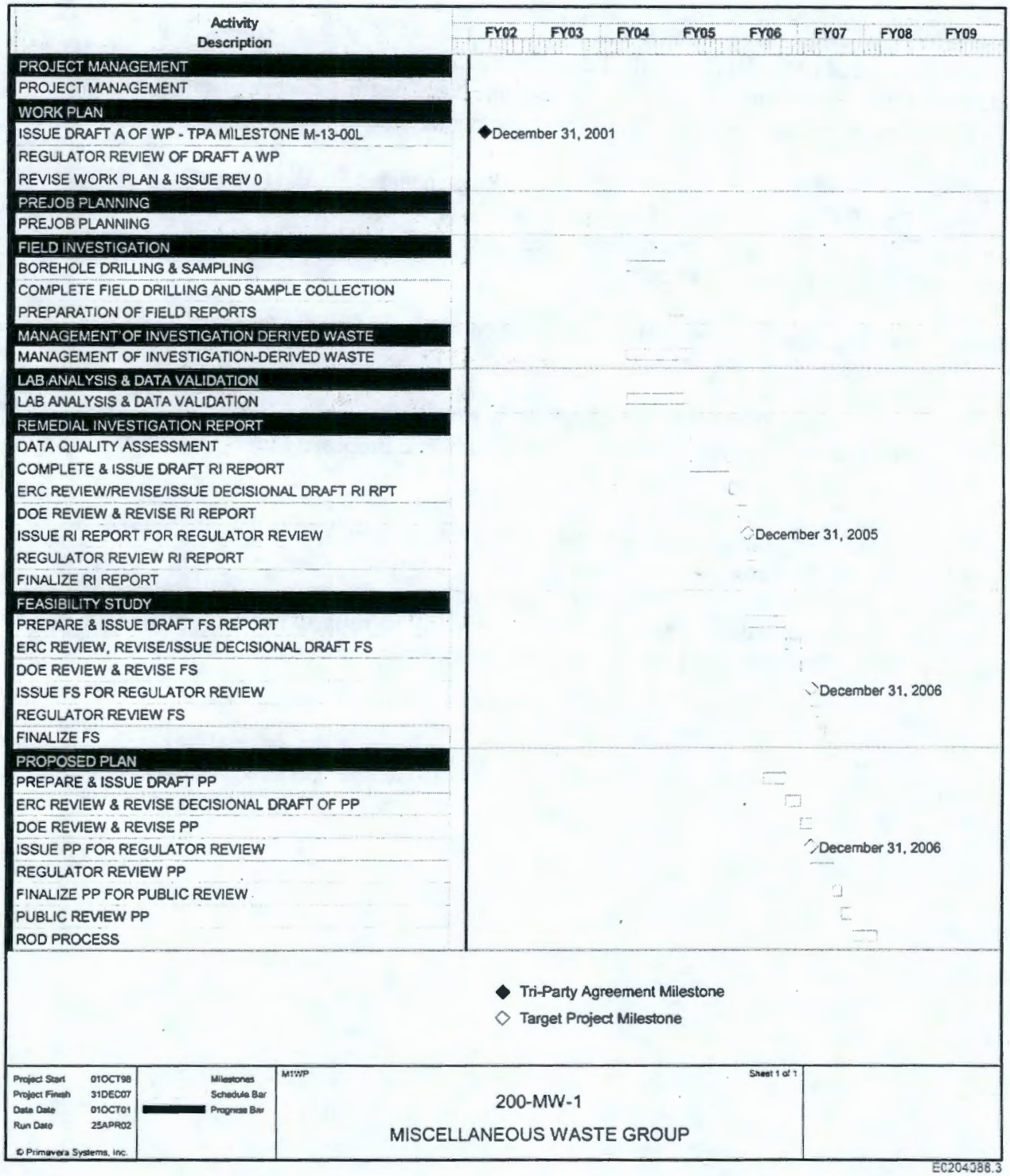
The portion of the schedule most germane to this work plan and the SAP (Appendix A) is fiscal year 2002. One Tri-Party Agreement milestone (M-13-00L) is associated with this OU, and it requires submittal of three OU work plans by December 31, 2001. This work plan fulfills the requirements for one of these work plans.

The following are proposed project target milestone completion dates for key activities at the 200-MW-1 OU:

- M-15-44A: Submit 200-MW-1 OU Remedial Investigation Report – December 31, 2005
- M-15-44B: Submit 200-MW-1 OU Feasibility Study and Proposed Plan – December 31, 2006.

Interim milestones to be designated under the Tri-Party Agreement will be established through negotiations among the Tri-Parties. A Class II change form will be submitted to the Washington State Department of Ecology and EPA to request the addition of any interim milestones. Any updates to the project schedule or associated milestones will be reflected in the annual work planning process. Currently, only fiscal year 2002 activities are funded.

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



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APPENDIX A

SAMPLING AND ANALYSIS PLAN

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ACRONYMNS

ASTM	American Society for Testing and Materials
BHI	Bechtel Hanford, Inc.
bgs	below ground surface
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
COC	contaminant of concern
COPC	contaminant of potential concern
DOE	U.S. Department of Energy
DQO	data quality objective
EPA	U.S. Environmental Protection Agency
ERC	Environmental Restoration Contractor
FS	feasibility study
HEIS	Hanford Environmental Information System
IDW	investigation-derived waste
OU	operable unit
QAPjP	quality assurance project plan
QC	quality control
RCT	radiological control technician
RESRAD	RESidual RADioactivity Dose Model
RI	remedial investigation
SAP	sampling and analysis plan
VOA	volatile organic analyte

APPENDIX A

SAMPLING AND ANALYSIS PLAN

A.1 INTRODUCTION

This sampling and analysis plan (SAP) directs sampling and analysis activities that will be performed to characterize the vadose zone at five waste sites: the 216-A-4 Crib, the 216-T-13 Trench, the 216-T-33 Crib, the 216-U-3 French Drain, and the 200-E-4 French Drain. These waste sites are part of the 200-MW-1 Miscellaneous Waste Group Operable Unit (OU) in the 200 Areas of the Hanford Site. The sampling and analyses described in this document will provide soil data to refine the preliminary conceptual contaminant distribution models, support an assessment of risk, and evaluate a range of remedial alternatives for waste sites in this OU. Characterization activities described in this plan are based on the implementation of the data quality objectives (DQO) process as documented in the *Remedial Investigation Data Quality Objectives Summary Report for the 200-MW-1 Operable Unit* (BHI 2002).

The scope of activities described in this SAP involves the excavation of two test pits, trenches, and/or shallow hand augers, and the drilling of three boreholes. Test pits and/or shallow hand augers will be excavated at the 216-T-13 Trench and the 200-E-4 French Drain. Boreholes will be drilled to groundwater at the 216-A-4 Crib, the 216-T-33 Crib, and the 216-U-3 French Drain. Soil samples will be collected and analyzed for radiological and nonradiological contaminants of concern (COCs) and selected physical properties. Geophysical logging will also be conducted for the three deep boreholes drilled at three waste sites and existing boreholes to obtain additional information on the distribution of contamination at the waste sites. Sampling for waste designation is addressed during a waste designation DQO performed before initiation of the characterization activities.

A.1.1 Background

The 200-MW-1 waste sites consist of the remaining radioactive liquid waste disposal sites not included in the other waste stream groupings and the sites that have been added since the issuance of the *200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program* (hereinafter referred to as the Implementation Plan [DOE-RL 1999]). The waste sites associated with the 200-MW-1 OU primarily consist of french drains, cribs, and trenches, which generally received relatively low volumes of liquid waste that contained low concentrations of radionuclides and nonradiological constituents. Contamination has penetrated the vadose zone and potentially reached the aquifer beneath some of the waste sites.

Five representative waste sites within this OU will be characterized to determine the nature and vertical extent of contamination. Three representative waste sites were originally identified for the 200-MW-1 OU in the *Waste Site Grouping for 200 Area Soil Investigations* report (DOE-RL 1997) and the Implementation Plan (DOE-RL 1999). Two additional representative waste sites

are added during the DQO process. As defined in the waste site grouping report, the 200-MW-1 OU is the only OU in the miscellaneous waste category.

Knowledge gained from characterizing these sites will be used to refine the preliminary conceptual contaminant distribution models and facilitate the use of the analogous site approach in reaching remedial action decisions for all the waste sites in this OU. The analogous site approach is described in detail in the Implementation Plan (DOE-RL 1999).

A.1.2 200-MW-1 Group/Waste Site Locations

The 200-MW-1 OU is located on the Hanford Site in southeastern Washington State, in the vicinity of the 200 East and 200 West Areas. All waste sites are located within the land-use boundary identified in the *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement* (DOE 1999). Figures 2-8 through 2-12 in the work plan show the specific locations of waste sites in the OU.

A.1.3 Site Description and History

The following sections provide brief descriptions of the five waste sites that will be investigated. More detail is provided in Section 2.2 of the work plan. Section 3.3 of the work plan contains information on the nature and extent of contamination and previous investigations.

A.1.3.1 216-A-4 Crib. The 216-A-4 Crib operated from 1955 to 1958 and received waste from the ventilation fans (fan bearing, fan turbine condensate, and control house drain), Plutonium/Uranium Extraction (PUREX) laboratory low-activity waste tanks TK-U-3 and TK-U-4, the 241-A-151 Diversion Box Drain, and several sources associated with the 291-A Stack. The 291-A Stack sources include stack drain, stack liner drain after neutralization in tank 216A-TK1, sampler house sink and floor drain, stack gas filter drain, stack gutter drains, and the stack pit plenum (GE 1955). In December 1958, the crib plugged and flooded an area between the crib and the 291-A-1 Stack, causing an area of surface contamination. The contaminated soils were removed to a trench (200-E-102) along the southern boundary of the crib and were covered with 0.3 m (1 ft) of soil (GE 1959). The crib was deactivated in 1958 by blanking off the effluent piping after the crib had reached its specific retention capacity.

A.1.3.2 216-T-13 Trench. The 216-T-13 Trench site was used for of vehicle decontamination prior to repair at the 269-W Regulated Garage and operated from June 1954 to June 1964. Based on the descriptions given for other waste sites (e.g., 216-U-13) that served a similar function, it is assumed that the trench sides were sloped such that vehicles could be driven down to the decontamination area at the bottom. The site would have received wastes from vehicle decontamination activities or heavy equipment steam cleaning. The site was deactivated in June 1964 when all vehicle decontamination operations were transferred to the 2706-T Building (also known as 2706-W) and the pit was backfilled with soil.

In April 1972, approximately 3.06 m^3 (4 yd^3) of contaminated soil was removed and taken to the 200 West Area dry waste burial ground. The maximum contamination level found was 1,500 cpm. The site was then removed from radiological control.

A.1.3.3 216-T-33 Crib. The 216-T-33 Crib received low-concentration solutions of decontamination waste from the 2706-T Building from January to February 1963. After the perforations in the tile line plugged, sections of the tile line were removed after the line was rerouted to the 216-T-28 Crib. No surface contamination has been found at this site (Maxfield 1979). The site was stabilized in July 1991.

A.1.3.4 216-U-3 French Drain. The 216-U-3 French Drain operated from May 1954 to August 1955 and received condensate from the 241-U-110 waste tank (BHI 1995). According to the waste site grouping report (DOE-RL 1997), the site received low-salt, neutral to basic condensate. An area of contaminated soil related to the 200-W-67 waste site, adjacent to the 216-U-13 French Drain, was surface stabilized in 1998.

A.1.3.5 200-E-4 French Drain. The 200-E-4 French Drain operated from 1958 to 1983 and received steam condensate from the steam trap in a valve pit located approximately 1 m (3 ft) northwest of the french drain, plus steam condensate from the equipment room in the service building portion of the 209-E Building (Critical Mass Laboratory). Criticality experiments were conducted in the Critical Mass Laboratory from 1960 to 1983 using plutonium nitrate and enriched uranium solutions. Criticality research was also conducted with solid special nuclear materials and fuels such as plutonium blocks, uranium blocks and slabs, and fuel assemblies from the Fast Flux Test Facility and other reactors (DeFord 1992, DOE-RL 1993). The laboratory is currently closed but not decommissioned, and research has not occurred there since 1983.

A.1.4 Contaminants of Concern

Step 1 of the DQO process identifies the need to develop a list of contaminants of potential concern (COPCs) for the 200-MW-1 OU waste sites. Development of the COPCs is an essential step towards refining the preliminary conceptual contaminant distribution models. From an investigation of historical sources including process documents, logbooks, original plant technical manuals, and interviews of plant operators, a list of potential contaminants was identified. Screening of this list was conducted during the DQO process to arrive at a final list of COCs for the 200-MW-1 OU. Development of these lists is described in the 200-MW-1 DQO summary report (BHI 2002) and is summarized in Section 3.5 of the work plan. The COCs are identified in Tables A-1 through A-5.

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

A.1.5 Data Quality Objectives

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

This section summarizes the key outputs resulting from the implementation of the seven-step DQO process. Additional details are included in the DQO summary report (BHI 2002).

A.1.5.1 Statement of the Problem. The 200-MW-1 OU consists of waste sites that received relatively low volumes of liquid waste that contained low concentrations of radionuclides and nonradiological constituents. All of the sites *are Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) past-practice waste sites. A number of the sites are unplanned release sites. Vadose zone soils and the aquifer have been impacted by effluent released to some of the 200-MW-1 waste sites.

The objective of the DQO process for this OU is to determine the environmental measurements necessary to support the remedial investigation/feasibility study (RI/FS) process and remedial decision making, including refinement of the preliminary conceptual contaminant distribution model. Additionally, the DQO process supports development of this SAP.

Possible alternatives identified in the Implementation Plan (DOE-RL 1999) include the following:

- No action alternative (no institutional controls)
- Engineered multimedia barrier
- Excavation and disposal of waste
- In situ vitrification of soil
- In situ grouting or stabilization
- Monitored natural attenuation (with institutional controls).

A.1.5.2 Decision Rules. Decision rules are developed from the combined results of DQO Steps 2, 3, and 4. These results include the principal study questions, decision statements, remedial action alternatives, data needs, COC action levels, analytical requirements, and scale of the decision(s). Decision rules are generally structured as "IF…THEN" statements that indicate the action that will be taken when a prescribed condition is met. Decision rules incorporate the parameters of interest (e.g., COCs), the scale of the decision (e.g., location), the preliminary action level (e.g., COC concentration), and the resulting action(s). The 200-MW-1 decision statements are summarized in Table A-6.

A.1.5.3 Error Tolerance and Decision Consequences. The consequence of selecting an inadequate nonstatistical sampling design is not considered severe. Based on Section 6.0 of the DQO summary report (BHI 2002), the sampling design rigor requirements are not significant because of the combination of low severity and accessibility after remedial investigation sampling. If the sampling design is determined to be inadequate, additional sampling can be performed because the sites will be still accessible. Section 5.0 of the work plan summarizes the sampling activities that are planned after the evaluation of initial characterization efforts that are described in this SAP.

A.1.5.4 Sample Design Summary. A nonstatistical sampling design (i.e., professional judgement) was used to select sample locations at the waste sites. This biased (or focused) sampling approach was selected based on process knowledge, expected behavior of COCs, observed distribution of contamination, waste site configuration, and the preliminary conceptual contaminant distribution models developed for the waste sites. Using this approach, sample locations are selected that increase the likelihood of encountering the worst-case conditions or maximum concentrations of contaminants.

The total number of samples for the waste sites is selected based on the conceptual contaminant distribution models and the physical setting of the waste sites. The models suggest that the highest potential for contamination should be near the bottom of the crib/trench/french drains and decrease with depth. Therefore, a greater number of sample intervals is planned in the zone immediately below the release point of the contaminants (i.e., the bottom of the cribs/trenches). The number of sample intervals will decrease with depth based on the expected distribution of contamination. Additional samples will be collected at the discretion of the site geologist based on the field screening data and geological conditions encountered during the investigation. All material excavated will be screened as described in Section A.3.2.2. Field screening will be performed to reduce the potential of overlooking zones of significant contamination. The optimal sample design for this initial phase of characterization is presented in Section A.3.

Changes to the work scope detailed in the SAP may be required because of unexpected field conditions, new information, health and safety concerns, or other conditions. Minor changes that have no adverse effect on the DQOs or schedule can be made in the field with the approval by the project manager or assigned task lead and documented in the daily field logbook and/or field summary reports. Changes that impact DQOs will require concurrence by the U.S. Department of Energy, Richland Operations Office and the lead regulatory agency and can be documented through unit managers' meetings. Alternatively, if substantial changes are required, the SAP can be revised and issued as a separate document requiring U.S. Department of Energy, Richland Operations Office and regulator approval.

Table A-1. 200-MW-1 Operable Unit Final COC List Process Facility Ventilation Stack and Sand Filter Sources. (2 Pages)

CAS #	Final COCs	Rationale for Inclusion
Radiological Constituents		
14596-10-2	Americium-241	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
10045-97-3	Cesium-137	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
10198-40-0	Cobalt-60	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
14683-23-9	Europium-152	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
15585-10-1	Europium-154	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
14391-16-3	Europium-155	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
15046-84-1	Iodine-129	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
13981-16-3	Plutonium-238	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
15117-48-3	Plutonium-239	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
14119-33-6	Plutonium-240	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
10098-97-2	Strontium-90	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
14133-76-7	Technetium-99	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
10028-17-8	Tritium	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
13966-29-5	Uranium-233/234	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
15117-96-1	Uranium-235/236	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
13982-70-2	Uranium-238	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
Nonradiological Constituents – Metals		
7440-43-9	Cadmium	Analytical results from sediment samples collected in 200 Areas (Rohay 1994).
7440-47-3	Chromium	Due to sodium/potassium dichromate added during first- and second-cycle decontamination and concentration operations of bismuth-phosphate process (GE 1944 [Section C], WHC 1990a).
7440-47-3	Chromium (VI)	Due to sodium/potassium dichromate added during first- and second-cycle decontamination and concentration operations of bismuth-phosphate process (GE 1944 [Section C], WHC 1990a).
7440-50-8	Copper	Associated with ventilation and cooling systems.
7439-92-1	Lead	Metal used in lead-dipped cladding and cladding waste stream (1952 to 1956) (GE 1944 [Section A]).
7429-90-5	Silver	Associated with ventilation system silver reactors (Agnew et al. 1997).
7439-97-6	Mercury	Several uses in bismuth-phosphate campaign including addition to cladding and metal waste streams to prevent gaseous generations and miscellaneous laboratory uses (Agnew et al. 1997).
Nonradiological Constituents – General Inorganics		
57-12-5	Cyanide	Extensive use (1954 to 1958) as nickel ferro/ferric cyanide during scavenging and recovery processes. Listed as a result of tank farm integration (Agnew et al. 1997, Borsheim and Simpson 1991, GE 1951b).
16984-48-8	Fluoride	Several compounds contained fluoride. The most widely used included lanthanum-fluoride (which was used during the concentration operations of the bismuth-phosphate process) and ammonium silica fluoride (which was used as a cleaning and decontamination compound based on ability to dissolve metals and fission products) (GE 1944 [Section C], 1951a; HEW 1945).
N02-N03-N	Nitrate/nitrite	Several compounds contained nitrates/nitrites. The most widely used included sodium nitrite, a salting agent during the cladding removal; nitric acid, used throughout the bismuth-phosphate process and Uranium Reclamation Process (URP); and bismuth subnitrate, which was used to create the bismuth-phosphate/plutonium solid during the first and second decontamination cycles (GE 1944 [Section C], 1951a; HEW 1945).
14265-44-2	Phosphate	Several compounds contained phosphate. The most widely used included phosphoric acid, which was used throughout bismuth-phosphate process (GE 1944 [Section C], HEW 1945).

Table A-1. 200-MW-1 Operable Unit Final COC List Process Facility Ventilation Stack and Sand Filter Sources. (2 Pages)

CAS #	Final COCs	Rationale for Inclusion
14808-79-8	Sulfate	Several compounds contained sulfate. The most widely used included sulfuric acid, which was used in dissolving the fuel rods during the bismuth-phosphate process (GE 1944 [Section C], 1951a; HEW 1945). Other sulfate complexes were used as carriers for various metals.
Volatile Organics		
75-34-3	1,1-dichloroethane (DCA)	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
107-06-2	1,2-dichloroethane (DCA)	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
71-55-6	1,1,1-trichloroethane (TCA)	Listed waste associated with B Plant operations-F001 (WHC 1996).
67-19-7	Acetone	Listed waste associated with PUREX Plant operations-F003 (WHC 1996).
71-43-2	Benzene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
156-59-2	cis-1,2-dichloroethylene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
100-41-4	Ethylbenzene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
108-10-1	Methyl isobutyl ketone	Listed waste associated with B Plant operations-F002 (WHC 1996).
156-60-5	trans-1,2-dichloroethylene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
78-93-3	Methyl ethyl ketone	Listed waste associated with B Plant operations-F005 (WHC 1996).
75-09-2	Methylene chloride	Listed waste associated with B Plant operations-F002 (WHC 1996).
71-63-3	n-butyl alcohol	Listed waste associated with PUREX Plant operations-F003 (WHC 1996).
104-51-8	n-butyl benzene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
127-18-4	Tetrachloroethylene (PCE)	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
79-01-6	Trichloroethylene (TCE)	TCE is a degradation product of carbon tetrachloride. Analytical results and measurements have illustrated that this contaminant is prevalent throughout the vadose zone and has impacted groundwater (Rohay 1994).
108-88-3	Toluene	Listed waste associated with PUREX Plant operations-F005 (WHC 1996).
1330-20-7	Xylene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
Semi-Volatile Organics		
8008-20-6	Normal paraffins[a]	Extensive use (1953 to 1957) in solvent extraction operation as the dilutant for TBP in URPs (GE 1951a).
1336-36-3	Polychlorinated biphenyls (PCBs)	Various types of normal paraffins were used as milling, cutting, and washing solutions during the production of plutonium buttons/rods. These solutions usually contained PCBs (discussions/publications with David A. Dodd, Plutonium Finishing Plant chemist [Mandis 2001]). Analytical results from sediment samples collected within tank 241-Z-361 (FH 2000).
126-73-8	Tributyl phosphate and derivatives (mono, bi)	Extensive use in the extraction of plutonium and uranium in the PUREX process and of uranium in the uranium recovery process (GE 1951b, 1955).

[a]Analyzed as kerosene by nonhalogenated volatile organic analytes via 8015 Method; total petroleum hydrocarbons, diesel to oil ranges; or total petroleum hydrocarbons, gasoline range.
CAS = Chemical Abstract Services

Table A-2. 200-MW-1 Operable Unit Final COC List Vehicle/Heavy Equipment Facility Decontamination Sources. (2 Pages)

CAS #	Final COCs	Rationale for Inclusion
Radiological Constituents		
14596-10-2	Americium-241	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
10045-97-3	Cesium-137	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
10198-40-0	Cobalt-60	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
14683-23-9	Europium-152	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
15585-10-1	Europium-154	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
14391-16-3	Europium-155	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
13981-16-3	Plutonium-238	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
15117-48-3	Plutonium-239	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
14119-33-6	Plutonium-240	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
10098-97-2	Strontium-90	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
14133-76-7	Technetium-99	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
13966-29-5	Uranium-233/234	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
15117-96-1	Uranium-235/236	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
13982-70-2	Uranium-238	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
Nonradiological Constituents – Metals		
7439-92-1	Lead	Metal used in lead-dipped cladding and cladding waste stream (1952 to 1956) (GE 1944 [Section A]).
7440-43-9	Cadmium	Expected to be present from contaminants/engine wear in oil/grease and pigments in paint.
7440-47-3	Chromium	Expected to be present from contaminants/engine wear in oil/grease and pigments in paint.
Nonradiological Constituents – General Inorganics		
14265-44-2	Phosphate	Several compounds contained phosphate. The most widely used included phosphoric acid, which was used throughout bismuth-phosphate process (GE 1944 [Section C], HEW 1945).
14808-79-8	Sulfate	Several compounds contained sulfate. The most widely used included sulfuric acid, which was used in dissolving the fuel rods during the bismuth-phosphate process (GE 1944 [Section C], 1951a; HEW 1945). Other sulfate complexes were used as carriers for various metals.
Volatile Organics		
75-34-3	1,1-dichloroethane (DCA)	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
107-06-2	1,2-dichloroethane (DCA)	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
71-55-6	1,1,1-trichloroethane (TCA)	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
67-19-7	Acetone	Listed waste associated with T Plant operations-F003 (WHC 1996).
71-43-2	Benzene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
156-59-2	cis-1,2-dichloroethylene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
100-41-4	Ethylbenzene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
75-09-2	Methylene chloride	Listed waste associated with T Plant operations-F002
71-63-3	n-butyl alcohol	Associated with T Plant heavy equipment decontamination operations-F003 (WHC 1990a).

Table A-2. 200-MW-1 Operable Unit Final COC List Vehicle/Heavy Equipment Facility Decontamination Sources. (2 Pages)

CAS #	Final COCs	Rationale for Inclusion
104-51-8	n-butyl benzene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
127-18-4	Tetrachloroethylene (PCE)	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
156-60-5	trans-1,2-dichloroethylene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
79-01-6	Trichloroethylene (TCE)	TCE is a degradation product of carbon tetrachloride. Analytical results and measurements have illustrated that this contaminant is prevalent throughout the vadose zone and has impacted groundwater (Rohay 1994).
108-88-3	Toluene	Listed waste associated with PUREX Plant operations-F005 (WHC 1996).
1330-20-7	Xylene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
Semi-Volatile Organics		
8008-20-6	Normal paraffins[a]	Expected from vehicle oil and grease removed during decontamination.
1336-36-3	Polychlorinated biphenyls (PCBs)	Expected from vehicle oil and grease removed during decontamination.

