0074121

Department of Energy
Richland Operations Office
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OCT 10 2007

08-AMCP-0006

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EDMC

Addressees:

REMEDIAL DESIGN/REMEDIAL ACTION WORK PLAN FOR THE 221-U FACILITY, DOE/RL-2006-21, DRAFT B

The purpose of this letter is to respond to the September 6, 2007, request for an updated work plan from the U.S. Department of Energy, Richland Operations Office (RL).

As required by Hanford Federal Facility Agreement and Consent Order Action Plan, Figure 9-1, "Review and Comment Period on Primary Documents," the Remedial Design/Remedial Action Work Plan (RD/RAWP) for the 221-U Facility, DOE/RL-2006-21, Draft B is being forwarded to the U.S. Environmental Protection Agency and the State of Washington, Department of Ecology for review and approval.

Due to time constraints and information discussed at recent meetings, this RD/RAWP does not yet address the previous comments concerning applicable or relevant and appropriate requirements. Specifically, RL is changing Table 2-1 to reflect that items 1 and 3 are applicable or relevant and appropriate in case of a spill during remediation in accordance with this work plan. In addition, appropriate clean-up levels for a spill will be provided. RL agrees to provide a revised work plan to reflect this by October 31, 2007.

If you have any questions, please contact me, or your staff may contact Matthew McCormick, Assistant Manager for the Central Plateau, on (509) 373-9971.

Sincerely,

Doug S. Shoop for

David A. Brockman
Manager

AMCP:WCW

Attachment

cc w/attach:
G. Bohnee, NPT
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Administrative Record 200-UP-1
Environmental Portal

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DOE/RL-2006-21
DRAFT B

Remedial Design/Remedial Action Work Plan for the 221-U Facility

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

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

Approved for Public Release;
Further Dissemination Unlimited

DOE/RL-2006-21
DRAFT B

Remedial Design/Remedial Action Work Plan for the 221-U Facility

Date Published
September 2007

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

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

J. D. Aardal 09/18/2007
Release Approval Date

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CONTENTS

FIGURES

TABLES

TERMS

ALARA	as low as reasonably achievable
ARAR	applicable or relevant and appropriate requirement
bgs	below ground surface
CDI	Canyon Disposition Initiative
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (also known as Superfund)
CFR	*Code of Federal Regulations*
CPP	CERCLA past-practice
CWC	Central Waste Complex
D&D	Decontamination and Demolition
DOE	U.S. Department of Energy
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
ET	evapotranspiration
HEPA	high-efficiency particulate air
MEI	maximally exposed individual
MTCA	Model Toxics Control Act Cleanup Regulation
O&M	operations and maintenance
PCB	polychlorinated biphenyl
PRG	preliminary remediation goal
QA	Quality Assurance
RAO	remedial action objective
RAG	remedial action goal
RC	remediation contractor
RCW	*Revised Code of Washington*
RCRA	*Resource Conservation and Recovery Act of 1976*
RD/RAWP	Remedial Design/Remedial Action Work Plan
RH-TRU	remote-handled transuranic (waste)
RMA	radiological materials area
ROD	record of decision
RPP	RCRA past practice
SAP	sampling and analysis plan
TEDE	total effective dose equivalent
Tri-Parties	U.S. Department of Energy, U.S. Environmental Protection Agency, and Washington State Department of Ecology
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
U Plant	221-U Facility
WAC	*Washington Administrative Code*
WIPP	Waste Isolation Pilot Plant

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	25.40	millimeters	millimeters	0.03937	inches
inches	2.54	centimeters	centimeters	0.393701	inches
feet	0.3048	meters	meters	3.28084	feet
yards	0.9144	meters	meters	1.0936	yards
miles (statute)	1.60934	kilometers	kilometers	0.62137	miles (statute)
Area			**Area**		
square inches	6.4516	square centimeters	square centimeters	0.155	square inches
square feet	0.09290304	square meters	square meters	10.7639	square feet
square yards	0.8361274	square meters	square meters	1.19599	square yards
square miles	2.59	square kilometers	square kilometers	0.386102	square miles
acres	0.404687	hectares	hectares	2.47104	acres
Mass (weight)			**Mass (weight)**		
ounces (avoir)	28.34952	grams	grams	0.035274	ounces (avoir)
pounds	0.45359237	kilograms	kilograms	2.204623	pounds (avoir)
tons (short)	0.9071847	tons (metric)	tons (metric)	1.1023	tons (short)
Volume			**Volume**		
ounces (U.S., liquid)	29.57353	milliliters	milliliters	0.033814	ounces (U.S., liquid)
quarts (U.S., liquid)	0.9463529	liters	liters	1.0567	quarts (U.S., liquid)
gallons (U.S., liquid)	3.7854	liters	liters	0.26417	gallons (U.S., liquid)
cubic feet	0.02831685	cubic meters	cubic meters	35.3147	cubic feet
cubic yards	0.7645549	cubic meters	cubic meters	1.308	cubic yards
Temperature			**Temperature**		
Fahrenheit	subtract 32 then multiply by 5/9ths	Celsius	Celsius	multiply by 9/5ths, then add 32	Fahrenheit
Energy			**Energy**		
kilowatt hour	3,412	British thermal unit	British thermal unit	0.