[a]Analyzed as kerosene by nonhalogenated volatile organic analytes via 8015 Method; total petroleum hydrocarbons, diesel to oil ranges; or total petroleum hydrocarbons, gasoline range.

Table A-3. 200-MW-1 Operable Unit Final COC List Vehicle/Heavy Equipment Field Decontamination Source. (2 Pages)

CAS #	Final COCs	Rationale for Inclusion
Radiological Constituents		
14596-10-2	Americium-241	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
10045-97-3	Cesium-137	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
10198-40-0	Cobalt-60	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
14683-23-9	Europium-152	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
15585-10-1	Europium-154	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
14391-16-3	Europium-155	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
13981-16-3	Plutonium-238	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
15117-48-3	Plutonium-239	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
14119-33-6	Plutonium-240	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
10098-97-2	Strontium-90	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
14133-76-7	Technetium-99	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
13966-29-5	Uranium-233/234	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
15117-96-1	Uranium-235/236	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
13982-70-2	Uranium-238	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
Nonradiological Constituents – Metals		
7439-92-1	Lead	Expected to be present from contaminants/engine wear in oil/grease and pigments in paint.
7440-43-9	Cadmium	Expected to be present from contaminants/engine wear in oil/grease and pigments in paint.
7440-47-3	Chromium	Expected to be present from contaminants/engine wear in oil/grease and pigments in paint.
Nonradiological Constituents – General Inorganics		
14265-44-2	Phosphate	Several compounds contained phosphate. The most widely used included phosphoric acid, which was used throughout bismuth-phosphate process (GE 1944 [Section C], HEW 1945).
14808-79-8	Sulfate	Several compounds contained sulfate. The most widely used included sulfuric acid, which was used in dissolving the fuel rods during the bismuth-phosphate process (GE 1944 [Section C], 1951a; HEW 1945). Other sulfate complexes were used as carriers for various metals.
Volatile Organics		
75-34-3	1,1-dichloroethane (DCA)	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
107-06-2	1,2-dichloroethane (DCA)	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
71-55-6	1,1,1-trichloroethane (TCA)	Listed waste associated with B Plant operations-F001 (WHC 1996).
67-19-7	Acetone	Listed waste associated with PUREX Plant operations-F003 (WHC 1996).
71-43-2	Benzene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
156-59-2	cis-1,2-dichloroethylene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
108-10-1	Methyl isobutyl ketone	Listed waste associated with B Plant operations-F002 (WHC 1996).
78-93-3	Methyl ethyl ketone	Listed waste associated with B Plant operations-F005 (WHC 1996).
75-09-2	Methylene chloride	Listed waste associated with B Plant operations-F002.

Table A-3. 200-MW-1 Operable Unit Final COC List Vehicle/Heavy Equipment Field Decontamination Source. (2 Pages)

CAS #	Final COCs	Rationale for Inclusion
71-63-3	n-butyl alcohol	Listed waste associated with PUREX Plant operations-F003 (WHC 1996).
127-18-4	Tetrachloroethylene (PCE)	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
156-60-5	trans-1,2-dichloroethylene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
79-01-6	Trichloroethylene (TCE)	TCE is a degradation product of carbon tetrachloride. Analytical results and measurements have illustrated that this contaminant is prevalent throughout the vadose zone and has impacted groundwater (Rohay 1994).
108-88-3	Toluene	Listed waste associated with PUREX Plant operations-F005 (WHC 1996).
1330-20-7	Xylene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
Semi-Volatile Organics		
8008-20-6	Normal paraffins (greases and oils)	Expected from vehicle oil and grease removed during decontamination.
1336-36-3	Polychlorinated biphenyls (PCBs)	Expected from vehicle oil and grease removed during decontamination.

Table A-4. 200-MW-1 Operable Unit Final COC List Low-Level Radioactive Process or Steam Condensate Source. (2 Pages)

CAS #	Final COCs	Rationale for Inclusion
Radiological Constituents		
14596-10-2	Americium-241	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
10045-97-3	Cesium-137	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
10198-40-0	Cobalt-60	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
14683-23-9	Europium-152	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
15585-10-1	Europium-154	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
14391-16-3	Europium-155	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
13981-16-3	Plutonium-238	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
15117-48-3	Plutonium-239	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
14119-33-6	Plutonium-240	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
10098-97-2	Strontium-90	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
14133-76-7	Technetium-99	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
10028-17-8	Tritium	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
13966-29-5	Uranium-234	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
15117-96-1	Uranium-235	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
13982-70-2	Uranium-238	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
Nonradiological Constituents – Metals		
7440-43-9	Cadmium	Analytical results from sediment samples collected in 200 Areas (Rohay 1994).
7440-47-3	Chromium	Due to sodium/potassium dichromate added during first- and second-cycle decontamination and concentration operations of bismuth-phosphate process (GE 1944 [Section C], WHC 1990a).
7440-47-3	Chromium (VI)	Due to sodium/potassium dichromate added during first- and second-cycle decontamination and concentration operations of bismuth-phosphate process (GE 1944 [Section C], WHC 1990a).
7440-50-8	Copper	Associated with ventilation and cooling systems.
7439-92-1	Lead	Metal used in lead-dipped cladding and cladding waste stream (1952 to 1956) (GE 1944 [Section A]).
7439-97-6	Mercury	Several uses in bismuth-phosphate campaign including addition to cladding and metal waste streams to prevent gaseous generations and miscellaneous laboratory uses (Agnew et al. 1997).
Nonradiological Constituents – General Inorganics		
57-12-5	Cyanide	Extensive use (1954 to 1958) as nickel ferro/ferric cyanide during scavenging and recovery processes. Listed as a result of tank farm integration (Agnew et al. 1997, Borsheim and Simpson 1991, GE 1951a).
16984-48-8	Fluoride	Several compounds contained fluoride. The most widely used included lanthanum-fluoride (which was used during the concentration operations of the bismuth-phosphate process) and ammonium silica fluoride (which was used as a cleaning and decontamination compound based on ability to dissolve metals and fission products) (GE 1944 [Section C], 1951a; HEW 1945).
N02+N03-N	Nitrate/nitrite	Several compounds contained nitrates/nitrites. The most widely used included sodium nitrite, a salting agent during the cladding removal; nitric acid, used throughout the bismuth-phosphate process and URP; and bismuth subnitrate, which was used to create the bismuth-phosphate/plutonium solid during the first and second decontamination cycles (GE 1944 [Section C], 1951a; HEW 1945).

Table A-4. 200-MW-1 Operable Unit Final COC List Low-Level Radioactive Process or Steam Condensate Source. (2 Pages)

CAS #	Final COCs	Rationale for Inclusion
14265-44-2	Phosphate	Several compounds contained phosphate. The most widely used included phosphoric acid, which was used throughout bismuth-phosphate process (GE 1944 [Section C], HEW 1945).
14808-79-8	Sulfate	Several compounds contained sulfate. The most widely used included sulfuric acid, which was used in dissolving the fuel rods during the bismuth-phosphate process (GE 1944 [Section C], 1951a; HEW 1945). Other sulfate complexes were used as carriers for various metals.
Volatile Organics		
75-34-3	1,1-dichloroethane (DCA)	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
107-06-2	1,2-dichloroethane (DCA)	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
71-55-6	1,1,1-trichloroethane (TCA)	Listed waste associated with B Plant operations-F001 (WHC 1996).
67-19-7	Acetone	Listed waste associated with PUREX Plant operations-F003 (WHC 1996).
71-43-2	Benzene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
156-59-2	cis-1,2-dichloroethylene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
100-41-4	Ethylbenzene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
108-10-1	Methyl isobutyl ketone	Listed waste associated with B Plant operations-F002 (WHC 1996).
78-93-3	Methyl ethyl ketone	Listed waste associated with B Plant operations-F005 (WHC 1996).
75-09-2	Methylene chloride	Listed waste associated with B Plant operations-F002.
71-63-3	n-butyl alcohol	Listed waste associated with PUREX Plant operations-F003 (WHC 1996).
104-51-8	n-butyl benzene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
127-18-4	Tetrachloroethylene (PCE)	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
156-60-5	trans-1,2-dichloroethylene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
79-01-6	Trichloroethylene (TCE)	TCE is a degradation product of carbon tetrachloride. Analytical results and measurements have illustrated that this contaminant is prevalent throughout the vadose zone and has impacted groundwater (Rohay 1994).
108-88-3	Toluene	Listed waste associated with PUREX Plant operations-F005 (WHC 1996).
1330-20-7	Xylene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
Semi-Volatile Organics		
8008-20-6	Normal paraffins[a]	Extensive use (1953 to 1957) in solvent extraction operation as the dilutant for TBP in URPs (GE 1951a).
1336-36-3	Polychlorinated biphenyls (PCBs)	Various types of normal paraffins were used as milling, cutting, and washing solutions during the production of plutonium buttons/rods. These solutions usually contained PCBs (discussions/publications with David A. Dodd, PFP chemist [Mandis 2001]). Analytical results from sediment samples collected within the 241-Z-361 tank (FH 2000).
126-73-8	Tributyl phosphate and derivatives (mono, bi)	Extensive use in the extraction of plutonium and uranium in the PUREX process and of uranium in the uranium recovery process (GE 1951b, 1955).

[a]Analyzed as kerosene by nonhalogenated volatile organic analytes via 8015 Method; total petroleum hydrocarbons, diesel to oil ranges; or total petroleum hydrocarbons, gasoline range.

Table A-5. 200-MW-1 Operable Unit Final COC List Nonradiological Process Steam Condensate with Radiological Cross Contamination. (2 Pages)

CAS #	Final COCs	Rationale for Inclusion
Radiological Constituents		
14596-10-2	Americium-241	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
10045-97-3	Cesium-137	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
10198-40-0	Cobalt-60	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
14683-23-9	Europium-152	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
15585-10-1	Europium-154	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
14391-16-3	Europium-155	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
13981-16-3	Plutonium-238	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
15117-48-3	Plutonium-239	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
14119-33-6	Plutonium-240	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
10098-97-2	Strontium-90	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
14133-76-7	Technetium-99	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
13966-29-5	Uranium-233/234	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
15117-96-1	Uranium-235/236	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
13982-70-2	Uranium-238	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
Nonradiological Constituents – Metals		
7440-50-8	Copper	Associated with ventilation and cooling systems.
7439-92-1	Lead	Metal used in lead-dipped cladding and cladding waste stream (1952 to 1956) (GE 1944 [Section A]).
Nonradiological Constituents – General Inorganics		
N02+N03-N	Nitrate/nitrite	Several compounds contained nitrates/nitrites. The most widely used included sodium nitrite, a salting agent during the cladding removal; nitric acid, used throughout the bismuth-phosphate process and URP; and bismuth subnitrate, which was used to create the bismuth-phosphate/plutonium solid during the first and second decontamination cycles (GE 1944 [Section C], 1951a; HEW 1945).
14265-44-2	Phosphate	Several compounds contained phosphate. The most widely used included phosphoric acid, which was used throughout bismuth-phosphate process (GE 1944 [Section C], HEW 1945).
14808-79-8	Sulfate	Several compounds contained sulfate. The most widely used included sulfuric acid, which was used in dissolving the fuel rods during the bismuth-phosphate process (GE 1944 [Section C], 1951a; HEW 1945). Other sulfate complexes were used as carriers for various metals.
Volatile Organics		
71-55-6	1,1,1-trichloroethane (TCA)	Listed waste associated with B Plant operations-F001 (WHC 1996).
67-19-7	Acetone	Listed waste associated with PUREX Plant operations-F003 (WHC 1996).
156-59-2	cis-1,2-dichloroethylene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
108-10-1	Methyl isobutyl ketone	Listed waste associated with B Plant operations-F002 (WHC 1996).
78-93-3	Methyl ethyl ketone	Listed waste associated with B Plant operations-F005 (WHC 1996).
75-09-2	Methylene chloride	Listed waste associated with B Plant operations-F002.

Table A-5. 200-MW-1 Operable Unit Final COC List Nonradiological Process Steam Condensate with Radiological Cross Contamination. (2 Pages)

CAS #	Final COCs	Rationale for Inclusion
71-63-3	n-butyl alcohol	Listed waste associated with PUREX Plant operations-F003 (WHC 1996).
108-88-3	Toluene	Listed waste associated with PUREX Plant operations-F005 (WHC 1996).
Semi-Volatile Organics		
8008-20-6	Normal paraffins[a]	Extensive use (1953 to 1957) in solvent extraction operation as the dilutant for TBP in URPS (GE 1951a).
1336-36-3	Polychlorinated biphenyls (PCBs)	Various types of normal paraffins were used as milling, cutting, and washing solutions during the production of plutonium buttons/rods. These solutions usually contained PCBs (discussions/publications with David A. Dodd, PFP chemist [Mandis 2001]). Analytical results from sediment samples collected within the 241-Z-361 tank (FH 2000).
126-73-8	Tributyl phosphate and derivatives (mono, bi)	Extensive use in the extraction of plutonium and uranium in the PUREX process and of uranium in the uranium recovery process (GE 1951b, 1955).

[a]Analyzed as kerosene by nonhalogenated volatile organic analytes via 8015 Method; total petroleum hydrocarbons, diesel to oil ranges; or total petroleum hydrocarbons, gasoline range.

Table A-6. Decision Rules.

DR #	Decision Rule
1	If the true maximum (as estimated by the maximum detected sample values) activity of radionuclides within the soil samples in each of the applicable strata[a] is greater than or equal to 100 nCi/g (transuranic waste definition) or the greater than Class C definition, evaluate special remedial alternatives in a FS; otherwise, evaluate conventional remedial alternatives in a FS.
2	If the true maximum (as estimated by the maximum detected sample values) activity of radionuclides within the soil samples in each of the applicable strata[a] results in a radiological dose greater than or equal to 15 to 500 mrem/yr above background, evaluate remedial alternatives in a FS; otherwise, evaluate the site for closure with no remedial action.
3	If the true maximum (as estimated by the maximum detected sample values) concentration of nonradiological constituents within the soil samples in each of the applicable strata[a] is greater than or equal to the preliminary action levels in Table 3-6 of the DQO summary report (BHI 2002), evaluate remedial alternatives in a FS; otherwise, evaluate the site for closure with no remedial action.

[a]The applicable strata include the highest contaminant concentration layers, the moderate-to-low contaminant concentration layers, and the low contaminant concentration layers.

A.2 QUALITY ASSURANCE PROJECT PLAN

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

- U.S. Department of Energy (DOE) Directive CRD 414.1A, *Quality Assurance*
- *Code of Federal Regulations* (CFR), 40 CFR 830.120, "Quality Assurance Requirements"
- *EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations* (EPA 1994a)
- *Hanford Analytical Services Quality Assurance Requirements Documents* (DOE-RL 1996).

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

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

- **Analytical Performance.** Requirements for detection limits, precision, and accuracy are presented in Table A-7. The analytical methods are also shown in this table.
- **Field Quality Control.** The frequency and type of quality control (QC) samples to be collected are addressed in Section A.2.1.
- **Sample Preservation, Containers, and Holding Time.** The requirements for the specific test/laboratory methods are addressed in Section A.2.3 and in Table A-8.
- **Onsite Measurements Quality Control.** The specific types of QC samples for onsite measurements and the frequency of collection are addressed in Section A.2.4.
- **Data Validation and Usability.** Specific validation requirements, including the frequency and level of validation, are addressed in Section A.2.6.

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

A.2.1 Field Quality Control

Field QC samples shall be collected to evaluate the potential for cross-contamination and laboratory performance. Field QC for sampling in the 200-MW-1 OU will require the collection of duplicate, field split, equipment rinsate blanks, and trip blank samples. The QC samples are described in this section with the required frequency of collection.

QC samples will not be collected from zones within the boreholes that are expected to contain transuranic-contaminated soils because of the extreme cost and handling requirements associated with transuranic materials.

A.2.1.1 Field Duplicates. Field duplicates shall each be retrieved from the sample interval using the same equipment (collected from one split spoon or bowl) and sampling technique. Field duplicates for soil are collected and homogenized before being divided into two samples in the field. If volatile organic analyte (VOA) samples are required, they should be collected prior to homogenization. The duplicate samples shall be sent to the primary laboratory in the same manner as the routine site samples. Field duplicates provide information regarding the homogeneity of the sample matrix and may also provide an evaluation of the precision of the analysis process.

A minimum of 5% of the total collected soil samples will be duplicated (i.e., 1 field duplicate will be collected for every 20 samples). At least one field duplicate shall be collected from each representative waste site to be investigated. The duplicates should generally be collected from an area that is expected to have some contamination, so that valid comparisons between the samples can be made (i.e., at least some of the COCs will be above detection limit). The duplicate samples shall be suitable for analysis by an offsite laboratory and shall be analyzed for all the COCs listed in Tables A-1 through A-5, as applicable.

A.2.1.2 Field Splits. Field split samples will be collected at the same frequency as field duplicate samples from each representative site to be sampled in the RI. The split samples shall each be retrieved from the same sample interval using the same equipment (collected from one split spoon) and sampling technique. Samples shall be homogenized, split into two separate aliquots in the field, and sent to two independent laboratories. If VOA samples are required, they should be collected prior to homogenization. The splits will be used to verify the performance of the primary laboratory.

The split samples will be obtained from sample media that is expected to have some contamination and which is suitable for analysis in an offsite laboratory and shall be analyzed for all of the COCs listed in Tables A-1 through A-5, as applicable.

A.2.1.3 Equipment Rinsate Blanks. Equipment rinsate blanks shall be collected at the same frequency as field duplicate samples, and are used to verify the adequacy of sampling equipment decontamination procedures. The field geologist may request that additional equipment blanks be taken. Equipment blanks shall consist of pure deionized water washed through decontaminated sampling equipment and placed in containers identified on the sampling authorization forms.

Equipment rinsate blanks shall be analyzed for the following:

- Gross alpha
- Gross beta
- Metals (excluding hexavalent chromium and mercury)
- Anions (except cyanide)
- Volatile organic analytes of interest.

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

A.2.1.4 Trip Blanks. The volatile organic trip blanks will constitute a minimum of approximately 5% of all volatile organic compound samples. At least one trip blank shall be collected from each representative waste site to be investigated. A total of five trip blanks are expected to be collected (see Table A-15). Trip blanks are prepared at the 3728 Sample Storage and Shipping Facility and shall consist of laboratory-grade deionized water that is added to the clean sample containers. The trip blanks shall travel to the field with their associated bottle sets and will be returned to the laboratory with these samples. They will remain unopened during their transport and handling. Trip blanks are prepared as a check for possible contamination originating from container preparation methods, shipment, handling, storage, or site conditions. The trip blank shall be analyzed for volatile organic compounds only.

A.2.1.5 Prevention of Cross-Contamination. Special care should be taken to prevent cross-contamination of soil samples. Particular care will be exercised to avoid the following common ways in which cross-contamination or background contamination may compromise the samples:

- Improperly storing or transporting sampling equipment and sample containers
- Contaminating the equipment or sample bottles by setting them on or near potential contamination sources, such as uncovered ground
- Handling bottles or equipment with dirty hands
- Improperly decontaminating equipment before sampling or between sampling events.

A.2.2 Quality Objectives and Criteria for Measurement Data

Quality objectives and criteria for soil measurement data are presented in Table A-7 for radiological and nonradiological analytes, as well as physical properties of interest. Analysis of soil physical properties will be performed according to American Society for Testing and Materials (ASTM) procedures, if applicable.

A.2.3 Sample Preservation, Containers, and Holding Times

Soil sample preservation, containers, and holding times for radiological and nonradiological analytes of interest and physical property test are presented in Table A-8. Final sample collection requirements will be identified on the sampling authorization form.

A.2.4 Onsite Measurements Quality Control

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

A.2.5 Data Management

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

A.2.6 Validation and Verification Requirement

Validation will be performed on completed data packages by qualified Bechtel Hanford, Inc. (BHI) Sample Management personnel or by a qualified independent contractor. Validation will consist of verifying required deliverables, requested versus reported analyses, and transcription errors. Validation will also include the evaluation and qualification of results based on holding time, method blanks, matrix spikes, laboratory control samples, laboratory duplicates, and chemical and tracer recoveries, as appropriate to the methods used. No other validation or calculation checks will be performed. At least 5% of all data will be validated.

Assuming that about 56 samples will be collected during the 200-MW-1 OU representative site investigations (including full QC sets, but exclusive of discretionary samples; see Tables A-10 through A-14), approximately 15 to 20 sample delivery groups will be submitted to the laboratory containing between 3 and 5 samples in each sample delivery group. At least one data validation package will be generated for each OU. Validation requirements identified in this section are consistent with Level C validation, as defined in *Data Validation Procedure for Radiochemistry Analysis* (BHI 2000a) and *Data Validation Procedure for Chemical Analysis* (BHI 2000b). No validation for physical property data will be performed.

A.2.7 Technical Procedures and Specifications

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

- BHI-EE-01, *Environmental Investigations Procedures*

  Section 1.0, General Information

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

  Section 2.0, Sample Management

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

  Section 3.0, General Sampling

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

  Section 4.0, Soil, Groundwater, and Biotic Sampling

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

  Section 5.0, Sampling Techniques

  - Procedure 5.2, "Test Pit Excavation in Contaminated Areas"

  Section 6.0, Drilling

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

  Section 7.0, Geologic and Hydrologic Data Collection

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

- BHI-EE-02, *Environmental Requirements*
  - Procedure 14.0, "Drilling, Maintaining, Remediating, and Decommissioning Resource Protection Wells, Geoprobe™, and Geotechnical Soil Borings"
- BHI-EE-05, *Field Screening Procedures*
  - Procedure 1.0, "Routine Field Screening"
  - Procedure 2.5, "Operation of Mobile Surface Contamination Monitor II"
  - Procedure 2.7, "Operation of the Aptec Gamma Spectroscopy System"
  - Procedure 2.11, "Portable Environmental Survey Instrument Operation"
  - Procedure 2.14, "Radiological Counting Facility Quality Control"
  - Procedure 2.22, "Operation of Global Positioning Environmental Radiological Surveyor (GPERS-II)"
  - Procedure 2.27, "Calibration of the Aptec Gamma Spectroscopy System"
  - Procedure 2.32, "Radiological Counting Facility Sample Analysis and Reporting"
  - Procedure 2.38, "Radiological Counting Facility Instrument Preventive Maintenance"
- BHI-EE-10, *Waste Management Plan, Part II*
  - Procedure 9.0, "Control of CERCLA and Other Past-Practice Investigation-Derived Waste"

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

- BHI-EE-02, *Environmental Requirements*, Section 11.0, "Solid Waste System Operations"
- BHI-QA-01, *ERC Quality Program*
- BHI-QA-03, *ERC Quality Assurance Program Plans*
  - Plan 5.1, "Field Sampling Quality Assurance Program Plan"
  - Plan 5.2, "Onsite Measurements Quality Assurance Program Plan"
  - Plan 5.3, "Environmental Radiological Measurements Quality Assurance"
- BHI-MA-02, *ERC Project Procedures*

- BHI-SH-01, *ERC Safety and Health Program*
- BHI-SH-02, *Safety and Health Procedures*, Volumes 1, 3, and 4
- BHI-SH-05, *Industrial Hygiene Work Instructions*
- BHI-EE-10, *Waste Management Plan*
- BHI-RC-04, *Radiological Control Work Instructions*
- Specification for environmental drilling services specific to 200-MW-1
- *Sampling Services Procedures Manual*, ES-SSPM-001, Rev. 0, Procedure 2-5, "Laboratory Cleaning of Sampling Equipment," Waste Management Northwest (WMNW 1998).

A.2.7.1 Sample Location. Sample locations (e.g., boreholes and test pits) will be staked and labeled before starting the activity. Locations will be staked by the technical lead or field team leader assigned by the project manager. After the locations have been staked, minor adjustments to the location may be made to mitigate unsafe conditions, avoid structural interferences, or bypass utilities. Locations will be identified during or after sampling following BHI-EE-01, Procedure 1.6, "Survey Requirements and Techniques." Changes in sample locations that do not impact the DQOs will require approval of the project manager. However, changes to sample locations that result in impacts to the DQOs will require EPA concurrence.

Prior to borehole/test pit activities, surface geophysical and radiation surveys will be conducted at all sites. The surface geophysical surveys will be conducted using ground-penetrating radar and/or electromagnetic imaging and will aid in verifying waste site construction and geometry and in selecting borehole locations to avoid subsurface obstructions. The surface radiation surveys will identify areas of surface contamination that might impact the drilling activities and health and safety.

A.2.7.2 Sample Identification. The ERC Sample and Data Tracking database will be used to track the samples through the collection and laboratory analysis process. The HEIS database is the repository for the laboratory analytical results. The HEIS sample numbers will be issued to the sampling organization for this project in accordance with BHI-EE-01, Procedure 2.0, "Sample Event Coordination." Each radiological/nonradiological and physical properties sample will be identified and labeled with a unique HEIS sample number. The sample location, depth, and corresponding HEIS numbers will be documented in the sampler's field logbook.

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

- HEIS number
- Sample collection date/time
- Name/initials of person collecting the sample

- Analysis required
- Preservation method, if applicable.

A.2.7.3 Field Sampling Log. All information pertinent to field sampling and analysis will be recorded in bound logbooks in accordance with BHI-EE-01, Procedure 1.5, "Field Logbooks." The sampling team will be responsible for recording all relevant sampling information including, but not limited to, the information listed in Appendix A of Procedure 1.5. Entries made in the logbook will be dated and signed by the individual who made the entry.

A.2.7.4 Sample Custody. A chain-of-custody record will be initiated in the field at the time of sampling and will accompany each set of samples (cooler) shipped to any laboratory in accordance with BHI-EE-01, Procedure 3.0, "Chain of Custody." The analyses requested for each sample will be indicated on the accompanying chain-of-custody form. Chain-of-custody procedures will be followed throughout sample collection, transfer, analysis, and disposal to ensure that sample integrity is maintained. Each time responsibility for custody of the sample changes, the new and previous custodians will sign the record and note the date and time. The sampler will make a copy of the signed record before sample shipment and transmit it to ERC Sample Management within 24 hours of shipping, as detailed in BHI-EE-01, Procedure 2.1, "Sampling Documentation Processing."

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

A.2.7.5 Sample Containers and Preservatives. EPA pre-cleaned sample containers will be used for soil samples collected for radiological and nonradiological analysis. Container sizes may vary depending on laboratory-specific volumes needed to meet analytical detection limits. If, however, the dose rate on the outside of a sample jar or the curie content exceeds levels acceptable by an offsite laboratory, the sampling lead and task lead can send smaller volumes to the laboratory after consultation with ERC Sample Management to determine acceptable volumes. Preliminary container types and volumes are identified in Table A-8. Final types and volumes will be provided on the sampling authorization form.

A.2.7.6 Sample Shipping. The outside of each sample jar will be surveyed by the radiological control technician (RCT) to verify that the container is free of smearable surface contamination. The RCT will also measure the radiological activity on the outside of the sample container (through the container) and will mark the container with the highest contact radiological reading in either dpm or mrem/hr, as applicable. Total activity analysis performed by the Radiological Counting Facility, 222-S Laboratory, or another suitable onsite laboratory will be used for determining U.S. Department of Transportation shipping criteria. This information, along with other data that may pre-qualify the samples, will be used to select proper packaging, marking, labeling, and shipping paperwork in accordance with U.S. Department of Transportation regulations (49 CFR) and to verify that the sample can be received by the offsite analytical

laboratory in accordance with the laboratory's acceptance criteria. The sampler will send copies of the shipping documentation to ERC Sample Management within 24 hours of shipping, as detailed in BHI-EE-01, Procedure 2.1, "Sampling Documentation Processing."

As a general rule, samples with activities <1 mrem/hr will be shipped to an offsite laboratory. Samples with activities greater than 1 mrem/hr may be shipped to an offsite laboratory; these samples with activities in this range will be evaluated on a case-by-case basis by ERC Sample Management. If no offsite laboratory can be identified for high-activity samples, ERC Sample Management will arrange to send the samples to an onsite laboratory.

Table A-7. Analytical Performance Requirements – Shallow and Deep Zone Soils. (4 Pages)

COCs	CAS #	Preliminary Action Level [a]			Name/Analytical Technology [c]	Required Target Quantitation Limits [d]				Precision Water	Accuracy Water	Precision Soil	Accuracy Soil
		15 mrem/yr [b] (pCi/g)	500 mrem/yr [b] (pCi/g)	GW Protection [b] (pCi/g)		Water Low Activity (pCi/L)	Water High Activity (pCi/L)	Soil-Other Low Activity (pCi/g)	Soil-Other High Activity (pCi/g)				
Americium-241	14596-10-2	335	112,000	N/A	Americium isotopic – AEA	1	400	1	4,000	±20%	80-120%	±35%	65-135%
Cesium-137	10045-97-3	23.4	780	N/A	GEA	15	200	0.1	2,000	±20%	80-120%	±35%	65-135%
Cobalt-60	10198-40-0	4.90	164	N/A	GEA	25	200	0.05	2,000	±20%	80-120%	±35%	65-135%
Europium-152	14683-23-9	11.4	388	N/A	GEA	50	200	0.1	2,000	±20%	70-130%	±35%	70-130%
Europium-154	15585-10-1	10.3	345	N/A	GEA	50	200	0.1	2,000	±20%	70-130%	±35%	70-130%
Europium-155	14391-16-3	426	14,200	N/A	GEA	50	200	0.1	2,000	±20%	70-130%	±35%	70-130%
Iodine-129	15046-84-1	--	--	--	Chemical separation low-energy photon spectroscopy	5	N/A	2	N/A	±20%	70-130%	±35%	70-130%
Plutonium-238	13981-16-3	470	15,700	N/A	Plutonium isotopic – AEA	1	130	1	1,300	±20%	80-120%	±35%	65-135%
Plutonium-239/240	Pu-239/240	425	14,200	N/A	Plutonium isotopic – AEA	1	130	1	1,300	±20%	80-120%	±35%	65-135%
Strontium-90	Rad-Sr	2,410	80,300	N/A	Total radioactive strontium – GPC	2	80	1	800	±20%	80-120%	±35%	65-135%
Technetium-99	14133-76-7	412,000	13,700,000	171	Technetium-99 – liquid scintillation	15	400	15	4,000	±20%	80-120%	±35%	65-135%
Tritium (H-3)	10028-17-8	66,900	2,230,000	4,100	Tritium – liquid scintillation	400	400	400	400	±20%	80-120%	±35%	65-135%
Uranium-233/234	13966-29-5	2,660	88,800	39.5	Uranium isotopic – AEA (pCi) ICPMS (mg)	1	0.002 mg/L	1	0.02 mg/kg	±20%	80-120%	±35%	65-135%
Uranium-235/236	15117-96-1	101	3,370	3.92	Uranium isotopic – AEA (pCi) ICPMS (mg)	1	0.002 mg/L	1	0.02 mg/kg	±20%	80-120%	±35%	65-135%
Uranium-238	U-238	504	16,800	38.1	Uranium isotopic – AEA (pCi) ICPMS (mg)	1	0.002 mg/L	1	0.02 mg/kg	±20%	80-120%	±35%	65-135%

Table A-7. Analytical Performance Requirements – Shallow and Deep Zone Soils. (4 Pages)

COCs	CAS #	Preliminary Action Level [a]			Name/Analytical Technology	Required Target Quantitation Limits [d]				Precision Water	Accuracy Water	Precision Soil	Accuracy Soil
		MTCA Method C [e] (mg/kg)	GW Protection [f] (mg/kg)	Terrestrial Biota Protection [g] (mg/kg)		Water Low Conc. (mg/L)	Water High Conc. (mg/L)	Soil-Other Low Conc. (mg/kg)	Soil-Other High Conc. (mg/kg)				
Metals													
Cadmium	7440-43-9	139 [h]	0.81 [i]	4	Metals – 6010 – ICP	0.005	0.01	0.5	1	j	j	j	j
					Metals – 6010 [c] – ICP (trace)	0.005	N/A	0.5	N/A	j	j	j	j
Chromium (total)	7440-47-3	Unlimited	2,000 [f]	42	Metals – 6010 – ICP	0.01	0.01	1	2	j	j	j	j
					Metals – 6010 – ICP (trace)	0.01	N/A	1	N/A	j	j	j	j
Chromium VI	18540-29-9	21 [h]	7.7 [k]	42	Chromium (hexavalent) – 7196 – colorimetric	0.01	4	0.5	200	j	j	j	j
Copper	7440-50-8	130,000	22 [i]	50	Metals – 6010 – ICP	0.025	0.025	2.5	2.5	j	j	j	j
Lead	7439-92-1	1,000 [l]	840 [k]	50	Metals – 6010 – ICP	0.1	0.2	10	20	j	j	j	j
					Metals – 6010 – ICP (trace)	0.01	N/A	1	N/A	j	j	j	j
Mercury	7439-97-6	1,050	0.33 [i]	0.33 [i]	Mercury – 7470 – CVAA	0.0005	0.005	N/A	N/A	j	j	j	j
					Mercury – 7471 – CVAA	N/A	N/A	0.2	0.2	j	j	j	j
Silver	7440-22-4	17,500	0.88 [f]	2	Metals – 6010 – ICP	0.02	0.02	2	2	j	j	j	j
					Metals – 6010 – ICP (trace)	0.005	N/A	0.5	N/A	j	j	j	j
Uranium (total)	7440-61-1	10,500 [m]	115	5	Uranium total – kinetic phosphorescence analysis	0.0001	0.02	1	0.2	±20%	80-120%	±35%	65-135%
Inorganics													
Cyanide	57-12-5	70,000	0.80 [f]	N/A	Total cyanide – 9010 – colorimetric	0.005	0.005	0.5	0.5	j	j	j	j
Fluoride	16984-48-8	210,000	16 [f]	N/A	Anions – 300.0 – IC	0.5	5	5	5	j	j	j	j
Nitrate	14797-55-8	Unlimited	40 [f]	N/A	Anions – 300.0 – IC	0.25	10	2.5	40	j	j	j	j
Nitrite	14797-65-0	350,000	4 [f]	N/A	Anions – 300.0 – IC	0.25	15	2.5	20	j	j	j	j
Phosphate	14265-44-2	N/A	N/A	N/A	Anions – 300.0 – IC	0.5	15	5	40	j	j	j	j
Sulfate	14808-79-8	N/A	1,000 [f]	N/A	Anions – 300.0 – IC	0.5	15	5	40	j	j	j	j
Organics													
Acetone (2-propanone)	67-64-1	350,000	3.21	N/A	Volatile organics – 8260 – GCMS	0.02	0.02	0.02	0.02	j	j	j	j
Benzene	71-43-2	2,390	2.42	N/A	Volatile organics – 8260 – GCMS	0.005	0.005	0.005	0.005	j	j	j	j
n-butyl alcohol	71-36-3	350,000	6.62	N/A	GC organic – 8015	5	5	5	5	j	j	j	j
Butyl benzene; n	104-51-8	N/A	N/A	N/A	Volatile organics – 8260 – GCMS	0.005	N/A	0.005	N/A	N/A	N/A	N/A	N/A
Dichloroethane; 1,1	75-34-3	350,000	4.37	N/A	Volatile organics – 8260 – GCMS	0.01	0.01	0.01	0.01	j	j	j	j

Table A-7. Analytical Performance Requirements – Shallow and Deep Zone Soils. (4 Pages)

COCs	CAS #	Preliminary Action Level [a]			Name/Analytical Technology	Required Target Quantitation Limits [d]				Precision Water	Accuracy Water	Precision Soil	Accuracy Soil
		MTCA Method C [e] (mg/kg)	GW Protection [f] (mg/kg)	Terrestrial Biota Protection [g] (mg/kg)		Water Low Conc. (mg/L)	Water High Conc. (mg/L)	Soil-Other Low Conc. (mg/kg)	Soil-Other High Conc. (mg/kg)				
Dichloroethane; 1,2	107-06-2	1,440	0.005[a]	N/A	Volatile organics – 8260 – GCMS	0.005	0.005	0.005	0.005	j	j	j	j
Dichloroethylene; 1,2- (trans)	156-60-5	31,500	0.36 [f]	N/A	Volatile organics – 8260 – GCMS	0.001	0.001	0.001	0.001	j	j	j	j
Dichloroethylene; 1,2-cis-	156-59-2	31,500	0.36 [f]	N/A	Volatile organics – 8260 – GCMS	0.001	0.001	0.001	0.001	j	j	j	j
Ethylbenzene	100-41-4	350,000	6.91	N/A	Volatile organics – 8260 – GCMS	0.005	0.005	0.005	0.005	j	j	j	j
Methyl ethyl ketone (MEK; 2-butanone)	78-93-3	Unlimited	N/A	N/A	Volatile organics – 8260 – GCMS	0.01	0.01	0.01	0.01	j	j	j	j
Methyl isobutyl ketone (MIBK hexone)	108-10-1	280,000	N/A	N/A	Volatile organics – 8260 – GCMS	0.01	0.01	0.01	0.01	j	j	j	j
Methylene chloride (dichloromethane)	75-09-2	17,500	0.022 [f]	N/A	Volatile organics – 8260 – GCMS	0.005	0.005	0.005	0.005	j	j	j	j
PCBs	1336-36-3	10 [i]	0.0165 [a]	0.65	PCBs – 8082 – GC	0.0005	0.005	0.0165	0.1	j	j	j	j
Tetrachloroethylene	127-18-4	2,570	0.0091	N/A	Volatile organics – 8260 – GCMS	0.005	0.005	0.005	0.005	j	j	j	j
Toluene	108-88-3	70,000	7.3 [f]	200	Volatile organics – 8260 – GCMS	0.005	0.005	0.005	0.005	j	j	j	j
Tributyl phosphate	126-73-8	N/A	N/A	N/A	Semi-volatiles – 8270 – GCMS	0.1	0.5	3.3	5	j	j	j	j
Trichlorethane; 1,1,1	71-55-6	Unlimited	57	N/A	Volatile organics – 8260 – GCMS	0.005	0.005	0.005	0.005	j	j	j	j
Trichloroethylene	79-01-6	11,900	0.0263	N/A	Volatile organics – 8260 – GCMS	0.005	0.005	0.005	0.005	j	j	j	j
Xylene (total)	1330-20-7	Unlimited	135	N/A	Volatile organics – 8260 – GCMS	0.005	0.005	0.005	0.005	j	j	j	j
Total petroleum hydrocarbons – diesel to oil range (kerosene)	68334-30-5	2,000 [i]	2,000 [i]	200	WTPH-D[c]	0.5	0.5	5	5	j	j	j	j
Total petroleum hydrocarbons – gasoline range	8006-61-9	30 [i]	30 [i]	100	WTPH-G[c]	0.5	0.5	5	5	j	j	j	j
Normal paraffin hydrocarbons	8008-20-6	2,000 [i]	2,000 [i]	200	Nonhalogenated VOA – 8015M – GC modified for hydrocarbons	0.5	0.5	5	5	j	j	j	j

Table A-7. Analytical Performance Requirements – Shallow and Deep Zone Soils. (4 Pages)

COCs	CAS #	Preliminary Action Level [a]			Name/Analytical Technology	Required Target Quantitation Limits [d]				Precision Water	Accuracy Water	Precision Soil	Accuracy Soil
		MTCA Method C [e] (mg/kg)	GW Protection [f] (mg/kg)	Terrestrial Biota Protection [g] (mg/kg)		Water Low Conc. (mg/L)	Water High Conc. (mg/L)	Soil-Other Low Conc. (mg/kg)	Soil-Other High Conc. (mg/kg)				
Normal paraffins (grease; heavy oils)	8008-20-6	2,000 [l]	2,000 [l]	N/A	Oil and grease (total recoverable) – 413.N [p]	2	N/A	200	N/A	j	j	j	j
Field Screening Measurements													
pH	N/A	N/A	N/A	N/A	TBD	TBD		TBD		TBD	TBD	TBD	TBD
Soil Physical Properties													
Bulk density	N/A	N/A	N/A	N/A	D2937, or BHI-EE-05, Procedure 3.9	N/A		wt%		N/A	N/A	N/A	N/A
Lithology	N/A	N/A	N/A	N/A	BHI-EE-01, Procedure 7.0	N/A		Descriptive		N/A	N/A	N/A	N/A
Moisture content	N/A	N/A	N/A	N/A	D2216	N/A		wt%		N/A	N/A	N/A	N/A
Particle size distribution	N/A	N/A	N/A	N/A	D422	N/A		wt%		N/A	N/A	N/A	N/A

[a]The preliminary action level is the regulatory or risk-based value used to determine appropriate analytical requirements (e.g., detection limits). Remedial action levels will be proposed in the FS, will be finalized in the record of decision, and will drive remediation of the sites.
[b]15 mrem/yr = nonrad worker industrial exposure scenario; 2,000 hrs/yr onsite, 60% indoors, 40% outdoors. 500 mrem/yr = rad-worker industrial scenario; 2,000 hrs/yr onsite, 60% indoors, 40% outdoors. GW = groundwater protection radionuclide values based on RESRAD modeling of drinking water exposure with the entire vadose zone presumed to be contaminated. Groundwater protection may be evaluated using the STOMP code or another model to predict movement of contaminants through the vadose zone.
[c]All four-digit numbers refer to *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods* (EPA 1986).
[d]Water values for sampling quality control (e.g., equipment blanks/rinses) or drainable liquid (if recovered). For both water and soil mediums, matrix effects may impact on a specific sample basis.
[e]*Model Toxics Control Act* (MTCA) Method C industrial soil values for direct exposure from the CLARC Version 3.1 tables, updated August 2001 (Ecology 2001).
[f]Calculated using MTCA Method B drinking water standards as inputs to the MTCA three-phase model for protection of drinking water (*Washington Administrative Code* [WAC] 173-340-747[4], amended February 12, 2001), except as noted.
[g]Value is the lowest concentration for each analyte (adjusted for background) from Tables 749-2 and 749-3 of WAC 173-340-900, amended February 12, 2001.
[h]Calculated using MTCA air cleanup standards from WAC 173-340-750(3)(a)(ii)(B), page 210, equation 750-2, with Washington State Department of Health mass loading of particulates in air of 10^{-4} g/m^3.
[i]Cleanup value is less than Hanford Site soil background. Therefore, the soil background concentration is used as the preliminary action level.
[j]Precision and accuracy requirements as identified and defined in the referenced procedures implemented by laboratory analysis and QA procedures.
[k]Calculated using standards for surface water protection (40 CFR 131 and WAC 173-201A-040) as inputs to the MTCA three-phase model for protection of drinking water (WAC 173-340-747[4], February 12, 2001).
[l]Based on MTCA Method A values from Tables 740-1 and 745-1 of WAC 173-340-900, amended February 12, 2001.
[m]Value based upon nickel or uranium soluble salts value.
[n]Because the calculated groundwater protection action level is less than the soil detection limit, the calculated value is replaced with the required target quantitation limit required of the laboratory.
[o]From "Analytical Methods for Petroleum Hydrocarbons," Publication No. ECY 97-602, June 1997, Washington State Department of Ecology.
[p]From *Methods for Chemical Analysis of Water and Wastes*, EPA-600/4-79-020, March 1983, United States Environmental Protection Agency.

AEA = alpha energy analysis
CAS = Chemical Abstract Services
CVAA = cold vapor atomic absorption
GC = gas chromatograph
GCMS = gas chromatograph/mass spectrometry
GPC = gas proportional counter
GW = groundwater
IC = ion chromatography
ICPMS = inductively coupled plasma mass spectrometer
N/A = not applicable
TBD = to be determined
VOA = volatile organic analysis

Table A-8. Sample Preservation, Container, and Holding Time Guidelines. (2 Pages)

Analytes	Analytical Priority	Matrix	Bottle		Amount[a,b,c]	Preservation	Packing Requirements	Holding Time
			Number	Type				
Radionuclides								
Americium-241	10	Soil	1	G/P	10-1000 g	None	None	6 months
Cesium-137	1	Soil	1	G/P	100-1500 g	None	None	6 months
Cobalt-60	1	Soil						
Europium-152	1	Soil						
Europium-154	1	Soil						
Europium-155	1	Soil						
Iodine-129	13	Soil	1	G/P	10-1000 g	None	None	6 months
Plutonium-238	1	Soil	1	G/P	10-1000 g	None	None	6 months
Plutonium-239/240	1	Soil						
Strontium-90	1	Soil	1	G/P	10-1000 g	None	None	6 months
Technetium-99	5	Soil	1	G/P	10-1000 g	None	None	6 months
Tritium (H-3)	13	Soil	1	G	100-500 g	None	None	6 months
Uranium-233/234	1	Soil	1	G/P	10-1000 g	None	None	6 months
Uranium-235/236	1	Soil						
Uranium-238	1	Soil						
Chemicals								
IC anions – 300.0	3	Soil	1	G/P	50-500 g	Cool 4°C	None	28 days/ 48 hours
IC anions – 353.1 for nitrate/nitrite	3	Soil	1	G/P	50-500 g	Cool 4°C	None	28 days/ 48 hours
ICP metals – 6010A	2	Soil	1	G/P	10-500 g	None	None	6 months
Chromium hex – 7196	4	Soil	1	G/P	5-500 g	None	Cool 4°C	30 days
Mercury – 7471 – (CVAA)	2	Soil	1	G	5-125 g	None	None	28 days
Total cyanide – 9010	11	Soil	1	G	10-1000 g	None	Cool 4°C	14 days
pH (soil) – 9045	14	Soil	1	G/P	10-250 g	None	None	ASAP
SVOA – 8270A	6	Soil	1	AG	125-1000 g	None	Cool 4°C	14/40 days
VOA - 8260	7	Soil	1	AG	125 g	None	Cool 4°C	14 days
Nonhalogenated VOA – 8015M – GC modified for normal paraffin hydrocarbon	8	Soil	1	AG	125-250 g	None	Cool 4°C	14 days
NWTPH – diesel	8	Soil	1	G	50-150 g	None	Cool 4°C	14 days
NWTPH – gasoline	8	Soil	1	G	50-150 g	None	Cool 4°C	14 days
Oil and grease	9	Soil	1	G	200 g	None	Cool 4°C	28 days
PCBs – EPA 8082	12	Soil	1	G	10-50 g	None	Cool 4°C	14 days

Table A-8. Sample Preservation, Container, and Holding Time Guidelines. (2 Pages)

Analytes	Analytical Priority	Matrix	Bottle		Amount[a,b,c]	Preservation	Packing Requirements	Holding Time
			Number	Type				
Physical Properties								
Bulk density – D2937	15	Soil	1	Liner	Liner	None	None	None established for analysis
Moisture content – ASTM D2216	16	Soil	1	Moisture Tin[d]	250 g	None	None	None established for analysis
Particle size distribution – ASTM D422	17	Soil	1	G/P	100-4000 g	None	None	None established for analysis

[a]Optimal volumes, which may be adjusted downward to accommodate the possibility of retrieval of small amount of sample. Minimum sample size will be defined on the sampling authorization form.

[b]Should samples be liquid rather than soils, the following volumes need to be collected:

Radionuclides – 4 L for all radionuclides (except carbon-14, tritium, and technetium-99; they require approximately 500 mL each sample).

Chemicals – All liquid samples require the amount as listed for soil samples. Preservation and holding times are also affected if liquid samples are collected. Consult ERC Sample Management staff for details.

[c]Mixed soil samples may be obtained and submitted to the analytical laboratory for analyses for specific analytes, including the following:

Radionuclides – 100 g of soil for all radionuclides (except carbon-14, tritium, and technetium-99; they require approximately 10 g each sample).

Chemicals – A 10-g soil sample is required for all ICP analysis, 10-g soil sample is required for IC anion analysis, 5-g soil sample for hexavalent chromium analysis, 10-g soil sample for CA analysis, 10-g soil sample for 8015 analysis, and 125-g soil samples for each 8270 and TOC analyses.

[d]Vessel must be sealed.

AG = amber glass
ASAP = as soon as possible
G = glass
NWTPH = Northwest total petroleum hydrocarbons
P = plastic
SVOA = semivolatile organic analyte
TBD = to be determined
VOA = volatile organic analyte

A.3 FIELD SAMPLING PLAN

A.3.1 Sampling Objectives

The primary objective of the field sampling plan is to clearly identify and describe sampling and analysis activities that will be conducted to resolve decision rules identified in Step 5 of the DQO process (see Section A.1.5.2). Decision rule statements indicate that remedial action may be necessary if preliminary action levels and annual exposure protection limits are exceeded. The field sampling plan uses the sampling design proposed in Step 7 of the DQO process and describes pertinent elements of the sampling program. Sample methods, procedures, locations, frequencies, parameters of interest, and bottle requirements are identified in this section.

Three boreholes and two test pits (or shallow hand augers) will be excavated or drilled through each of the representative sites identified in the DQO as needing additional data to support the RI/FS process: the 216-A-4 Crib, the 216-T-13 Trench, the 216-T-33 Crib, the 216-U-3 French Drain, and the 200-E-4 French Drain.

Soil samples will be collected from the vadose zone for laboratory analysis. Physical property samples will also be collected at major lithologic changes for the boreholes. The boreholes will be geophysically logged for gamma-emitting radionuclides and neutron moisture content. A split-spoon sampler will be the primary sampling device used to collect the soil samples from the boreholes (or auger borings); test pits shall be excavated and sampled using an excavator. The locations of the planned and historical boreholes and the planned test pits are shown in Figures A-1 through A-5.

A.3.2 Field Measurements

A.3.2.1 Surface Radiation Survey. A surface radiation survey will be performed at each waste site to be investigated to document existing surface contamination and to support preparation of supporting health and safety documentation. Surface radiation surveys will be conducted by qualified RCTs in accordance with applicable health and safety procedures. A survey report will be prepared for each site. Surveys will be performed according to BHI-EE-05, Procedure 2.5, "Operation of Mobile Surface Contamination Monitor II," or other applicable approved procedures. A post-sampling survey will also be performed at each sampling site to ensure that sampling activities have not contributed to surface contamination.

A.3.2.2 Soil Screening. All samples and cuttings from boreholes and test pits will be field screened for evidence of radioactive contamination by the RCT or other qualified personnel. Surveys of these materials will be conducted with field instruments and visual observations. Potential screening instruments are listed in Table A-9 with their respective detection limits. RCT will record all field measurements, noting the depth of the sample and the instrument reading.

Prior to excavation or drilling, a local area background reading will be taken with the field screening instruments at a background site to be selected in the field, in accordance with the requirements of BHI-EE-05, Procedure 2.11, "Portable Environmental Survey Instrument

Operation." Field screening and interpretations of geologic conditions will be used to identify the bottom of the waste site (i.e., crib/trench/french drain) and adjust sampling points, assist in determining sample shipping requirements, and support worker health and safety monitoring. The site geologists will use professional judgment, screening data, and the information provided in Tables A-10 through A-14 to finalize sampling decisions.

The field action level for radionuclide screening is three times background. Intervals above this field action level will be assessed for sampling by the field geologist. Samples exceeding 0.5 mrem/hr will be stored at a temporary radioactive material storage area at the filed location until shipment to the laboratory. Samples less than 0.5 mrem/hr will be stored at the 3728 Sample Storage and Shipping Facility until shipment to the laboratory.

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

A.3.3 Soil Sampling and Analysis

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

A.3.3.1 Borehole Sampling and Analysis. Nonradiological and radiological samples will be collected from three deep boreholes. Boreholes will be drilled in the 216-A-4 Crib, the 216-T-33 Crib, and the 216-U-3 French Drain. Borehole sample collection will be guided by the sampling approaches outlined in Tables A-11, A-12, and A-14. Actual sampling intervals may vary from these approaches depending on the thickness of clean soil cover placed over the cribs and trench. The intent of the sampling design is to begin sample collection at the crib/trench bottom and continue sampling intermittently (based on the site's conceptual contaminant distribution model, results of nearby borehole logging events, and professional judgement of the field geologist) until a significant decrease in contamination is noted. The zone of highest potential for contamination will likely contain low-mobility contaminants. Additional samples above and below this zone of highest potential for contamination will be collected based on characteristics exhibited during the field screening activities and geologic observations. Figures A-6, A-8, and A-9 illustrate hypothetical sampling intervals in boreholes. Additional samples may be collected and analyzed at the discretion of the field geologist/engineer, based on field conditions, measurements, or observations made during the conduct of remedial investigations.

The bottoms of the waste sites are considered critical sample points because the highest levels of contamination are expected to begin at this location. Samples from 4.6 m (15 ft) below ground surface (bgs) and 7.6 m (25 ft) bgs are also considered critical sampling points to evaluate exposure scenarios and remedial alternatives. Sample from depths greater than 7.6 m (25 ft) bgs will be used to verify the conceptual contaminant distribution models and to evaluate remedial action alternatives and groundwater impacts. Drilling and sampling will stop when the water table is encountered.

For waste sites requiring boreholes for characterization, the depth of drilling and associated soil sampling will be based on site-specific conditions. When available information indicates the

presence of deep vadose zone contamination or that groundwater has been impacted by a waste site, soil sampling to the water table will be performed. For waste sites where deep contamination has not been observed or no information exists, sampling to groundwater may not be necessary. In this case, the drilling and sampling depth will be determined based on the observational approach. At a minimum, samples will be collected to the Plio-Pleistocene unit, if present, and at a maximum, to the water table. The Plio-Pleistocene unit is expected to be a zone of higher moisture content and where contaminants would tend to concentrate. Decisions to collect samples past the Plio-Pleistocene unit will be based on field screening of retrieved soil samples or drill cuttings for radioactive contamination. For the 200-MW-1 OU, this observational approach to borehole sampling applies to the 216-U-3 French Drain and 216-T-33 Crib.

As shown in the contaminant distribution models (Section 3.0 of the work plan), liquid waste streams discharged to the 216-U-3 French Drain and 216-T-33 Crib are not expected to have significantly impacted the vadose zone below the Plio-Pleistocene unit. At these two sites uranium and cesium-137 are primary contaminants based on inventory records (DOE-RL 1997, Appendix A) and are gamma-emitting radionuclides than can be detectable in the field. As a result, soil samples will be collected down to and within the Plio-Pleistocene unit. The soil samples/drill cutting from the Plio-Pleistocene unit will be screened using a hand-held rate meter with a gamma detector. If contamination is above three times background, drilling and sampling will resume to the next sample interval until contamination is less than three times background. The three times background criterion is considered appropriate to minimize the potential for a false positive. If contamination is less than three times background, the borehole will be logged with the spectral gamma logging system to confirm that significant contamination is not present prior to abandoning the borehole. These decisions will be made in the field by the site geologist.

Sampling will be performed in accordance with BHI-EE-01, Procedure 4.0, "Soil and Sediment Sampling," using a split-spoon sampler. The split-spoon samplers will be equipped with four separate stainless steel liners. Site personnel will not overdrive the sampling device. With the exception of the volatile organic analyte samples, soil will be transferred to a pre-cleaned, stainless steel mixing bowl, homogenized, and then containerized in accordance with the sampling procedure. Radiological and nonradiological analytes of interest are presented in Table A-7. If sample volume requirements cannot be met, samples will be collected according to the priority presented in Table A-8. Radiological and nonradiological samples will always take precedence over physical property samples.

Physical property samples will be collected from the boreholes to provide site-specific values to support RESidual RADioactivity (RESRAD) dose model or other modeling efforts. Soil properties of interest are moisture content, grain-size distribution, and soil density. Samples for soil density shall generally be collected with a split-spoon sampler equipped with four separate stainless steel or lexan liners. Physical property samples will be analyzed in accordance with ASTM methods, listed in Table A-7 (ASTM 1993) or in accordance with ERC procedures identified in Table A-8. The physical property samples will be collected from lithologies that represent the major facies in the vadose zone as identified in Tables A-11, A-12 and A-14. The samples will be collected coincident with nonradiological and radiological split-spoon sample intervals, where possible. Additional samples may be obtained with the approval of the project manager.

Investigation-derived waste (IDW) generated during this activity will be handled according to procedures in Section A.5 and a waste control plan.

A.3.3.2 Test Pit (Auger) Sampling and Analysis. Nonradiological and radiological samples will be collected from two test pits (or shallow hand augers). Test pits will be excavated at the 216-T-13 Trench and 200-E-4 French Drain sites. Sampling locations are shown in Figures A-2 and A-5, respectively.

Test pit sample collection will be guided by the sampling approaches outlined in Tables A-10 and A-13. Actual sampling intervals may vary depending on the thickness of backfill placed over the trench or french drain. The intent of the sampling design is to begin sample collection at the bottom of the trench/french drain and continue sampling intermittently (based on the site's conceptual contamination distribution model and professional judgement) until a significant decrease in contamination is noted. The bottom of the trench or french drain will be identified using radiological field screening measurements, visual observation of soil, and the professional judgment of the site geologist. The maximum sampling depths vary by site (7.6 m [25 ft] bgs for the 216-T-33 Trench and 4.6 m [15 ft] bgs for the 200-E-4 French Drain). If contamination is observed during the excavation process via field screening equipment at the maximum sampling depth, an additional deeper sample will be attempted (depending on the limitations of the excavating equipment) for further resolution of the vertical contamination concentration profile.

If field screening shows contamination greater than the limitations of the excavating equipment (approximately 7.6 m [25 ft]), one Geoprobe®, drive casing, or cone penetrometer will be installed directly adjacent to the test pit and logged with a detector with the sensitivity required to determine how far contamination is present below 7.6 m (25 ft). The depth of the direct push boring will be as deep as possible but is limited by subsurface conditions. The maximum depth of approximately 18 m (60 ft) bgs is anticipated.

The bottoms of the waste sites are considered critical sample points because the highest levels of contamination are expected to begin at this location. Samples from 4.6 m (15 ft) bgs and 7.6 m (25 ft) are also considered critical sampling points to evaluate exposure scenarios and remedial alternatives. At the 200-E-4 French Drain, the area of the waste site may be too small to allow excavation and sampling using heavy equipment for shallow or near-surface samples. Therefore, a portion of the test pits may be accessed at this location using hand augers and shovels for the shallow samples or near-surface samples.

Sampling will be performed in accordance with BHI-EE-01, Procedure 4.0, "Soil and Sediment Sampling," using the excavator bucket or a hand auger, as applicable. If an excavator bucket is used as the sampling device, samples will be collected directly from the excavator bucket, which will target the sampling intervals. If a hand auger is used to collect samples, samples will be collected in 0.6-m (2-ft) segments. Radiological and nonradiological analytes of interest are presented in Table A-7. If sample volume requirements cannot be met, samples will be collected and analyzed in the sequence shown in Table A-8. Samples will be collected to evaluate soil physical properties based on the determination of the field geologist.

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

Waste generated during this activity will be handled according to procedures listed in Section A.2.7 and in a waste control plan.

A.3.3.3 Pre-Shipment Sample Screening. A representative portion of each sample to be shipped to an offsite laboratory will be submitted to the Radiological Counting Facility, 222-S Laboratory, or other suitable onsite laboratory for total activity analysis prior to shipment. Total activities will be used for sample pre-shipment characterization. Samples that slightly exceed the offsite laboratory criterion discussed in Section A.2.7.6 may be reduced in volume to allow offsite shipment. Onsite and offsite laboratories will be identified prior to initiating field activities and will be mutually acceptable to the ERC's Sample Management group and to the task lead.

A.3.3.4 Summary of Sampling Activities. A summary of the number and types of samples to be collected at all five waste sites is presented in Table A-15.

A.3.4 Geophysical Logging

The planned boreholes and selected existing boreholes will be geophysically logged with the high-resolution spectral gamma-ray logging system to determine the vertical distribution and concentration of gamma-emitting radionuclides. Soil moisture will also be determined using a neutron logging tool. These methods are described in Section 4.3 of the work plan. The new boreholes will be logged prior to telescoping of casing and before abandonment. The starting point for logging will be recorded; this is usually ground surface or top of casing. The site geologist will witness logging runs and verify before and after field calibrations and repeat log intervals. The list of boreholes and wells that will be logged with the radionuclide logging system is presented in Table A-16. These boreholes represent data collection points in the vicinity of the individual waste sites. Logging of these boreholes will provide additional, updated, site-specific information on contaminant distribution, both laterally and vertically in the area of the waste sites.

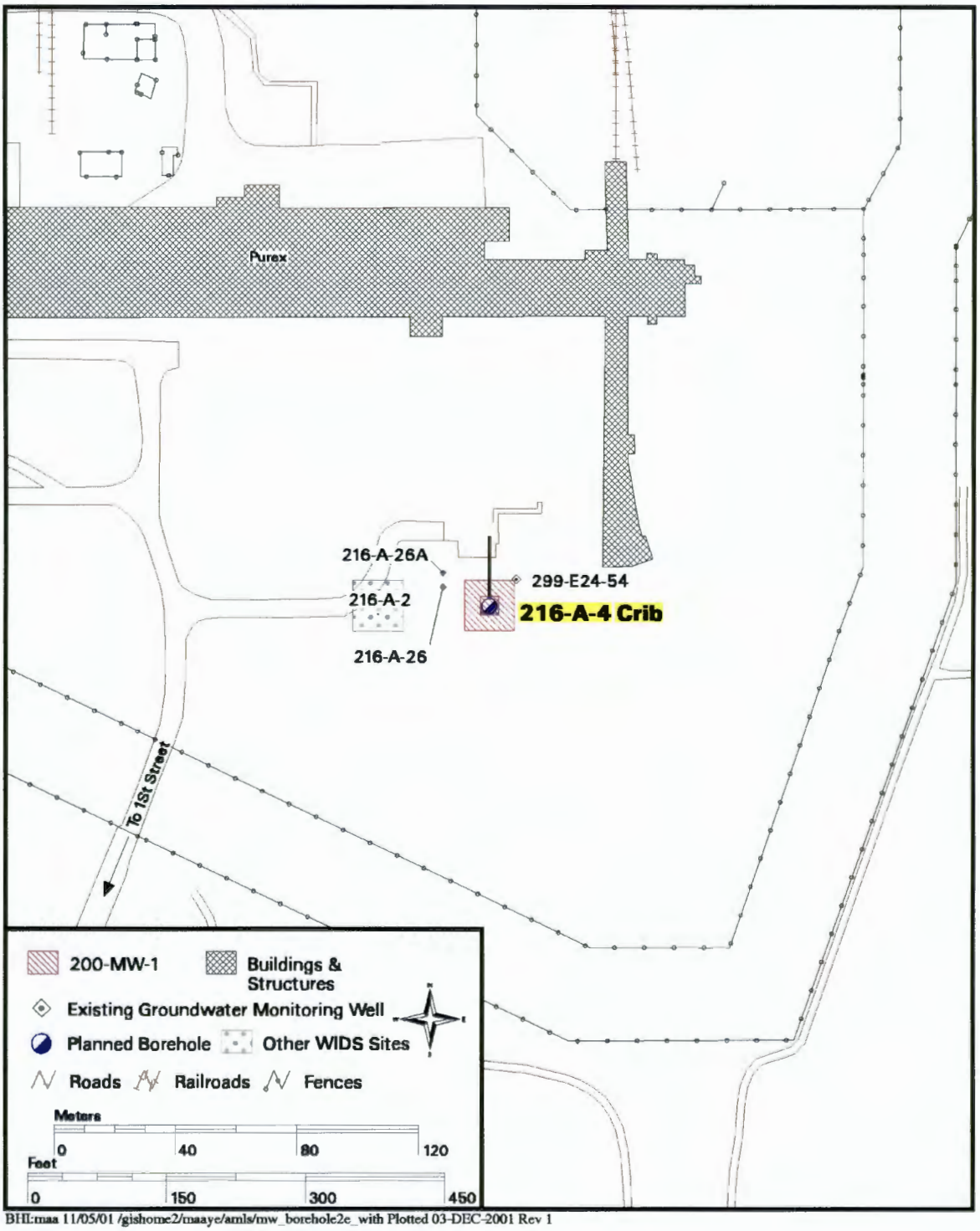
A.3.5 Surveying

The location of all planned boreholes will be surveyed after the sampling and abandonment activities are completed. Surveys will be performed according to BHI-EE-01, Procedure 1.6, "Survey Requirements and Techniques." Data will be recorded in the North American Vertical Datum of 1988 (NAVD88) and the Washington State Plane (South Zone) North American Datum of 1983 (NAD83), with the 1991 adjustment for horizontal coordinates. All survey data will be recorded in meters and feet.

A.3.6 Waste Management Sampling

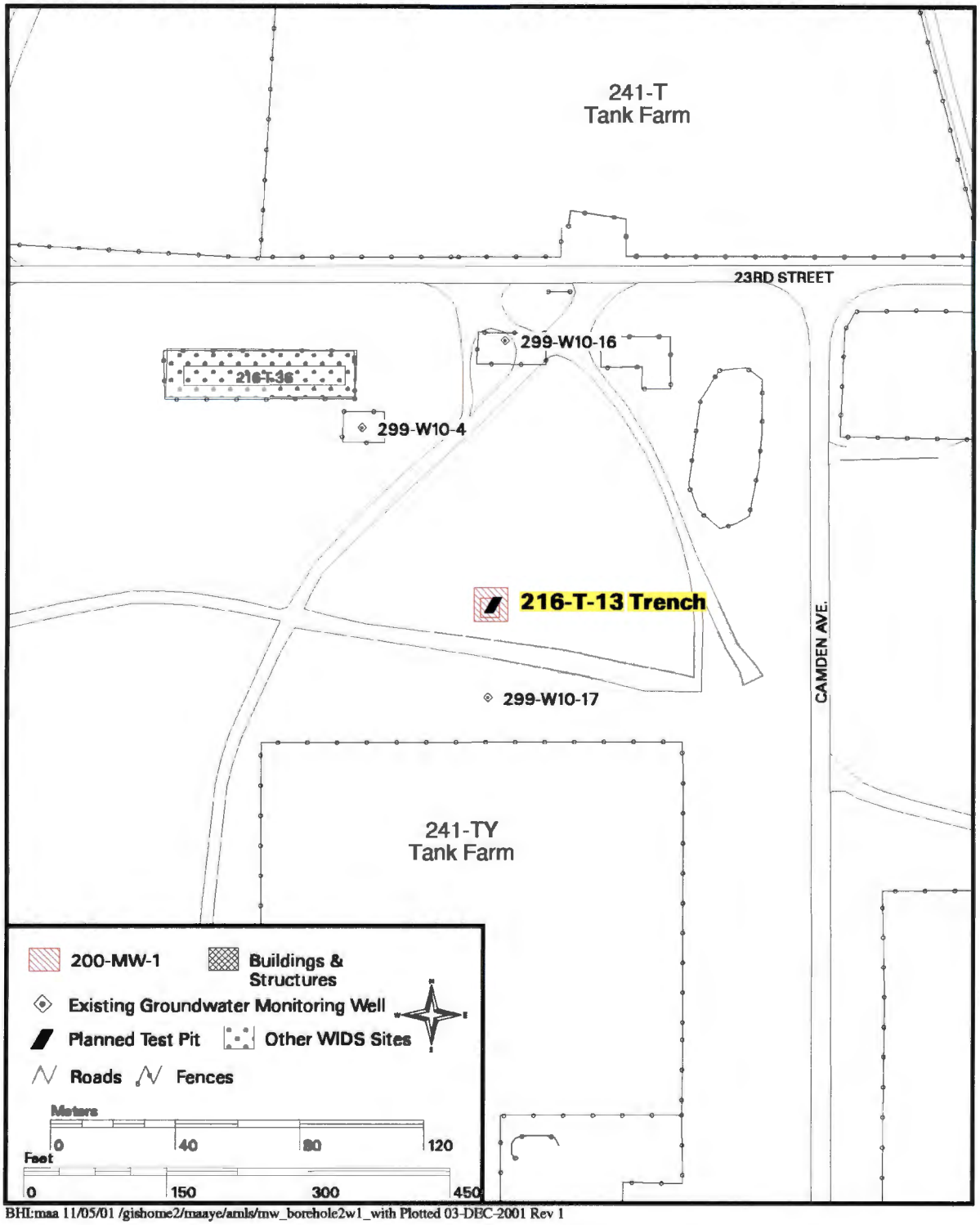
A waste designation DQO effort will be performed before the initiation of the characterization activities to ensure that the proper information is collected during the field effort to support the designation of all project IDW. During the IDW DQO effort, any listed waste issues will also be resolved. Any additional sampling requirements or analytes needed to support designation activities will be identified and implemented through the waste designation DQO summary report that will be prepared at that time.

Figure A-1. Location of Planned and Existing Boreholes and Wells at the 216-A-4 Crib.



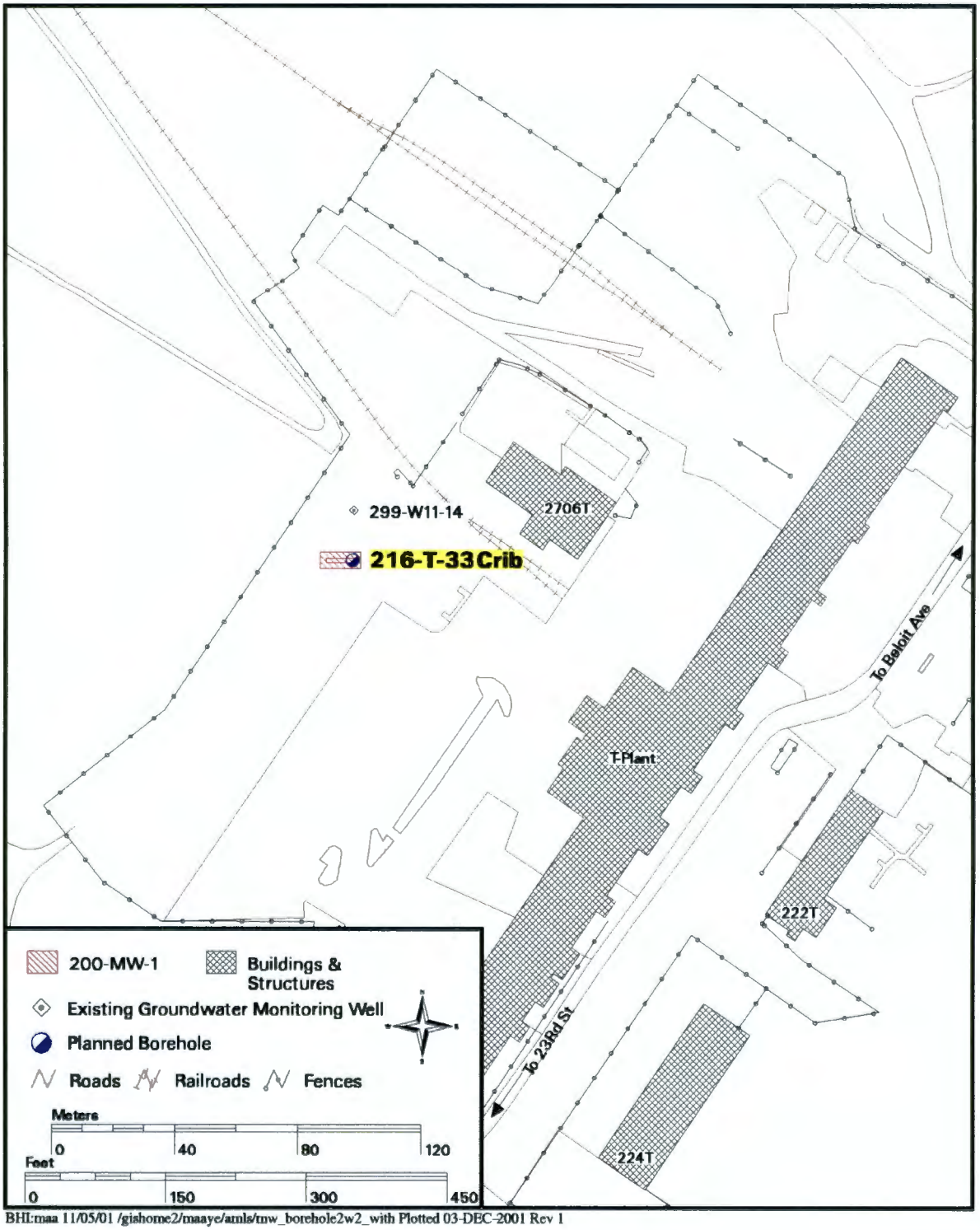
BHI:maa 11/05/01 /gishome2/maaye/amls/mw_borehole2e_with Plotted 03-DEC-2001 Rev 1

Figure A-2. Location of Planned Test Pit at the 216-T-13 Trench.



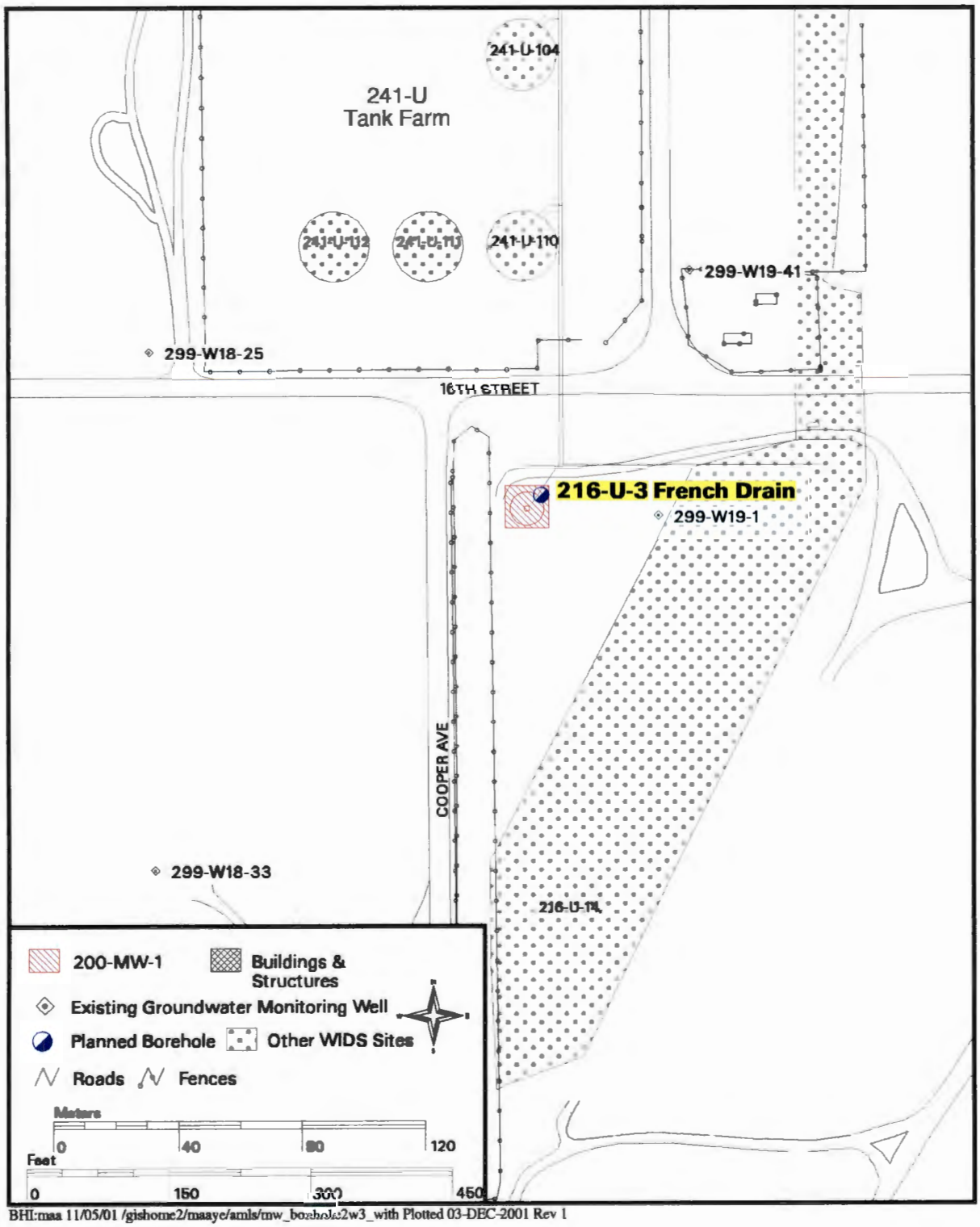
BHI:maa 11/05/01 /gishome2/maaye/amls/mw_borehole2w1_with Plotted 03-DEC-2001 Rev 1

Figure A-3. Location of Planned and Existing Boreholes and Wells at the 216-T-33 Crib.



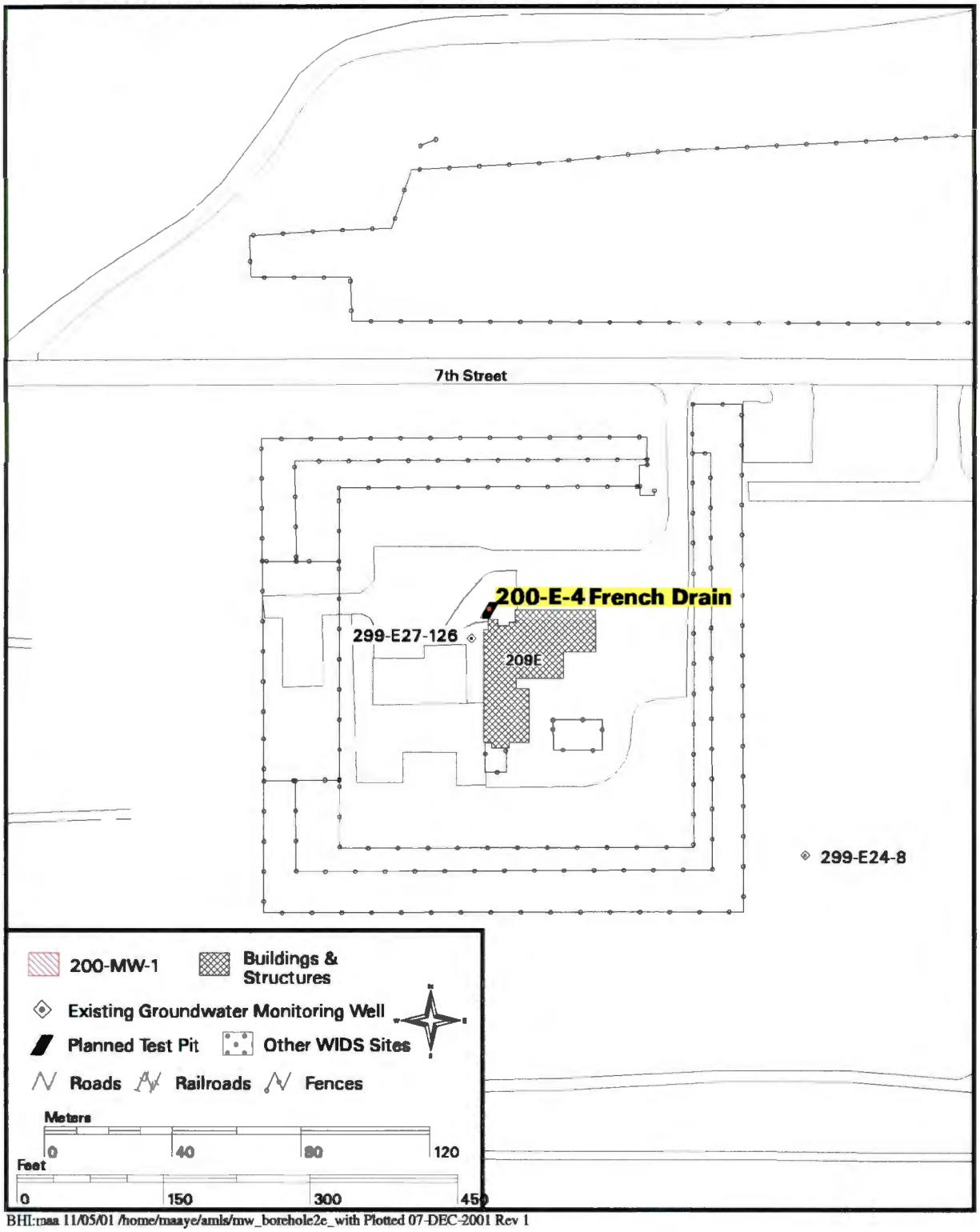
BHI:maa 11/05/01 /gishome2/maaye/amls/tmw_borehole2w2_with Plotted 03-DEC-2001 Rev 1

Figure A-4. Location of Planned and Existing Boreholes and Wells at the 216-U-3 French Drain.



BHI:maa 11/05/01 /gishome2/maaye/amls/mw_borehole2w3_with Plotted 03-DEC-2001 Rev 1

Figure A-5. Location of Planned Test Pit at the 200-E-4 French Drain.



BHI:maa 11/05/01 /home/maaye/amls/mw_borehole2c_with Plotted 07-DEC-2001 Rev 1

Figure A-6. Approximate Sampling Intervals in the 216-A-4 Crib Borehole.

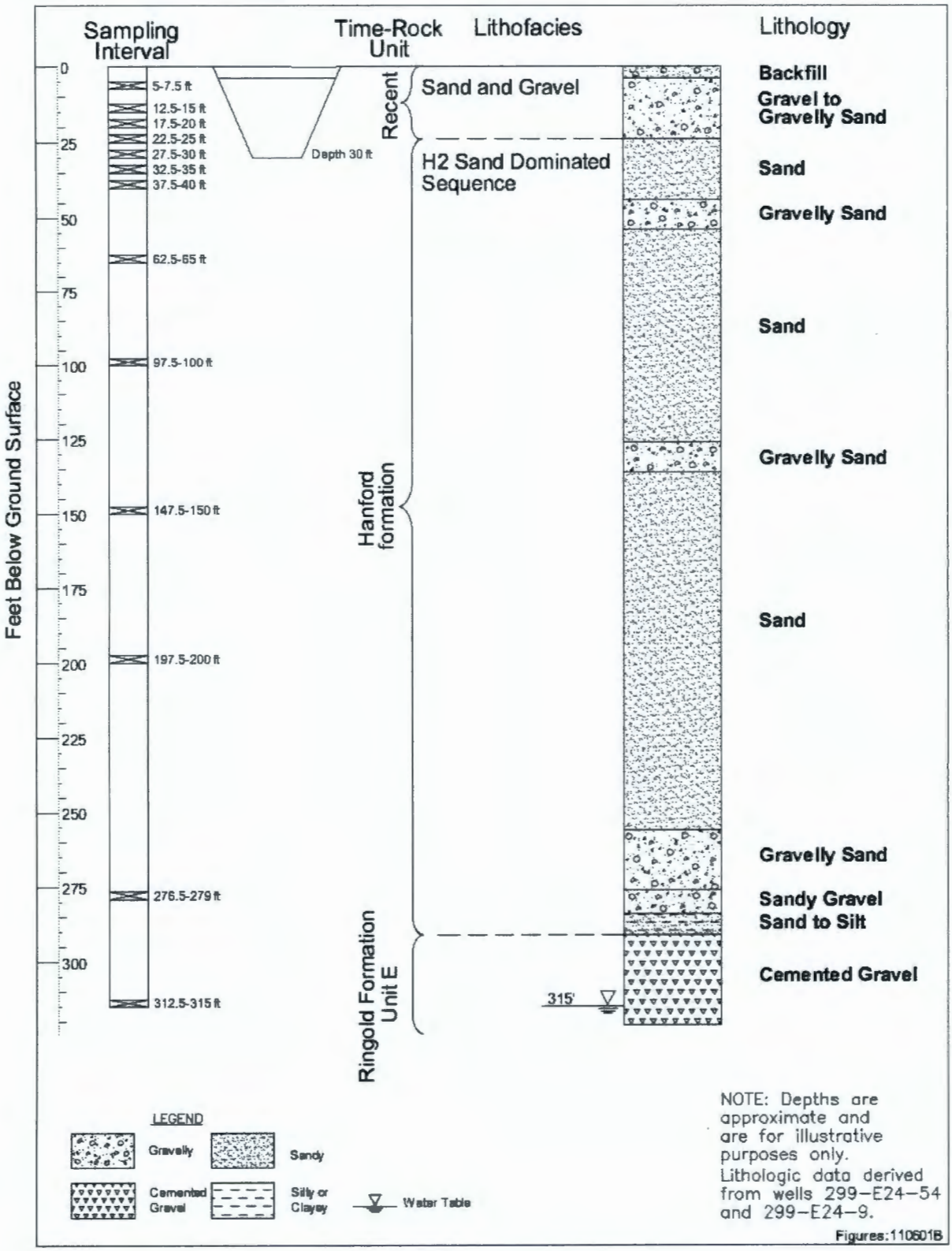


Figure A-7. Approximate Sampling Intervals in the 216-T-13 Trench Test Pit.

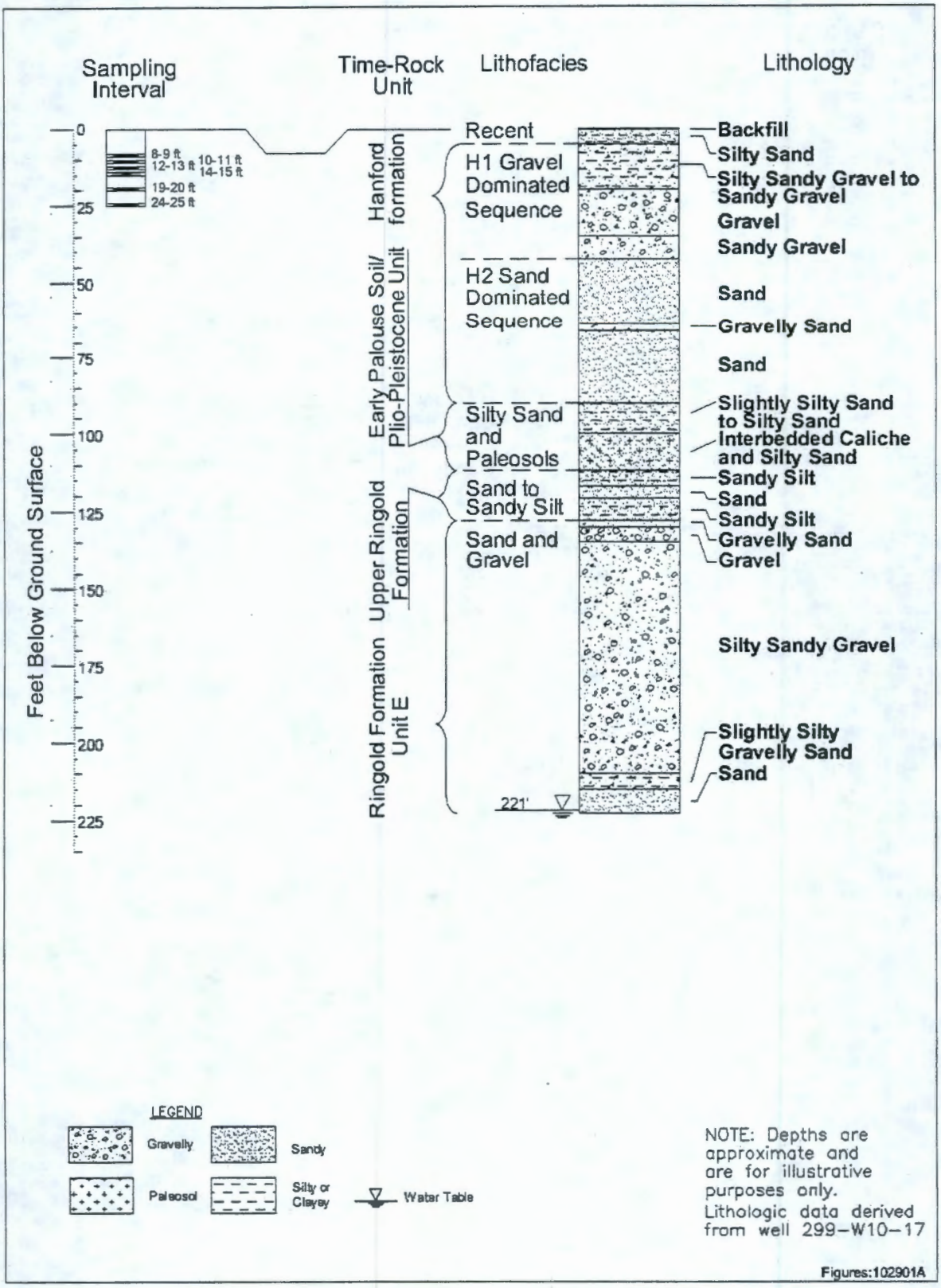


Figure A-8. Approximate Sampling Intervals for the 216-T-33 Crib Borehole.

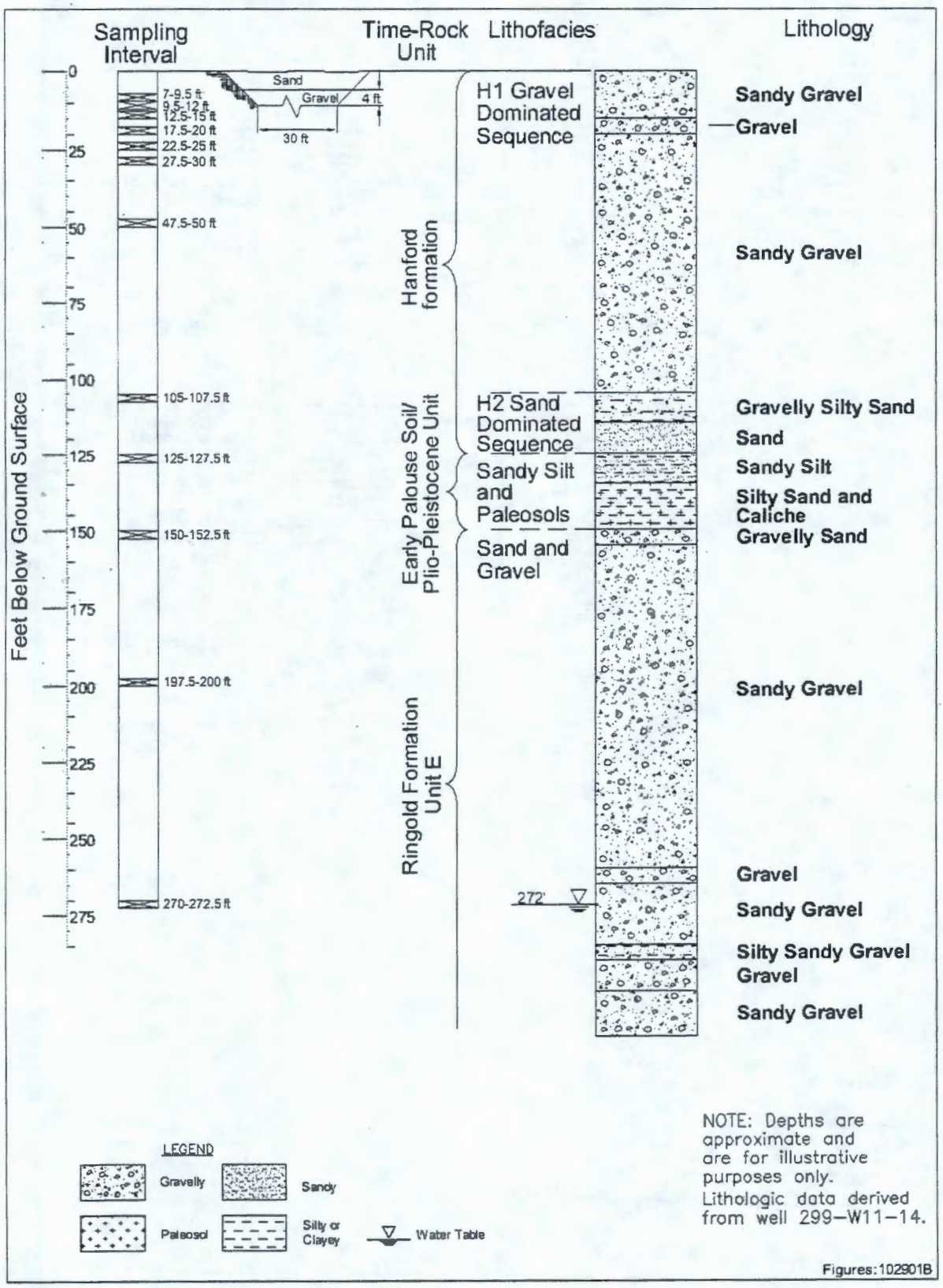


Figure A-9. Approximate Sampling Intervals for the 216-U-3 French Drain Borehole.

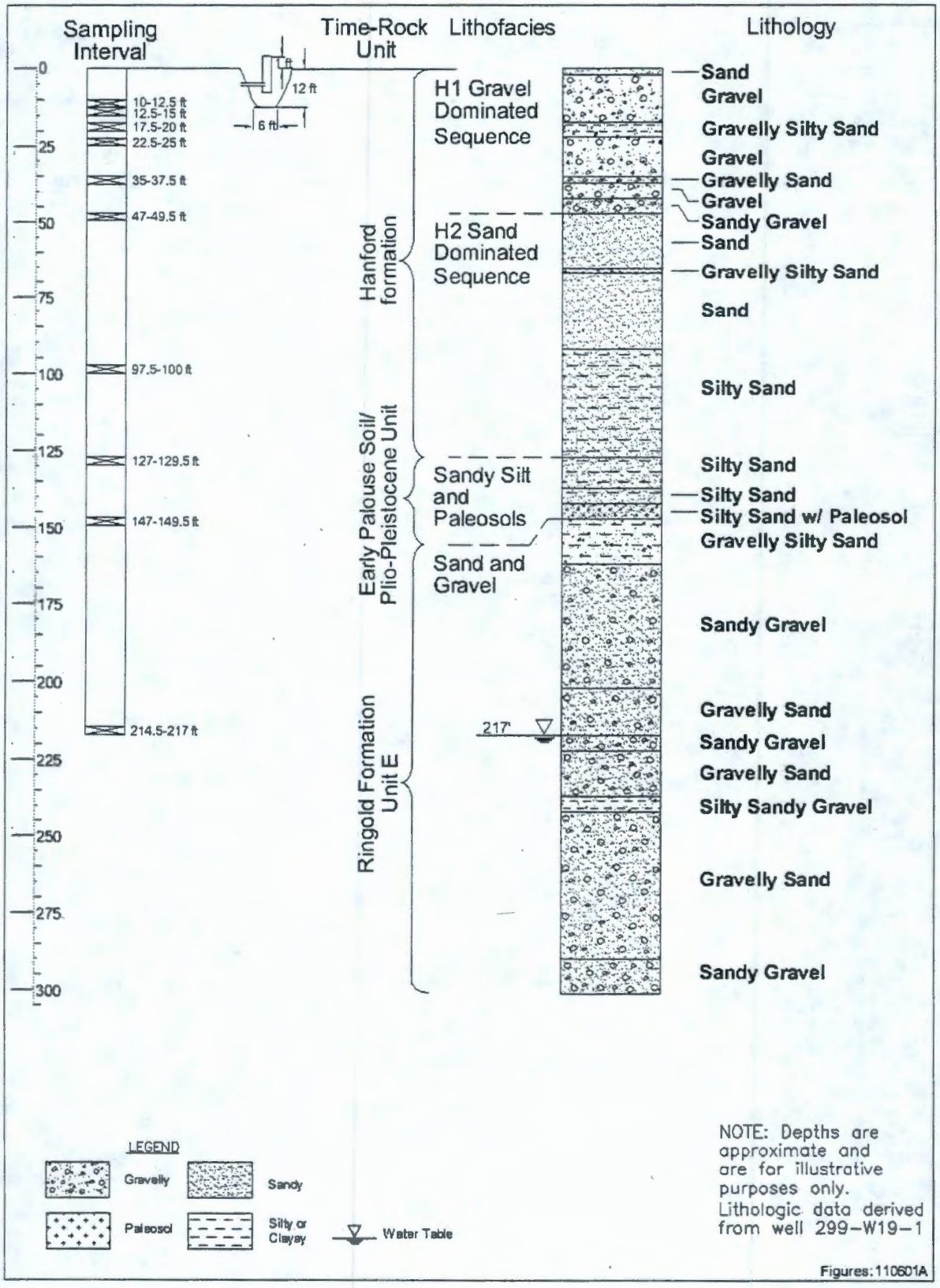


Figure A-10. Approximate Sampling Intervals for the 200-E-4 French Drain Test Pit.

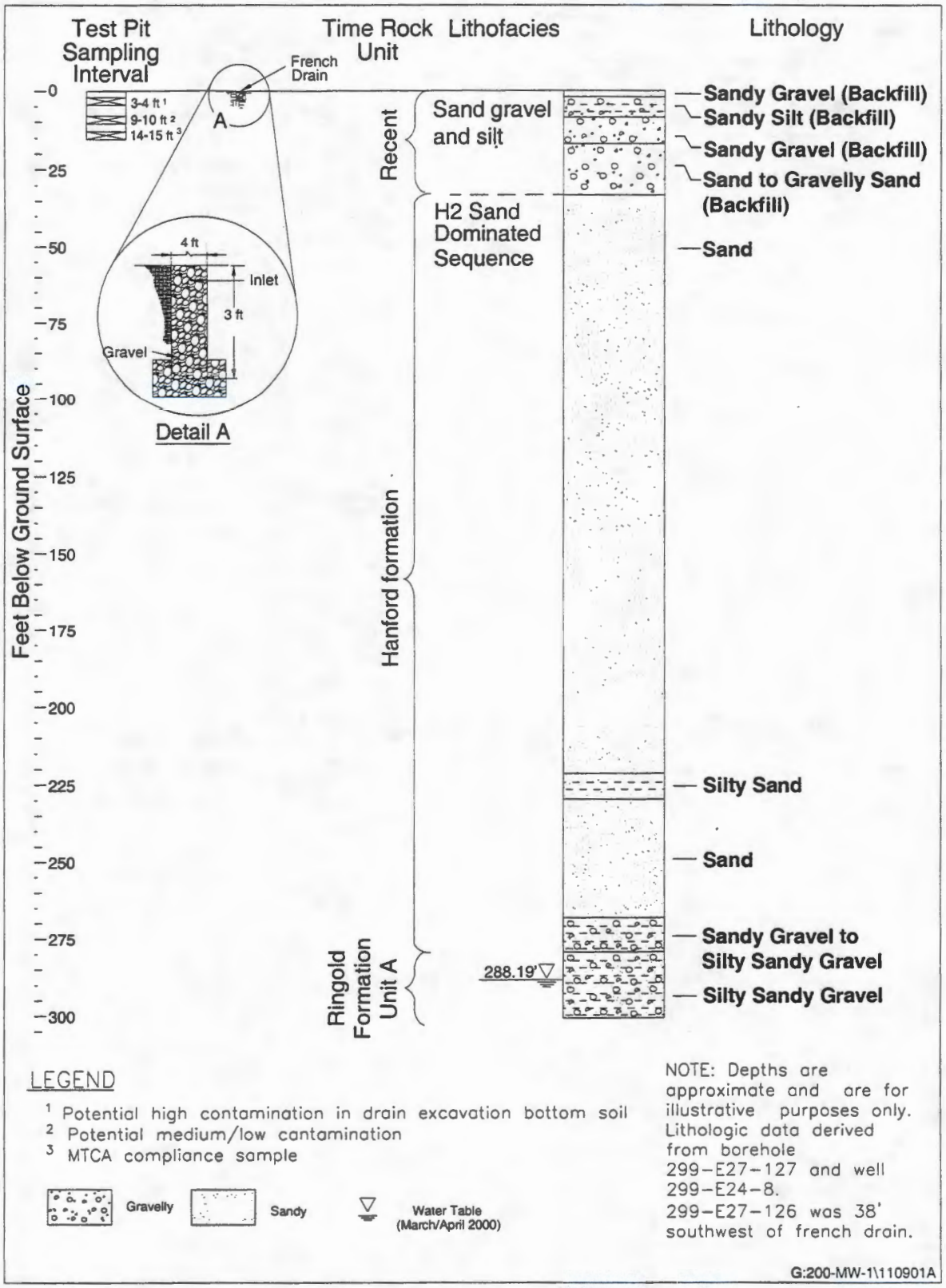


Table A-9. Field Screening Methods.

Measurement Type	Emission Type	Method/Instrument	Detection Limit
Exposure/dose rate	Beta/gamma	RO-20/RO-03 portable ionization chamber	0.5 mrem/hr
Contamination level	Alpha/beta-gamma	E-600 ratemeter with a SHP380-A/B scintillation probe	100 dpm α 1,921 dpm β–γ

Table A-10. 216-T-13 Trench Sampling Plan.

Sample Collection Methodology	Sample Location	Maximum Depth of Investigation	Sample Interval Depth (ft) bgs	Analyte List[a]	Physical Properties	
					Sample Interval (bgs)	Parameters
Test pit	E566776.396, N136522.525[c]	25 ft	8-9, 10-11, 12-13, 14-15, 19-20, 24-25	Table A-3	As determined by the field geologist	Bulk density, moisture content, particle size distribution
Maximum Number of Samples		6				
Approximate Number of Field QC Samples		4[b]				
Approximate Total Number of Samples		10				

bgs = below ground surface
[a]See Table A-7 for detection limits and other analytical parameters.
[b]See Table A-15 for details of QC samples.
[c]Planned field location. Field location may be different based on the actual field conditions as determined by the field team lead.

Table A-11. 216-T-33 Crib Sampling Plan.

Sample Collection Methodology	Sample Location	Maximum Depth of Investigation	Sample Interval Depth (ft) bgs	Analyte List[a]	Physical Properties	
					Sample Interval (bgs)	Parameters
Borehole	E567453.622, N136897.941[c]	272 ft	12.5-15, 16.5-19, 19-21.5, 22.5-25, 27.5-30, 47.5-50, 110.5-113, 130.5-133, 155.5-158, 197.5-200, 270-272.5	Table A-3	1 sample from each of the following: • H_1 • H_2 • HF/PPU (?) Gravel • Ringold Unit E	Bulk density, moisture content, particle size distribution
Maximum Number of Samples		11				
Approximate Number of Field QC Samples		4[b]				
Approximate Total Number of Samples		15				

bgs = below ground surface
H_1 = Hanford formation upper gravel sequence
H_2 = Hanford formation sandy sequence
HF/PPU (?) Gravel = Hanford formation/Plio-Pleistocene unit (?) gravel
[a]See Table A-7 for detection limits and other analytical parameters.
[b]See Table A-15 for details of QC samples.
[c]Planned field location. Field location may be different based on the actual field conditions as determined by the field team lead.

Table A-12. 216-U-3 French Drain Sampling Plan.

Sample Collection Methodology	Sample Location	Maximum Depth of Investigation	Sample Interval Depth (ft) bgs	Analyte List[a]	Physical Properties	
					Sample Interval (bgs)	Parameters
Borehole	E566844.750, N134927.891[c]	217 ft	12.5-15, 17.5-20, 22.5-25, 35-37.5, 47-49.5, 97.5-100, 127-129.5, 147-149.5, 217-219.5	Table A-3	1 sample from each of the following: • H_1 • H_2 • HF/PPU (?) Gravel • Ringold Unit E	Bulk density, moisture content, particle size distribution
Maximum Number of Samples		9				
Approximate Number of Field QC Samples		4[b]				
Approximate Total Number of Samples		13				

bgs = below ground surface
H_1 = Hanford formation upper gravel sequence
H_2 = Hanford formation sandy sequence
HF/PPU (?) Gravel = Hanford formation/Plio-Pleistocene unit (?) gravel
[a]See Table A-7 for detection limits and other analytical parameters.
[b]See Table A-15 for details of QC samples.
[c]Planned field location. Field location may be different based on the actual field conditions as determined by the field team lead.

Table A-13. 200-E-4 French Drain Sampling Plan.

Sample Collection Methodology	Sample Location	Maximum Depth of Investigation	Sample Interval Depth (ft) bgs	Analyte List[a]	Physical Properties	
					Sample Interval (bgs)	Parameters
Test pit	E574448.687, N136348.218[c]	15 ft	3-4, 9-10, 14-15	Table A-3	As determined by the field geologist	Bulk density, moisture content, particle size distribution
Maximum Number of Samples		3				
Approximate Number of Field QC Samples		4[b]				
Approximate Total Number of Samples		7				

bgs = below ground surface
[a]See Table A-7 for detection limits and other analytical parameters.
[b]See Table A-15 for details of QC samples.
[c]Planned field location. Field location may be different based on the actual field conditions as determined by the field team lead.

Table A-14. 216-A-4 Crib Sampling Plan.

Sample Collection Methodology	Sample Location	Maximum Depth of Investigation	Sample Interval Depth (ft) bgs	Analyte List[a]	Physical Properties	
					Sample Interval (bgs)	Parameters
Borehole	E575215.736, N135527.603[c]	311.5 ft bgs	0.5-3, 12.5-15, 18.5-21, 26.5-29, 29-31.5, 34-36.5, 62.5-65, 97.5-100, 147.5-150, 197.5-200, 287.5-290, 309-311.5	Table A-3	1 sample from each of the following: • H_2 • Ringold Unit E	Bulk density, moisture content, particle size distribution
Maximum Number of Samples		12				
Approximate Number of Field QC Samples		4[b]				
Approximate Total Number of Samples		16				

bgs = below ground surface
H_2 = Hanford formation sandy sequence
[a]See Table A-7 for detection limits and other analytical parameters.
[b]See Table A-15 for details of QC samples.
[c]Planned field location. Field location may be different based on the actual field conditions as determined by the field team lead.

Table A-15. Summary of Projected Sample Collection Requirements.

	216-A-4 Crib	216-T-13 Trench	216-T-33 Crib	216-U-3 French Drain	200-E-4 French Drain	Project Total
Chemical Parameters						
Maximum number of characterization samples	12	6	11	9	3	41
Detail of QC samples						
Duplicates	1	1	1	1	1	5
Splits	1	1	1	1	1	5
Equipment blanks	1	1	1	1	1	5
Trip blank	1	1	1	1	1	10
Approximate number of field QC samples	4	4	4	4	4	15
Approximate total number of samples	16	10	15	13	7	61
Physical Properties						
Bulk density, moisture content, particle size distribution	2	TBD	4	4	TBD	10

TBD = To be determined by the field geologist based on soil conditions.

Table A-16. List of Boreholes for Spectral Gamma Ray Logging.

Borehole Number	Approximate Location	Coordinates (Wash. State Plane, NAD83[91])	
		Northing	Easting
TBD[a]	Within the boundaries of the 216-A-4 Crib	TBD	TBD
TBD[a]	Within the boundaries of the 216-T-33 Crib	TBD	TBD
TBD[a]	Within the boundaries of the 216-U-3 French Drain	TBD	TBD
299-W11-14	North of 216-T-33 Crib	136913.962	567457.917

NOTE: Initial selection of existing wells was based on a review of well construction as-built diagrams. A single casing in contact with the formation is the preferred configuration for logging. A field inspection of the well configuration will be performed for final selection of boreholes.

TBD = to be determined
[a]Planned boreholes.

A.4 HEALTH AND SAFETY

All field operations will be performed in accordance with BHI health and safety requirements outlined in BHI-SH-01, *ERC Safety and Health Program*. In addition, appropriate documentation will be prepared per BHI-EE-02 procedures for drilling and test pit activities. This documentation will include an activity hazard analysis, site-specific health and safety plan, and applicable radiological work permits.

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

A.5 MANAGEMENT OF INVESTIGATION-DERIVED WASTE

Investigation-derived waste generated by characterization activities will be managed in accordance with BHI-EE-10, *Waste Management Plan*, and Appendix E of the Implementation Plan. Containment, labeling, and tracking requirements are specified in BHI-EE-10, Part II, Procedure 9.0, "Control of CERCLA and Other Past Practice Investigation Derived Waste." These procedures have been prepared to implement the requirements of the Washington State Department of Ecology, found in *Strategy for Management of Investigation Derived Waste* (Ecology et al. 1999). Management of IDW, minimization practices, and waste types applicable to 200-MW-1 waste control will be described in a waste control plan.

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

A waste designation DQO effort will be performed before the initiation of the characterization activities to ensure that the proper information is collected during the field effort to support the designation of all project IDW. During the IDW DQO effort, any listed waste issues will also be resolved. Any additional sampling requirements or analytes needed to support designation activities will be identified and implemented through the waste designation DQO summary report that will be prepared at that time.

A.6 REFERENCES

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APPENDIX B

200-MW-1 OPERABLE UNIT SITES REVIEW PROCESS

APPENDIX B

200-MW-1 OPERABLE UNIT SITES REVIEW PROCESS

Included in this appendix are tables that provide summary information on the waste sites that are the subject of this work plan. The tables list the representative waste site groupings that resulted from the site selection process discussed in Section 4.4.1 of the work plan. All information included in the tables represents the present status of the sites in the Waste Information Data System (WIDS) at the time of issuance of this work plan (Rev. 0, April 2002).

The tables provide information regarding the following sites:

- WIDS Classification Status Rejected Sites (Table B-1)
- WIDS Classification Status Proposed Rejected Sites (Table B-2)
- WIDS Reclassification Status Rejected Sites (Table B-3)
- WIDS Classification Status 216/218 Regulatory Authority Sites (Table B-4)
- Summary of Information for the 200-MW-1 Waste Sites Reviewed for this Work Plan (Table B-5).

The 216/218 Regulatory Authority Sites are steam condensate surface discharge sites. The steam condensate consisted of sanitary water that had been sent through a water softener system to remove minerals (calcium and magnesium) and was then introduced into boilers to produce steam. This steam was superheated before distribution to facilities for heating and process use. Steam condensate from the steam distribution lines was released to these sites. When used for heating purposes, this was a seasonal discharge. In addition to sanitary water, the condensate contained nonregulated chemicals that were added to dechlorinate the water, prevent scale, and control corrosion of the boilers.

Table B-5 was reviewed to remove waste sites that are not technically appropriate for the 200-MW-1 OU based on the intent of the *Waste Site Grouping for 200 Areas Soil Investigation* (DOE-RL 1997) and the *200 Areas Remedial Investigation Feasibility Study Implementation Plan – Environmental Restoration Program* (DOE-RL 1999). The waste sites removed from Table B-5 are assigned to an appropriate waste group OU in Table B-6.

Table B-7 presents the analogous sites included in each 200-MW-1 subgroup, as follows:

- Process facility ventilation stack and sand filter sources
- Vehicle/heavy equipment facility decontamination sources

- Vehicle/heavy equipment field decontamination sources
- Nonradiological process steam condensate sources with radionuclide cross-contamination sources
- Low-level radioactive process or steam condensate sources.

REFERENCES

DOE-RL, 1996, *Miscellaneous Streams Best Management Practices (BMP) Report*, DOE/RL-96-40, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1997, *Waste Site Grouping for 200 Areas Soil Investigation*, DOE/RL-96-81, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

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

Table B-1. WIDS Classification Rejected Sites.

Site Code	Site Names	Site Type	Previous Operable Unit	Comments
600-267	600-267, Weather Station 90 Day Storage Pad	Storage pad (<90 day)	NA	Drums/barrels/buckets/cans
200-E-108	200-E-108, Well Drilling Laydown Yard Pit	Depression/pit (nonspecific)	NA	--
200-E-119	200-E-119, 225-B West Side 90 Day Pad	Storage pad (<90 day)	NA	Drums/barrels/buckets/cans
200-W-74	200-W-74, 90 Day Storage Area East Side of 622 F	Storage pad (<90 day)	NA	Drums/barrels/buckets/cans

NA = not applicable

Table B-2. WIDS Classification Proposed Rejected Sites.

Site Code	Site Names	Site Type	Previous Operable Unit	Comments
600-254	600-254, Abandoned 251-W Substation Mineral Oil Underground Pipelines	Product piping	200-NO-1	Oil
616-WS-1	616-WS-1, 616 NDWSF French Drain	French drain	200-IU-5	Storm runoff
200-W-19	200-W-19, Steam Line Asbestos Release	Unplanned release	200-RO-2	Asbestos (friable)
200-W-65	200-W-65, Concrete Vault Northwest of WRAP, Water Pumping Station Vault, Abandoned Water System Pump Vault	Control structure	200-ZP-3	Miscellaneous trash and debris
200-E-61	200-E-61, 202A Building Stormwater Runoff, Miscellaneous Stream #467	Injection/reverse well	200-PO-2	Storm runoff

NDWSF = Nonradioactive Dangerous Waste Storage Facility
WRAP = Waste Receiving and Processing (Facility)

Table B-3. WIDS Reclass Status Rejected Sites.

Site Code	Site Names	Site Type	Previous Operable Unit	Comments
209-E-WS-1	209-E-WS-1, 209-E French Drain	French drain	200-SO-1	Steam condensate
216-B-56	216-B-56, 216-B-56 Crib	Crib	200-BP-6	Process effluent
216-B-61	216-B-61, 216-B-61 Crib	Crib	200-BP-1	Steam condensate
2704-E-HWSA	2704-E HWSA, 2704-E Hazardous Waste Storage Area	Storage pad (<90 day)	200-SS-1	Barrels/drums/buckets/cans
2718-E-WS-1	2718-E-WS-1, 2718 French Drains	French drain	200-SO-1	Water
UPR-200-E-13	UPR-200-E-13, Overflow from 216-A-4, UN-200-E-13, UPR-200-E-15	Unplanned release	200-PO-2	Process effluent
UPR-200-E-15	UPR-200-E-15, Overflow at 216-A-4, UN-200-E-15, UPR-200-E-13	Unplanned release	200-PO-2	Process effluent
UPR-200-W-30	216-S-12, UPR-200-W-30, 291-S Stack Wash Sump, REDOX Stack Flush Trench	Trench	200-RO-3	Water
200-E-32	200-E-32, 226-B Pad East Side 90-Day Waste Accumulation Area	Storage pad (<90 day)	200-BP-6	--
200-E-40	200-E-40, PUREX Sample Gallery 90-Day Waste Accumulation Area	Storage pad (<90 day)	200-PO-2	--
200-E-33	200-E-33, PUREX 214-A 90-Day Waste Accumulation Areas	Storage pad (<90 day)	200-PO-2	--
200-E-34	200-E-34, PUREX High Level Waste Room 90-Day Waste Accumulation Area	Storage pad (<90 day)	200-PO-2	--
200-E-35	200-E-35, 209-E 90-Day Waste Accumulation Area, 209-EA	Storage pad (<90 day)	200-SO-1	--
200-E-36	200-E-36, 241-AZ 90-Day Waste Accumulation Area	Storage pad (<90 day)	200-PO-2	--
200-W-47	200-W-47, 211-T Storage Pad 90-Day Waste Accumulation Area	Storage pad (<90 day)	200-TP-4	--
600-215	600-215, 6265A 90-Day Waste Accumulation Area	Storage pad (<90 day)	200-IU-5	Barrels/drums/buckets/cans
200-E-50	200-E-50, 284-E Brine Pit, 284-E Salt Dissolving Pit and Brine Pump Pit	Sump	200-SS-1	Demolition and inert waste
200-W-60	200-W-60, 284-W Brine Pit, 284-W Salt Dissolving Pit and Brine Pump Pit	Sump	200-SS-2	Demolition and inert waste
200-W-61	200-W-61, 284 Powerhouse Coal Ramp Washdown Pit, 200 West Powerhouse Coal Ramp Washdown Pit, Miscellaneous Stream #471	Depression/pit (nonspecific)	200-SS-2	Water
200-E-51	200-E-51, 284-E Powerhouse Coal Ramp Washdown Pit, 200 East Powerhouse Coal Ramp Washdown Pit, Miscellaneous Stream 177	Depression/pit (nonspecific)	200-SS-1	Water
200-W-50	200-W-50, 2706-T 90-Day Waste Accumulation Area	Storage pad (<90 day)	200-TP-4	--
200-E-39	200-E-39, PUREX Room 52, Hood 32 90-Day Waste Accumulation Area	Storage pad (<90 day)	200-PO-2	--

Table B-4. 216/218 Regulatory Authority Sites.[a] (2 Pages)

Site Code	Site Names	Site Type	Previous Operable Unit	Comments
200-E-62	200-E-62, 202A Building Steam Condensate, Miscellaneous Stream #71, Injection Well (Z)	Injection/reverse well	200-PO-2	Steam condensate
200-E-63	200-E-63, Line #8801 Steam Condensate, Miscellaneous Stream #72, Injection Well (AA)	Injection/reverse well	200-PO-2	Steam condensate
200-E-64	200-E-64, Line #8801 Steam Condensate, Miscellaneous Stream #69, Injection Well (W)	Injection/reverse well	200-PO-2	Steam condensate
200-E-65	200-E-65, 202A Building Steam Condensate, Miscellaneous Stream #464, Injection Well (R)	Injection/reverse well	200-PO-2	Steam condensate
200-E-68	200-E-68, 291A Control House Steam Condensate, Miscellaneous Stream #59, Injection Well (L)	Injection/reverse well	200-PO-2	Steam condensate
200-E-69	200-E-69, Line #8801 Steam Condensate, Miscellaneous Stream #56, Injection Well (A)	Injection/reverse well	200-PO-2	Steam condensate
200-E-70	200-E-70, Line #8801 Steam Condensate, Miscellaneous Stream #64, Injection Well (Q)	Injection/reverse well	200-PO-2	Steam condensate
200-E-71	200-E-71, Line #8801 Steam Condensate, Miscellaneous Stream #63, Injection Well (O)	Injection/reverse well	200-PO-2	Steam condensate
200-E-72	200-E-72, Line #8801 Steam Condensate, Miscellaneous Stream #60, Injection Well (G)	Injection/reverse well	200-PO-2	Steam condensate
200-E-73	200-E-73, Line #8801 Steam Condensate, Miscellaneous Stream #61, Injection Well (M)	Injection/reverse well	200-PO-2	Steam condensate
200-E-74	200-E-74, Line #8801 Steam Condensate, Miscellaneous Stream #62, Injection Well (N)	Injection/reverse well	200-PO-2	Steam condensate
200-E-75	200-E-75, Line #8801 Steam Condensate, Miscellaneous Stream #67, Injection Well (B)	Injection/reverse well	200-PO-2	Steam condensate
200-E-76	200-E-76, Line #8801 Steam Condensate, Miscellaneous Stream #65, Injection Well (U)	Injection/reverse well	200-PO-2	Steam condensate
200-E-77	200-E-77, Line #8801 Steam Condensate, Miscellaneous Stream #70, Injection Well (S)	Injection/reverse well	200-PO-2	Steam condensate
200-E-78	200-E-78, Line #8801 Steam Condensate, Miscellaneous Stream #70, Injection Well (Y)	Injection/reverse well	200-PO-2	Steam condensate
200-E-79	200-E-79, Line #8801 Steam Condensate, Miscellaneous Stream #66, Injection Well (T)	Injection/reverse well	200-PO-2	Steam condensate
200-E-80	200-E-80, Line #8801 Steam Condensate, Miscellaneous Stream #68, Injection Well (V)	Injection/reverse well	200-PO-2	Steam condensate
200-E-81	200-E-81, MO035 Facility Water Valve, Miscellaneous Stream #533	Injection/reverse well	200-PO-2	Water valve
200-E-82	200-E-82, Steam Trap 2P, Yard-MSS-TRP-040, Miscellaneous Stream #115	Injection/reverse well	200-PO-2	Steam condensate
200-E-84	200-E-84, 202A Building Steam Condensate, Miscellaneous Stream #58, Injection Well (C)	Injection/reverse well	200-PO-2	Steam condensate
200-E-88	200-E-88, B Plant Yard Steam Condensate, Miscellaneous Stream #3	Injection/reverse well	200-BP-6	Steam condensate
200-E-89	200-E-89, B Plant Yard Steam Condensate, Miscellaneous Stream #4	Injection/reverse well	200-BP-6	Steam condensate

Table B-4. 216/218 Regulatory Authority Sites.[a] (2 Pages)

Site Code	Site Names	Site Type	Previous Operable Unit	Comments
200-E-90	200-E-90, B Plant Yard Steam Condensate, Miscellaneous Stream #5	Injection/reverse well	200-BP-6	Steam condensate
200-E-91	200-E-91, B Plant Yard Steam Condensate, Miscellaneous Stream #6	Injection/reverse well	200-BP-6	Steam condensate
200-E-92	200-E-92, B Plant Yard Steam Condensate, Miscellaneous Stream #7	Injection/reverse well	200-BP-6	Steam condensate
200-E-93	200-E-93, B Plant Yard Steam Condensate, Miscellaneous Stream #8	Injection/reverse well	200-BP-6	Steam condensate
200-E-94	200-E-94, B Plant Yard Steam Condensate, Miscellaneous Stream #9	Injection/reverse well	200-BP-6	Steam condensate
200-E-95	200-E-95, 222B Building Steam Condensate, Miscellaneous Stream #308	Injection/reverse well	200-BP-6	Steam condensate
200-E-97	200-E-97, 212B Building, Steam Condensate, Miscellaneous Stream #470	Injection/reverse well	200-BP-6	Steam condensate
200-E-98	200-E-98, 271B Building Ice Machine Overflow, Miscellaneous Stream #490	Injection/reverse well	200-BP-6	Steam condensate
200-E-99	200-E-99 Steam Trap 2P-Yard-MSS-TRP-017, Miscellaneous Stream #570	Injection/reverse well	200-BP-6	Steam condensate
200-E-100	200-E-100 Steam Trap 2P-Yard-MSS-TRP-019, Miscellaneous Stream #571	Injection/reverse well	200-BP-6	Steam condensate

[a]The site names included in this table have been submitted to the regulatory agency for rejection.

Table B-5. Summary of Information for the 200-MW-1 Waste Sites Reviewed for this Work Plan. (21 Pages)

Site Code Type	Site Names	Location	Dates of Operation	Source Facility	Contaminant Inventory/Volume Released	Depth	Waste Site Dimensions	General Description
Process Facility Ventilation Stack and Sand Filter Sources								
216-A-4 Crib **(Rep. Site)**	216-A-4, 216-A-4 Cavern	South of the 202-A Building and east of 216-A-2, inside the PUREX exclusion fence	1955 to 1958	Laboratory cell drainage from the 202-A Building and 291-A-1 Stack drainage. For a detailed description of this site, see Section 2.2.3 of this work plan.	6,210,000 L with 395 kg U; 140 g Pu; 6.93 Ci Cs-137; 4.39 Ci Sr-90; 300 kg NO_3; 110 kg $Na_2Cr_2O_7$	5.5 m (18 ft) depth to top of crib, 2.1 m (7 ft) depth of rock bed, 0.3 m (1 ft) gravel, sand and sisalkraft paper	6.1 m x 6.1 m (20 ft x 20 ft)	For a detailed description of this site, see Section 2.2.3 of this work plan.
216-A-41 Crib	216-A-41, Crib, 291-AR Stack Drain, 296-A-13 Stack Drain	Northwest of the 296-A-13 Stack, west of Buffalo Avenue and north of the 244-AR Vault facility	1968 to 1974	Drainage from the 296-A-13 Stack. The stack connected to the 291-AR Filter Building.	10,000 L[a]	2 m (7 ft)	3 m x 3 m (10 ft x 10 ft)	The crib contains six 20- x 20- x 41-cm (8- x 8-x 16-in.)-bond beam concrete blocks placed end to end to form the dispersion structure 1.2 m (4 ft) below grade. The crib has an inlet pipe from the 296-A-13 Stack and a 20-mil polyethylene barrier separating the gravel from the backfill. The site is not marked in the field and the exact location of this unit has not been confirmed; several temporary buildings are located in the vicinity of the crib at the present time.

Table B-5. Summary of Information for the 200-MW-1 Waste Sites Reviewed for this Work Plan. (21 Pages)

Site Code Type	Site Names	Location	Dates of Operation	Source Facility	Contaminant Inventory/Volume Released	Depth	Waste Site Dimensions	General Description
216-A-21 Crib	216-A-21, 216-A-21 Crib	South of the 202-A Building inside the PUREX exclusion fence	1957 to 1965	Until June 1958, the site received sump waste from the 293-A Building. From June 1958 to December 1958, the site was inactive. From December 1958 to June 1965, the site received the above effluent, laboratory cell drainage from the 202-A Building, and the 291-A-1 Stack drainage.	77,900,000 L[a]	N/A	18 m x 5 m (62 ft x 16 ft)	A 10-cm (4-in.) stainless steel distribution line runs horizontally through the length of the site, 2.1 m (7 ft) below grade. Branching horizontally from this distribution line are four 1.2-m (4-ft) sections of 10-cm (4-in.) tubing. Branching vertically at the same locations are four 2.4-m (8-ft) sections of 10-cm (4-in.) schedule 40 perforated pipe running to the bottom of the site. The excavation is V-shaped in cross-section with a side slope of 1H:1.5V. The excavation has approximately 1.8 m (6 ft) of gravel fill and is backfilled over. The site was surface stabilized in 1999 and posted with Underground Radioactive Material signs.
216-A-27 Crib	216-A-27, 216-A-27 Crib	South of the PUREX facility, partially inside the double security fence	1965 to 1970	Sump waste from the 293-A Building, the laboratory cell drainage from the 202-A Building, and the 291-A-1 Stack drainage.	23,200,000 L with 67.5 kg U; 96.5 g Pu; 32.4 Ci Cs-137; 24.5 Ci Sr-90[a]	N/A	61 m x 3 m (200 ft x 10 ft)	A 15-cm (6-in.) perforated pipe is placed horizontally the length of the unit approximately 3 m (10 ft) below grade. The crib also has a 20-cm (8-in.)-diameter well extending from a concrete pad, a 20-cm (8-in.) vent riser with filter, a 41-cm (16-in.) pipe for a recorder, a 3.8-cm (1.5-in.) sensing bulb well, and a polyethylene barrier. The side slope is 1H:1.5V. The crib is covered with gravel and is marked and posted with Underground Radioactive Material signs. The crib was monitored by wells 299-E17-2 and 299-E17-3.

Table B-5. Summary of Information for the 200-MW-1 Waste Sites Reviewed for this Work Plan. (21 Pages)

Site Code Type	Site Names	Location	Dates of Operation	Source Facility	Contaminant Inventory/Volume Released	Depth	Waste Site Dimensions	General Description
216-S-12 Trench	216-S-12, UPR-200-W-30, 291-S Stack Wash Sump, REDOX Stack Flush Trench	Northeast of the 202-S (REDOX) facility, north of the 291-S Stack	1954	Liquid waste from 291-S Stack flush water.	68,100 L with 5.94 kg U; 1.0 g Pu; 0.43 Ci Cs-137; 0.41 Ci Sr-90	3 m (10 ft)	27 m x 6 m (89 ft x 20 ft)	The unit was constructed in July 1954 to receive flush water containing ammonium nitrate from the 291-S Stack Complex. The trench was retired when the flush of the 291-S-1 Stack was complete, also in July 1954. The trench was deactivated by removing the above-ground piping and then backfilling. The site is surrounded with cement marker posts and chain, posted with Underground Radioactive Material signs.
216-B-13 French Drain	216-B-13, 216-B-13 French Drain, 291-B Crib, 216-B-B, 216-B-13 Crib	South of 221-B and northeast of the 291-B-1 Stack	1945 to 1976	291-B Stack drainage.	21,000 L[a]	6 m (20 ft)	6 m x 1 m (20 ft x 3 ft)	The drain is constructed of two 1.22-m (4-ft)-diameter by 1.53-m (5-ft)-long tile pipes, stacked vertically and filled with crushed limestone. The unit has a plywood cover, located 2.44 m (8 ft) below grade. Two and a half tons (2,270 kg) of limestone were used as a base and to fill the tile pipes. The bottom of the drain is 5.5 m (18 ft) below ground surface. In June 1976, the stack drainage was rerouted to a cell drainage sample tank. A single concrete AC-540 marker is the only site identifier. An Underground Radioactive Materials sign is attached to the concrete post.
200-E-55 French Drain	200-E-55, Effluent Drain East of 291-B Sand Filter, Misc. Stream #322	East of the east end of the 291-B Sand Filter (WIDS Site Code 200-E-30)	1948 to 1997	Condensate from the B Plant canyon sand filter and rain water that leaked through the sand filter roof.	N/A	1 m (3 ft)	2 m x 1 m (7 ft x 3 ft)	There are no visual surface features for this drain. It has been marked with a single steel post. The drain is below grade and east of the B Plant sand filter.

Table B-5. Summary of Information for the 200-MW-1 Waste Sites Reviewed for this Work Plan. (21 Pages)

Site Code Type	Site Names	Location	Dates of Operation	Source Facility	Contaminant Inventory/Volume Released	Depth	Waste Site Dimensions	General Description
216-T-29 French Drain	216-T-29, 291-T Sand Filter Sewer, 216-T-29 French Drain	Adjacent to the north end of the 291-T Sand Filter and northeast of the 221-T Building	1949 to 1964	Canyon air condensate from the 291-T Sand Filter.	74,000 L[a]	1 m (3 ft)	1 m x 0.2 m (3 ft x 0.7 ft)	The site is part of the sand filter construction. In 1964 the sand filter bypass water seal was removed, deactivating the french drain. The sand filter was deactivated because new air filters were installed in each cell of the 221-T Building. The sand filter bypass water seal was removed, allowing the 221-T Building exhaust air to flow directly to the 291-T-1 Stack. The site has a vent riser protruding through the roof of the northwest corner of the sand filter. This is assumed to be the location of the drain. The site is marked and posted as a Contamination Area.
216-T-31 French Drain	216-T-31, 216-T-31 French Drain	West of Camden Avenue, near the southeast corner of the 241-TX Tank Farm, on the east side of 241-TX Tank Farm fence	1954 to 1962	Steam condensate from a steam line blowout during efforts to unplug a waste line.	N/A	N/A	1 m (3 ft) diameter	This drain is a registered underground injection well. The unit was in operation in 1954 and abandoned in 1959 after it was contaminated by steam condensate from a steam line blowout during efforts to unplug a waste line. A new steam line was installed in 1959, and a new steam condensate drain was made to replace the contaminated drain. The french drain was exhumed in 1962. The contaminated culvert, gravel, and soil were removed and buried in the 200 West Area dry burial ground. The site was released from radiation zone status in February 1962. The site is surrounded by a chainlink fence and is posted with surface contamination warning signs.

Table B-5. Summary of Information for the 200-MW-1 Waste Sites Reviewed for this Work Plan. (21 Pages)

Site Code Type	Site Names	Location	Dates of Operation	Source Facility	Contaminant Inventory/Volume Released	Depth	Waste Site Dimensions	General Description
216-A-33 French Drain	216-A-33, 216-A-33 Dry Well, 216-A-26B	Inside the PUREX security fence, south of 202-A, and southwest of the 291-A Stack	1955 to 1964	Bearing coolant waste from the 291-A-1 Stack electrical exhaust fans.	N/A	4 m (13 ft)	4 m x 2 m (13 ft x 7 ft)	A 5-cm (2-in.) inlet pipe enters the site 1.5 m (5 ft) below grade. Project B-295A constructed the 291-AE Building over the area where this drain was located. The inlet piping was capped and the drain was removed from service in 1964 because water was no longer used as a coolant for electrical fans. The site was deactivated by capping the effluent pipeline to the unit on the south side of the 291-A Fan Plenum.
216-C-2 Injection/ Reverse Well	216-C-2, 291-C Dry Well, 216-C-2 Dry Well	Inside the 200-E-41 stabilized area, south of 7th Street in 200 East Area. It is southeast of the former 291-C-1 Stack location, in the Hot Semi-Works area	1953 to 1988	291-C Stack drainage and the seal water drainage from the stack ventilation filters. The volume discharged to the unit is unknown.	N/A	12 m (40 ft)	12 m x 0.3 m (39 ft x 0.9 ft)	The dry well was a 30.5-cm (12-in.)-diameter pipe that extended 0.3 m (1 ft) above grade to 12 m (40 ft) below the surface. The bottom 7.6 m (25 ft) of the pipe was perforated. The drain is surrounded by a concrete collar at grade. A 10-cm (4-in.) stainless steel saran-lined inlet pipe connected the unit to the 291-C-1 Stack. A second inlet line constructed of 5.1-cm (2-in.) stainless steel pipe connected to the 291-C-1 Stack Ventilation Filter. The unit was decommissioned in 1988 and buried along with the 291-C-1 Stack during the demolition activities. The reverse well is no longer visible. It is not separately marked or posted from the surrounding stabilized area (200-E-41) that is posted as Underground Radioactive Material.
216-B-4 Injection/ Reverse Well	216-B-4, 216-B-4 French Drain, 216-B-4 Dry Well, 216-B-4 Reverse Well	South of the 221-B Building, east of the 222-B Building and northeast of the 292-B Building	1945 to 1949	Before August 1947, the site received 291-B Stack drainage. After August 1947, the site received floor drainage from the 292-B Building.	10,000 L[a]	N/A	34 m x 0.2 m (112 ft x 0.7 ft)	The top of the well extends 0.6 m (2 ft) above ground. The site is marked with a single concrete AC-540 marker post, with an Underground Radioactive Material sign attached to the post.

Table B-5. Summary of Information for the 200-MW-1 Waste Sites Reviewed for this Work Plan. (21 Pages)

Site Code Type	Site Names	Location	Dates of Operation	Source Facility	Contaminant Inventory/Volume Released	Depth	Waste Site Dimensions	General Description
Vehicle/Heavy Equipment Facility Decontamination Sources								
216-T-33 Crib **(Rep. Site)**	216-T-33, 216-T-33 Crib	West of 221-T Canyon Building and southwest of 2706-T	1963	Liquid waste from the 2706-T Building.	1,900,000 L with 5.94 kg U; 5.0 g Pu; 0.27 Ci Cs-137; 0.26 Ci Sr-90[a]	3.3 m (10.8 ft) depth to bottom of crib 2 m (6.8 ft) overburden	9 m x 2 m (30 ft x 7 ft)	For a detailed description of this site, see Section 2.2.3 of this work plan.
216-A-32 Crib	216-A-32, 216-A-32 Crib	Northeast of 202-A, inside the PUREX exclusion fence	1959 to 1972	202-A Canyon crane maintenance facility floor, sink, and shower drainage.	4,000 L	4 m (13 ft) depth of crib 2 m (7ft) overburden	21 m x 2 m (69 ft x 7 ft)	The site is constructed of 24 m (77.5 ft) of 15-cm (6-in.) perforated vitrified clay pipe placed horizontally 15 m (5 ft) below grade. Two layers of sisalkraft paper separate the crib gravel from the overlying earthen backfill. The excavation has a side slope of 1H:1.5V, which is filled to 1.5 m (5 ft) depth with 200 m^3 (6,000 ft^3) of gravel fill. The site is currently surrounded with cement posts with Underground Radioactive Material signs. There is an inner area marked with steel posts, chains, and Surface Contamination signs.
Vehicle/Heavy Equipment Field Decontamination Sources								
216-T-11 Trench	216-T-11, Decon. Trenches, Equipment Decon. Area	West of 221-T and southwest of the 216-T-33 Crib	1951 to 1954	Liquid waste disposal of heavy equipment and vehicle decontamination waste.	N/A	2 m (7 ft)	15 m x 3 m (49 ft x 10 ft)	The site consists of a backfilled trench. In 1954, the unit was backfilled, and decontamination operations were transferred to the 269-W Garage facility that discharged to the 216-T-13 Trench. In May 1972, the site was exhumed. All contamination was taken to the 200 West Area Dry Waste Burial Ground. The 216-T-9, 216-T-10, and 216-T-11 Trenches were then released from radiation zone status. This is no longer marked or posted.

Table B-5. Summary of Information for the 200-MW-1 Waste Sites Reviewed for this Work Plan. (21 Pages)

Site Code Type	Site Names	Location	Dates of Operation	Source Facility	Contaminant Inventory/Volume Released	Depth	Waste Site Dimensions	General Description
216-T-13 Trench **(Rep. Site)**	216-T-13, 269-W Regulated Garage, 269-W Decon. Pit or Trench, 216-T-12, 269-W Regulated Garage Decon. Pit	North side of the 241-TY Tank Farm, just outside the perimeter fence	1954 to 1964	Vehicle decontamination wastes from the 269-W Garage.	N/A	3 m (10 ft)	6.1 m x 6.1 m (20 ft x 20 ft)	For a detailed description of this site, see Section 2.2.3 of this work plan.
216-T-9 Trench	216-T-9, Decon. Trenches, Equipment Decon. Area	West of the 221-T Building and southwest of the 216-T-33 Crib	1951 to 1954	Subsurface liquid disposal of vehicle decontamination waste from heavy equipment and other vehicles.	N/A	2 m (7 ft)	15 m x 3 m (49 ft x 10 ft)	In May 1972 the site was exhumed. All contamination was taken to the 200 West Area dry waste burial ground. The 216-T-9, 216-T-10, and 216-T-11 Trenches were then released from radiation zone status. This site consists of a backfilled trench. The site is no longer marked or posted.
216-U-13 Trench	216-U-13, 216-U-13 Cribs, 216-U-13, Vehicle Steam Cleaning Pit	West of the 241-U Tank Farm	1952 to 1956	Drainage from equipment steam cleaning and decontamination activities done inside the trenches.	11,400 L with 0.35 kg U; 0.1 g Pu; 4.4×10^{-2} Ci Cs-137; 4.2×10^{-2} Ci Sr-90[a]	6 m (20 ft)	61 m x 6.1 m (200 ft x 20 ft)	The site consisted of two trenches of equal dimensions. It operated as a decontamination pit where vehicles could be driven down to the decontamination station at the bottom. The pits were used mainly to decontaminate trucks and cranes bearing low levels of radioactive contamination. Several large pumps used in the uranium recovery process were also cleaned here, but the residue was scraped and taken to the 200 West Area burial grounds. The site was deactivated because the decontamination operations were transferred to the 269-W Garage equipment decontamination waste pit (216-T-13). The 216-U-13 Trench was found to be free of surface and subsurface radiological contamination, and the area was released from radiological control in 1982. The two trenches are no longer marked or posted.

Table B-5. Summary of Information for the 200-MW-1 Waste Sites Reviewed for this Work Plan. (21 Pages)

Site Code Type	Site Names	Location	Dates of Operation	Source Facility	Contaminant Inventory/Volume Released	Depth	Waste Site Dimensions	General Description
216-T-10 Trench	216-T-10, Decon. Trenches, Equipment Decon. Area	West of the 221-T Building and southwest of the 216-T-33 Crib	1951 to 1954	Subsurface liquid disposal of heavy equipment and vehicle decontamination waste.	N/A	2 m (7 ft)	15 m x 3 m (49 ft x 10 ft)	In May 1972 the site was exhumed. All contamination was taken to the 200 West Area Dry Waste Burial Ground. The 216-T-9, 216-T-10, and 216-T-11 Trenches were then released from radiation zone status. This site consists of a backfilled trench. The site is no longer marked or posted.
216-S-18 Trench	216-S-18, 241-SX Steam Cleaning Pit, 216-S-14 Steam Cleaning Pit	North of 13th Street, east of 241-S Tank Farms and southwest of the 216-S-9 Crib	1954	Contaminated equipment and contaminated soil from the surrounding area.	98,400 L[a]	2 m (7 ft)	38 m x 4.6 m (125 ft x 16 ft)	The trench was built and retired in October 1954. It was active during the month of October 1954 as a vehicle decontamination pit. The unit is L-shaped, and the surface is composed of sand and gravel and is 1.2 to 1.8 m (4 to 6 ft) below grade. In 1972, the site was backfilled and released from radiation zone status. During the stabilization of UPR-200-W-165 and UPR-200-W-114 in 1995, contamination specks were found in the shallow trench excavation. The area was posted as a radiation area. The source of the contamination is assumed to be contamination specks form the operation of the 241-S Tank Farms. In 1997, a small area of contaminated soil remaining from UPR-200-W-114 was pushed into the 216-S-18 Trench depression. The 216-S-18 Trench area was then covered with clean dirt and posted as an Underground Radioactive Material area.

Table B-5. Summary of Information for the 200-MW-1 Waste Sites Reviewed for this Work Plan. (21 Pages)

Site Code Type	Site Names	Location	Dates of Operation	Source Facility	Contaminant Inventory/Volume Released	Depth	Waste Site Dimensions	General Description
200-E-102 Trench	200-E-102, Contaminated Soil Trench	20.7 m (68 ft) south of the south boundary of 216-A-4 Crib	1958	UPR-200-E-15.	N/A	1 m (3 ft)	24 m x 3 m (79 ft x 10 ft)	The trench was used to bury contaminated soil from an unplanned release (WIDS Site UPR-200-E-15). When the 216-A-4 Crib plugged in 1958, it caused the ground between the 216-A-4 Crib and the 291-A Turbine House to flood. The contaminated soil was scraped up and placed into a slit trench near the south end of the crib. The trench was covered with 0.3 m (1 ft) of clean dirt. The trench is inside the surface stabilized underground radioactive material area south of PUREX that is known as WIDS site code 200-E-103. The trench is not separately marked or posted.
Low-Level Radioactive Process or Steam Condensate Sources								
216-U-3 French Drain **(Rep. Site)**	216-U-3, 216-U-11, 216-U-3 French Drain	South of the 241-U Tank Farm on the south side of 16th Street	1954 to 1955	Condensate from the steam condenser on the 241-U-110 Tank.	791,000 L with 18 kg U; 0.1 g Pu; 0.43 Ci Cs-137; 0.41 Ci Sr-90	3.6 m (11.8 ft)	3.6 x 1.8 m (11.8 x 5.9 ft)	For a detailed description of this site, see Section 2.2.3 of this work plan.
216-U-7 French Drain	216-U-7, 221-U Vessel Vent Blower Pit French Drain	Southeast side of the 221-U Building and of the 241-UX-154 Diversion Box	1952 to 1957	Liquid wastes from a counting box floor drain during the metal recovery program at the 221-U Building.	7,000 L with 1.4 x 10^{-2} kg U	5 m (16 ft)	5 m x 1 m (16 ft x 3 ft)	The drain is constructed of a gravel-filled 76-cm (30-in.)-diameter concrete pipe set vertically into the ground, extending to a depth of 5 m (16 ft). Gravel fills 1.1 m (3.5 ft) of the pipe. The site was retired when the Uranium Recovery operations in the 221-U Building were shut down in 1957. In 1998, the contaminated areas on the east side of the 221-U Building were surface stabilized with material from the 200 Area Ash Pit. The area was reposted to Underground Radioactive Material (see UPR-200-W-138 and UPR-200-W-162).

Table B-5. Summary of Information for the 200-MW-1 Waste Sites Reviewed for this Work Plan. (21 Pages)

Site Code Type	Site Names	Location	Dates of Operation	Source Facility	Contaminant Inventory/Volume Released	Depth	Waste Site Dimensions	General Description
UPR-200-W-138 Unplanned Release	UPR-200-W-138, 221-U Vessel Vent Blower Pit French Drain, UN-216-W-11, UN-200-W-138, UN-200-W-22, UPR-200-W-22	Southeast corner of the 221-U Building, near the R-3 entrance. It is located inside the larger, surface stabilized area, UPR-200-W-162	1953 to 1953	The ground surface may have been contaminated through the 216-U-7 French Drain.	An estimated 140 kg (300 lb) of uranium nitrate hexahydrate solution, containing 14 kg (30 lb) of uranium[b]	N/A	N/A	Uranyl nitrate hexahydrate solution overflowed into the 221-U Building vessel vent blower pit, then onto the ground through the french drain. The site was described as the ground near the R-3 entrance to the 221-U Building. The area has been surface stabilized and posted with Underground Radioactive Material signs. In 1998, the contaminated areas on the east side of 221-U were covered with clean backfill material (see UPR-200-W-162). The area was reposted as Underground Radioactive Material.
Nonradiological Process Steam Condensate Sources with Radionuclide Cross-Contamination								
216-SX-2 Crib	216-SX-2 Crib	East side of Cooper Avenue adjacent to the 241-SX Tank Farm	1952 to 1965	Waste from the 241-SX-701 Compressor House.	N/A	N/A	19 m x 8 m (62 ft x 26 ft)	The site is a gravel-filled crib topped with a subsurface layer of sisalkraft paper. In July 2000, the vent risers were sealed as a preventive measure for potential passive radioactive emissions. It is labeled "216-SX-2" on three sides with old-style black and white signs. The crib is currently surrounded by light post and posted with Underground Radioactive Material signs.
2704-C-WS-1 French Drain	2704-C-WS-1, 2704-C French Drain, Gatehouse French Drain	200 East Area at the southwest corner of the 2704-C Building	1949 to 1998	2704-C Building steam condensate.	N/A	N/A	N/A	The 2704-C Building was originally built in 1949 to support the Hot Semiworks operations. It was a one-story wooden structure, on a cement slab foundation, which was designated a contaminated facility. The 2704-C Building was demolished in 1998. The area where the building stood is covered with gravel and posted with Underground Radioactive Material signs. The drain is no longer visible at the location described.

Table B-5. Summary of Information for the 200-MW-1 Waste Sites Reviewed for this Work Plan. (21 Pages)

Site Code Type	Site Names	Location	Dates of Operation	Source Facility	Contaminant Inventory/Volume Released	Depth	Waste Site Dimensions	General Description
216-Z-13 French Drain	216-Z-13, 234-5 Dry Well #1, 216-Z-13 Dry Well, Misc. Stream 261	Northeast of the 291-Z Stack	1949 to 1999	Steam condensate from the 219-Z Stack ET-8 exhaust fans and building steam condensate.	N/A	3 m (10 ft) overburden 5 m (16 ft) depth of drain	5 m x 1 m (16 ft x 3 ft)	The drain is constructed of two 90-cm (36-in.)-diameter tile culverts placed end to end in a 4.6-m (15-ft)-deep gravel-backfilled excavation. The site is beneath 2.7 m (9 ft) of gravel. Two pipes discharged to the french drain, but the miscellaneous stream (#261) to it has been eliminated. The site is addressed in the *Miscellaneous Streams Best Management Practices (BMP) Report*[c] as a "b" stream (a stream discharging in a surface contamination area). However, in 2001, the area was not posted as a surface contaminated area.
216-Z-14 French Drain	216-Z-14, 234-5 Dry Well #2, 216-Z-14 Dry Well, Misc. Stream #262	Northwest of the 291-Z Stack	1949 to present	Emergency condensate from the ET-9 exhaust fan and building steam condensate.	N/A	3 m (10 ft) overburden 5 m (16 ft) depth of drain	5 m x 1 m (15 ft x 3 ft)	The drain is constructed of two 90-cm (36-in.)-diameter tile culverts placed end-to-end in a 4.6-m (15-ft)-deep gravel-backfilled excavation. The site is beneath 2.7 m (9 ft) of gravel. Two pipes discharge to the french drain. The site is also addressed in the *Miscellaneous Streams Best Management Practices (BMP) Report*[c] as a "b" stream (a stream discharging in a surface contamination area). However, in 2001, the area was not posted a surface contamination area. The drain is marked with a single cement marker post.

Table B-5. Summary of Information for the 200-MW-1 Waste Sites Reviewed for this Work Plan. (21 Pages)

Site Code Type	Site Names	Location	Dates of Operation	Source Facility	Contaminant Inventory/Volume Released	Depth	Waste Site Dimensions	General Description
216-A-11 French Drain	216-A-11 French Drain, Misc. Stream #465	Near the southeast corner of the 202-A Building, south of Trap Pit #1	1956 to 1972	Steam and equipment leakage that drained from the 202-A Building.	100,000 L[a]	9 m (30 ft)	9 m x 1 m (30 ft x 3 ft)	The drain extends 9 m (30 ft) deep into the ground and is 0.8 m (2.6 ft) in diameter. It is constructed of two concrete pipes placed vertically end to end, placed in a 3-m (10-ft)-diameter excavation, which extends 1.5 m (5 ft) below the bottom of the pipe. The unit is composed of two reinforced concrete pipes placed vertically end to end. The site is inside a small area delineated by steel posts and chain. A 0.76-m (2.5-ft)-diameter circular metal cover is visible. One concrete AC-540 marker identifies the site. It is posted as an Underground Radioactive Material area.
216-A-12 French Drain	216-A-12, Misc. Stream #463	Center of the south side of the 202-A Building, approximately 23 m (75 ft) from the building	1955 to 1972	Steam condensate, rain water, and equipment leakage from the 202-A Building went to a sump in the bottom of Pit #3.	100,000 L[a]	6 m (20 ft)	6 m x 1 m (20 ft x 1 ft)	The unit is composed of two reinforced concrete tile pipes placed vertically end to end in a 3-m (10-ft)-diameter excavation extending 1.5 m (5 ft) below the bottom. Both the drain and the excavation are filled with gravel to the top of the unit and backfilled over. The drain has a side slope of 1H:1V. The site is not marked or posted and cannot be visually located.

Table B-5. Summary of Information for the 200-MW-1 Waste Sites Reviewed for this Work Plan. (21 Pages)

Site Code Type	Site Names	Location	Dates of Operation	Source Facility	Contaminant Inventory/Volume Released	Depth	Waste Site Dimensions	General Description
216-A-13 French Drain	216-A-13, 216-A-13 French Drain, Misc. Stream #460	Approximately 6 m (20 ft) west and 6 m (20 ft) south of the southwest corner of the 202-A Building	1956 to 1962	Seal water from the air sampler vacuum pumps in the 202-A Building.	10,000 L[a]	6 m (20 ft)	6 m x 1 m (20 ft x 3 ft)	The drain is constructed of two lengths of 1-m (3-ft)-diameter concrete pipe placed vertically end to end to a depth of 5.5 m (18 ft). The waste management unit is filled to a depth of 1 m (3 ft) with 5- to 8-cm (2- to 3-in.)-diameter gravel. The base of the drain was over-excavated by at least 0.3 m (1 ft) in all directions and was filled with a bed of gravel. The line to this french drain was cut and capped in 1962. The effluent was diverted to the 216-A-35 drain. The site is not marked or posted, and a 1.2-m (45-in.)-diameter metal cover is visible over the drain.
216-A-35 French Drain	216-A-35 French Drain, 216-A-35 Dry Well	Approximately 9 m (30 ft) south of the west end of the 202-A PUREX Building, south of the 216-A-13 French Drain	1963 to 1966	Seal cooling water from the air sampler vacuum pumps in the 202-A Building. The was is low in salt, neutral to basic, and contains less than 1 Ci total beta activity.	10,000 L[a]	5 m (16 ft)	5 m x 2 m (16 ft x 7 ft)	The site has an inlet pipe located 3.2 m (10.5 ft) below grade. This french drain was a replacement for the 216-A-13 French Drain. Disposal to the site was terminated when the effluent flow rate exceeded the infiltration capacity of the soil. The site was deactivated by capping the effluent pipeline to the unit and rerouting the effluent to the 216-A-29 Ditch via the 202-A Chemical Sewer. The drain is a raised cement structure, painted yellow and surrounded with Underground Radioactive Material signs. The top cover is marked Confined Space.

Table B-5. Summary of Information for the 200-MW-1 Waste Sites Reviewed for this Work Plan. (21 Pages)

Site Code Type	Site Names	Location	Dates of Operation	Source Facility	Contaminant Inventory/Volume Released	Depth	Waste Site Dimensions	General Description
216-A-14 French Drain	216-A-14, French Drain - Vacuum Cleaner Filter Pit, Misc. Stream #462	South of the center of the 202-A Building, 5.5 m (18 ft) east of the Filter Pit	1956 to 1972	Steam condensate, stormwater, and equipment leakage from the 202-A Building.	1,000 L[a]	9 m (30 ft)	9 m x 1 m (230 ft x 3 ft)	The unit is composed of two 0.8-m (2.6-ft)-diameter reinforced concrete pipes placed vertically end to end in a 3-m (10-ft)-diameter excavation. The pipes are placed to a depth of 8.8 m (28.8 ft) and the excavation extends below the bottom of the pipe 1.5 m (5 ft). Both the drain and the excavation are filled with 8 cm (3 in.) of gravel to the top. A sump is inside the pit and drains through an underground pipe to the buried french drain. The line to this site was cut and capped in 1962. The effluent was diverted to the 216-A-35 drain. The drain is not marked or posted and has no visible surface features.
216-A-26 French Drain	216-A-26, 216-A-26 French Drain, 216-A-26B, Misc. Stream #464	Inside the PUREX security fence, south of the 291-A Control House and approximately 4.57 m (15 ft) south of 216-A-26A French Drain	1965 to 1991	Effluent from floor drains inside the 291-A Fan House.	N/A	5 m (16 ft)	5 m x 1 m (16 ft x 3.ft)	This drain is constructed of three 1.5- x 1.2-m (5- x 4-ft)-diameter clay pipes placed end to end and filled with gravel. It was installed to replace the 216-A-26A French Drain. The drain is accessed by a subsurface feeder pipe. 216-A-26 was removed from service in 1991. There are no visible surface features for this drain.
216-A-26A French Drain	216-A-26A, 216-A-25 Crib, 216-A-26 French Drain, 291-A French Drain	Inside the PUREX security fence, south of the 291-A Building	1959 to 1965	Floor drainage from the 291-A Fan Control Room.	1,000 L[a]	5 m (16 ft)	5 m x 1 m (16 ft x 3 ft)	The construction design of this waste management unit is identical to the 216-A-26 French Drain except that the diameter is smaller. In 1965, the site was deactivated by removing the encasement and rerouting the effluent piping to the new 216-A-26 French Drain encasement, located 4.6 m (15 ft) south. There are no surface features for this drain.

Table B-5. Summary of Information for the 200-MW-1 Waste Sites Reviewed for this Work Plan. (21 Pages)

Site Code Type	Site Names	Location	Dates of Operation	Source Facility	Contaminant Inventory/Volume Released	Depth	Waste Site Dimensions	General Description
200-E-25 French Drain	200-E-25, 272-BB French Drain, Insulation Shop French Drain, Misc. Stream #659	Approximately 6 m (20 ft) north of the northeast corner of the 272-BB Insulation Shop	1971 to 1991	Possibly material used in the 272-BB Insulation Shop.	Calcium silicate, fiberglass, silicate. Prior to 1988, it is possible that organic chemicals, oils, and grease may have been introduced into the french drain.[b]	N/A	3 m x 0.6 m (10 ft x 2 ft)	The building sink and floor drain were connected to the site via a 5.1-cm (2-in.) schedule 40 carbon steel pipe. A 0.4-m (1.5-ft)-diameter grease trap with a removable cover is located on the east side of the 272-BB Building. The floor drain inside the building has been permanently plugged and the sink has been removed. The drain's structure is not visible from the surface. However, the location is marked with an old sign, mounted on two support posts. The sign says "Asbestos Waste Disposal Site - Do Not Excavate."
200-E-4 French Drain **(Rep. Site)**	200-E-4, Critical Mass Laboratory Dry Well North, 209-E North Dry Well, Misc. Stream #730	Approximately 7.6 m (25 ft) north of the northeast corner of the 209-E Critical Mass Laboratory Service Building	1958 to 1959	209-E Critical Mass Laboratory via underground piping.	N/A	N/A	1.2 m (4 ft)	For a detailed description of this site, see Section 2.2.3 of this work plan.

Table B-5. Summary of Information for the 200-MW-1 Waste Sites Reviewed for this Work Plan. (21 Pages)

Site Code Type	Site Names	Location	Dates of Operation	Source Facility	Contaminant Inventory/Volume Released	Depth	Waste Site Dimensions	General Description
216-Z-15 French Drain	216-Z-15, 234-5 Dry Well #3, 216-Z-15 Dry Well, Misc. Stream #263	Adjacent to the southeast corner of the 2731-Z Building and north of the 291-Z Ventilation Building	1949 to 1997	Condensate from the S-12 Evaporator Cooler.	N/A	5 m (16 ft) overburden 7 m (23 ft) depth of drain	7 m x 1 m (23 ft x 3 ft)	Drain consists of two 90-cm (36-in.)-diameter tile culverts stacked on end in a 4.9-m (16-ft)-deep gravel-backfilled excavation. The unit is composed of two sections of vitrified clay pipe in a vertical configuration. There is one inlet pipe. The pipe is filled with cobbles and the upper end is covered with a wood plank. The site is also addressed in the *Miscellaneous Streams Best Management Practices (BMP) Report*[c] as a "b" stream (a stream discharging in a surface contamination area). The 216-Z French Drain has been inactive and its discharge source has been eliminated, since May 1997. The site is marked with a single concrete marker post that reads "Buried Radioactivity - Do Not Excavate."
209-E-WS-2 French Drain	209-E-WS-2, Critical Mass Laboratory French Drain	Southeast corner of the Critical Mass Laboratory (laboratory wing)	N/A	Condensate from the Critical Mass Laboratory HEPA filters and heat exchange system.	N/A	N/A	1 m (3 ft)	The drain is a 1.2-m (4-ft)-diameter drain in a gravel area southeast of the building. The site is associated with the 209-E Critical Mass Laboratory. It is painted with yellow paint and has a metal cover.

Table B-5. Summary of Information for the 200-MW-1 Waste Sites Reviewed for this Work Plan. (21 Pages)

Site Code Type	Site Names	Location	Dates of Operation	Source Facility	Contaminant Inventory/Volume Released	Depth	Waste Site Dimensions	General Description
299-E24-111 Injection/ Reverse Well	299-E24-111, Experimental Test Well Site, Misc. Stream 803	Southwest of the PUREX facility and west of the 216-A-38-1 Crib	1980 to 2000	Radiological tracers of Sr-85 and Cs-134 were delivered for weekly injections and PNNL injected a potassium bromide tracer.	41,580 L with calcium chloride; calcium nitrate; Cs-134 (T½ =2.05 years); and Sr-85 (T½ = 64.85 days).[b]	N/A	20 m x 0.2 m (66 ft x 0.7 ft)	The site is an injection well surrounded by 32 observation wells. It was installed as an experimental test site, constructed to obtain information about radionuclide movement in soil for data modeling and migration forecasting. Sr-85 and Cs-134 were used as radioactive tracers. The original test start date was September 22, 1980, ending on February 2, 1981. PNNL scheduled an additional injection experiment at this site in 2000 that added another injection well near the center of the cluster; injected a potassium bromide tracer; and collected soil cores. The 299-E24-111 injection well head is located inside a small posted Underground Radioactive Material area. A small soil contamination area is located southwest of the well.
216-Z-21 Pond	216-Z-21, 216-Z-21 Seepage Basin, PFP Cold Waste Pond	East of the 234-5 complex (outside the Z Plant security fence) and southeast of the 216-Z-9 Trench	1980 to 1995	Effluent from various sources within Z Plant, including high tank overflow, storm drain runoff, ventilation steam condensate, dry air compressor cooling water, and ventilation air wash spray pans.	N/A	N/A	42 m x 42 m (138 ft x 138 ft)	The site is a large, soil-bermed depression constructed to receive Z Plant noncontact condensate and stormwater runoff. The site is an unlined seepage basin known as the 207-Z Basin. The name created confusion with the 207-Z Retention Basin (located inside the Z Plant security fence). For this reason, the name was officially changed to 216-Z-21 in June 1987. The basin is currently dry and is not radiologically posted.

Table B-5. Summary of Information for the 200-MW-1 Waste Sites Reviewed for this Work Plan. (21 Pages)

Site Code Type	Site Names	Location	Dates of Operation	Source Facility	Contaminant Inventory/Volume Released	Depth	Waste Site Dimensions	General Description
216-A-38-1 Crib	216-A-38-1, 216-A-38 Crib	Southwest of 202-A Building north of 1st Street. It is located south of the PUREX security fence	Never activated	Intended to receive the 202-A process condensate waste discharged to the 216-A-10 Crib (never used).	N/A	11 m (36 ft) depth 10 m (33 ft) overburden	159 m x 5 m (522 ft x 16 ft)	The site contains a 15-cm (6-in.)-perforated steel pipe narrowing to 10 cm (4 in.) placed horizontally 10 cm (33 ft) below grade. The unit also has a 20-cm (8-in.)-diameter inlet pipe, two 8-cm (3-in.) vent risers and filters, two 20-cm (8-in.) gage wells, a membrane barrier, and a 20-cm (8-in.) bypass line paralleling the distribution line in the southern half of the unit. Ancillary equipment include a proportional sampling pit and the 216-A-5 Neutralization Tank. The crib was built to replace the 216-A-10 Crib, but had not been activated when plans for modifying the PUREX head end process were begun. The planned building addition would have been constructed immediately adjacent to the crib. For this reason, the crib was never activated. The crib was posted as an Underground Radioactive Material area in 1980 because underground piping had been installed that connected the crib to the PUREX process. No surface contamination has ever been identified during routine surveillance, and no stabilization activities occurred at this crib. The site is surrounded by light posts and a chain.
200-E-67 Injection/ Reverse Well	200-E-67, 202A Building Steam Condensate, Misc. Stream #494	Adjacent to the south wall of 202-A	1996	N/A	N/A	N/A	N/A	The drain is located inside a dome-shaped caisson. The dome-shaped caisson is surrounded by post and chain and posted with Contamination Area signs. The dome is labeled 202-A-417.

Table B-5. Summary of Information for the 200-MW-1 Waste Sites Reviewed for this Work Plan. (21 Pages)

Site Code Type	Site Names	Location	Dates of Operation	Source Facility	Contaminant Inventory/Volume Released	Depth	Waste Site Dimensions	General Description
Recommended to be Moved to Other OUs								
UPR-200-E-17 Unplanned Release	UPR-200-E-17, Overflow at 216-A-22, UN-200-E-17	North of PUREX, north of the 203-A facility, near the 216-A-28 French Drain	1958	Failed 216-A-22 Crib inlet.	N/A	N/A	N/A	This site is recommended to be moved to the 200-PW-2 Operable Unit.
216-A-22 Crib	216-A-22, 216-A-22 French Drain, 216-A-22 Crib	Along the north wall of the 203-A Building, north of PUREX	1955 to 1958	The site received the drainage from the 203-A Building truck loadout apron, and the sump waste from the 203-A Building.	10,000 L[a]	3 m (10 ft) depth 2 m (7 ft) overburden	3 m x 5 m (10 ft x 16 ft)	This site is recommended to be moved to the 200-PW-2 Operable Unit.
200-E-122 Storage	200-E-122, Construction Forces Bullpen, CF Bullpen, Equipment Storage Yard	South of B Plant and south of 222-B	N/A	Radioactive contaminated material is stored inside the fenced area.	N/A	N/A	44 m x 20 m (144 ft x 66 ft)	This site is recommended to be moved to the 200-SW-1 Operable Unit.
600-268 Storage Pad (<90 day)	600-268, 200 East Pipe Yard Drum Accumulation Area, Pipe Laydown Yard Accumulation Area	Inside the 200 East Pipe Laydown Area, north of the 200 East Area 810 gate	1995 to 1998	Seventeen drums of mixed and radioactive waste from 200 West Area well drilling activities.	N/A	N/A	15 m x 15 m (49 ft x 49 ft)	This site is recommended to be moved to the 200-SW-2 Operable Unit.
200-W-89 Foundation	200-W-89, 252-U, U Plant Electrical Substation, C8S17 Substation, U-Cat Substation	Near the intersection of Beloit and 16th Street in 200 West Area, east of the 224-U Building	N/A	The site provided electric utility support to the 221-U and 224-U facilities.	N/A	N/A	30 m x 30 m (100 ft x 100 ft)	This site is recommended to be moved to the 200-UR-1 Operable Unit.
600-260 Unplanned Release	600-260, Roped Off Area Near Meteorological Tower	The area between 200 East and 200 West, north of Route 3	N/A	N/A	N/A	N/A	7 m x 6 m (23 ft x 20 ft)	This site is recommended to be moved to the 200-UR-1 Operable Unit.

Table B-5. Summary of Information for the 200-MW-1 Waste Sites Reviewed for this Work Plan. (21 Pages)

Site Code Type	Site Names	Location	Dates of Operation	Source Facility	Contaminant Inventory/Volume Released	Depth	Waste Site Dimensions	General Description
600-275 Foundation	600-275, 218-W-14, Igloo Site, Army Ammo Site, Regulated Storage Area	Approximately 1 mile west of the 200 West Area, south of Route 11A	N/A	The seven army igloos were originally used for ammunition storage. Later, plutonium scrap waste was stored in the igloos.	N/A	N/A	N/A	This site is recommended to be moved to the 200-UR-1 Operable Unit.
200-W-64 Foundation	200-W-64, 2724-W Contaminated Laundry Facility Building Foundation	200 West Area, at the corner of Beloit Avenue and 20th Street	1950 to 1994	The 2724-W Building housed the contaminated laundry facility.	N/A	N/A	42 m x 32 m (138 ft x 105 ft)	This site is recommended to be moved to the 200-UR-1 Operable Unit.
200-W-17 Unplanned Release	200-W-17, S-Plant Project W-087 Aluminum Silicate Discovery	200 West Area, southwest of REDOX	N/A	The source of the aluminum silicate at the site is likely the 200-W-1 Mud Pit.	The waste associated with this site was aluminum silicate.	1 m (3 ft)	1 m x 1 m (3 ft x 3 ft)	This site is recommended to be moved to the 200-SW-1 Operable Unit.
200-W-18 Unplanned Release	200-W-18, S-Plant Project W-087 Aluminum Oxide Discovery	N/A		The source of the aluminum oxide at this site is likely the 200-W-1 Mud Pit.	The analysis showed the material to be aluminum oxide and calcium.	0.1 m (0.3 ft)	3 m x 0.1 m (10 ft x 0.3)	This site is recommended to be moved to the 200-SW-1 Operable Unit.
200-W-86 Unplanned Release	200-W-86, Contamination Area Around Power Pole	The site is located northwest of 221-U, on a gravel road known as Bridgeport Avenue	N/A	The DynCorp Integrated Soil, Vegetation, and Animal Control group submitted this site to WIDS as a Discovery Site.	N/A	N/A	4 m x 4 m (13 ft x 13 ft)	This site is recommended to be moved to the 200-UR-1 Operable Unit.
200-W-75 Silo	200-W-75, Radiological Logging System (RLS) Calibration Silos	West of the 202-S Building, south of the 276-S Building, and north of the 211-S tanks	N/A	In the late 1970s, test well mockups were used to calibrate "in-well" radionuclide detectors.	Radioactive sources consisting of known quantities of Co-60, Sr-90, Ru-106, and Ce-144 in sealed capsules.	N/A	2 m x 1 m (7 ft x 3 ft)	This site is recommended to be moved to the 200-SW-2 Operable Unit.
200-W-80 Spoils Pile/Berm	200-W-80; Mound of Contaminated Soil Southwest of T Plant	West of 221-T and northeast of the 241-T-361 settling tank	N/A	It is possible that the mound was created during a parking lot expansion at T Plant that occurred several years ago.	N/A	N/A	16 m x 14 m (42 ft x 45 ft)	This site is recommended to be moved to the 200-UR-1 Operable Unit.

Table B-5. Summary of Information for the 200-MW-1 Waste Sites Reviewed for this Work Plan. (21 Pages)

Site Code Type	Site Names	Location	Dates of Operation	Source Facility	Contaminant Inventory/Volume Released	Depth	Waste Site Dimensions	General Description
200-E-85 Injection/ Reverse Well	200-E-85, 202A Building Pump Seal Water, Miscellaneous Stream #459	Adjacent to the north wall of the 2712-A Building, south of 202A	N/A	Pump seal water.	N/A	N/A	N/A	This sit is recommended to be moved to the 216/218 Injection/Reverse Well regulatory authority category.
200-E-101 Depression/ Pit (nonspecific)	200-E-101, 200 East Deep Lysimeter Site	Southeast of the 200 East Area, within the BC Radiologically Controlled Area	N/A	N/A	Short-lived radioisotopes may have been injected as tracers in early experiments.	N/A	18 m x 3 m (59 ft x 10 ft)	The site is recommended to be moved to the 200-UR-1 Operable Unit.
600-262 Crib	600-262, West Lake Test Crib	East of Route 4 North, southwest of West Lake	1959 to 1962	N/A	95,760 L, calcium nitrate, Sr-85[c]	0.6 m (2 ft)	0.6 m x 0.6 m (2 ft x 2 ft)	The site is recommended to be moved to the 200-UR-1 Operable Unit.
600-37 French Drain	600-37, Brown's Wells, Johnson's Wells	Southeast of the 200 West Area at the southern boundary	N/A	Assumed to be raw water. However, sampling testing should be conducted in the unit.	N/A	N/A	3 m x 2 m (10 ft x 7 ft)	The site is recommended to be moved to the 200-UR-1 Operable Unit.

[a]DOE-RL, 1997, *Waste Site Grouping for 200 Areas Soil Investigations*, DOE/RL-96-81, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
[b]WIDS
[c]DOE-RL, 1996, *Miscellaneous Streams Best Management Practices (BMP) Report*, DOE/RL-96-40, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
N/A = not available

Table B-6. 200-MW-1 Site Removal Rationale. (2 Pages)

Site Code	New Operable Unit	Rationale
216-A-22 Crib	200-PW-2	This site operated during the time PUREX was in a production mode. The drainage from the 203-A Building to the site was redirected to the 216-A-28 French Drain in December 1958. 216-A-28 is justifiably in the 200-PW-2 Uranium-Rich Process Condensate/Process Waste Group. Based on the description of the units, their identical sources, and the fact that they both operated during the time PUREX was in a production mode, they clearly should be approached the same from an expected remedy and therefore should be in the same OU.
UPR-200-E-17 Unplanned Release	200-PW-2	Sufficient splashing occurred when the 216-A-22 Crib inlet failed, causing the ground on top of the crib to become yellow with uranium. Since the 216-A-22 Crib is being moved to 200-PW-2, it is also accurate to move the associated UPR.
200-E-122 Storage	200-SW-1	This site is a construction laydown yard. Therefore, the Non-Rad Landfills and Dumps OU is the most logical for this site. The postings refer to potential due to contaminated material wrapped and stored there and not a release to the soil.
600-268 Storage Pad (<90 day)	200-SW-2	This site belongs in the Rad Landfills and Dumps Waste OU.
200-W-89 Foundation	200-UR-1	This site should be in an Unplanned Release OU instead of the 200-MW-1 OU.
600-260 Unplanned Release	200-UR-1	This site is a roped off area near a meteorological tower. It should be in an Unplanned Release OU instead of the 200-MW-1 OU.
600-275 Foundation	200-UR-1	This regulated storage area should be in an Unplanned Release OU instead of the 200-MW-1 OU.
200-W-64 Foundation	200-UR-1	This site should be in an Unplanned Release OU instead of the 200-MW-1 OU.
200-W-17 Unplanned Release	200-SW-1	This site should be included in the 200-SW-1 OU instead of the 200-MW-1 OU because the waste associated with this site was aluminum silicate, probably from drilling mud from 200-W-1.
200-W-18 Unplanned Release	200-SW-1	This site should be included in the 200-SW-1 OU instead of the 200-MW-1 OU because the waste associated with this site was aluminum silicate, probably from drilling mud from 200-W-1.
200-W-86 Unplanned Release	200-UR-1	This site is a small, graveled soil contamination area around an active (in use) power pole, near the intersection of the U Plant railroad scour and Bridgeport Avenue. This site should be in an Unplanned Release OU rather than the 200-MW-1 OU.
200-W-75 Silo	200-SW-2	This site should be included in 200-SW-1 since it consists of four calibration silos that contain radioactive sources. The four underground Radiological Logging System equipment calibration silos are located west of the 202-S building, south of the 276-S building and north of the 211-S tanks. One calibration silo is located west of the 211-S tanks, across an asphalt access road. The calibration mockups were constructed of a steel container approximately 2.4 m (8 ft) deep filled with soil. Tubes containing radioactive sources were inserted into the soil at distances of 2.5, 7.6, 15, 30, 46, and 61 cm from the well casing that was located in the center of the mockup. The mockup silo was buried so that a Radiological Logging System vehicle could drive up to the calibration silo and drop its logging probe into the center well casing.
200-W-80 Spoils Pile/Berm	200-UR-1	This site is a mound of contaminated soil southwest of T Plant. It should be included in an Unplanned Release OU instead of the 200-MW-1 OU, because the debris associated with this site appears to be from parking lot work rather than liquid waste site disposal.

Table B-6. 200-MW-1 Site Removal Rationale. (2 Pages)

Site Code	New Operable Unit	Rationale
200-E-85 Injection/Reverse Well	216/218 Regulatory Authority	This site received only condensate and should be included with 216/218 Regulatory Authority sites.
200-E-101 Depression/Pit (nonspecific)	200-UR-1	This site was a field lysimeter used to measure natural precipitation infiltration. While short-lived radionuclides may have been used as part of a test, it was not a liquid waste disposal site. It should be moved to the 200-UR-1 OU.
600-262 Crib	200-UR-1	This site was a test crib injected with short-lived radionuclides to determine soil capacity. Because it is not a liquid waste discharge site, it should be included in the 200-UR-1 OU.
600-37 French Drain	200-UR-1	This site was not a liquid waste discharge site and should be included in the 200-UR-1 OU.

Table B-7. 200-MW-1 Operable Unit Subgroup Sites.

Process Facility Ventilation Stack and Sand Filter Sources	Vehicle/Heavy Equipment Facility Decontamination Sources	Vehicle/Heavy Equipment Field Decontamination Sources	Low-Level Radioactive Process or Steam Condensate Sources	Nonradiological Process Steam Condensate Sources with Radionuclide Cross-Contamination Sources
216-A-4[a] Crib	216-T-33[b] Crib	216-T-11 Trench	216-U-3[d] French Drain	200-E-4[e] French Drain (Critical Mass Laboratory)
216-A-41 Crib	216-A-32 Crib	216-T-13[c] Trench	216-U-7 French Drain	200-E-25 French Drain (272 insulation shop)
216-A-21 Crib		216-T-9 Trench	UPR-200-W-138	216-SX-2 French Drain
216-A-27 Crib		216-U-13 Trench		2704-C-WS-1 French Drain (semi-works gate house)
216-S-12 Trench		216-T-10 Trench		216-Z-13 French Drain (ET-8 exhaust fan)
216-B-13 French Drain (stack drainage)		216-S-18 Trench		216-Z-14 French Drain (ET-9 exhaust fan)
200-E-55 French Drain (291-B sand filter)		200-E-102 Trench		216-A-11 French Drain (202-A steam trap pit #1)
216-T-29 French Drain (sand filter)				216-A-12 French Drain (202-A steam trap pit #3)
216-T-31 French Drain (241-TX farm steam condensate contaminated by line cleanout)				216-A-13 & 216-A-35 (seal water air sampler vacuum pumps) French Drains
216-A-33 French Drain				216-A-14 French Drain (vacuum cleaner filter/blower pit)
216-C-2 Injection/Reverse Well				216-A-26 & 216-A-26A (floor drainage 291-A fan control house) French Drains
216-B-4 Injection/Reverse Well				216-Z-15 French Drain (S12 evaporative cooler)
				209-E-WS-2 French Drain (Critical Mass Laboratory)
				299-E24-111 Injection/Reverse Well
				216-Z-21 Pond
				216-A-38 Crib
				200-E-67 Injection/Reverse Well

[a]216-A-4 is the representative site of the Process Facility Ventilation Stack and Sand Filter Sources subgroup for this OU. (Also recommended by the Implementation Plan [DOE-RL 1999].)
[b]216-T-33 is the representative site of the Vehicle/Heavy Equipment Facility Decontamination subgroup for this OU. (Also recommended by the Implementation Plan [DOE-RL 1999].)
[c]216-T-13 is the representative site of the Vehicle/Heavy Equipment Field Decontamination subgroup for this OU.
[d]216-U-3 is the representative site of the Low Level Radioactive Process or Steam Condensate Sources subgroup for this OU. (Also recommended by the Implementation Plan [DOE-RL 1999].)
[e]200-E-4 is the representative site of the Non Rad Process Steam Condensate with Rad from Cross Contamination from other Sources subgroup for this OU.

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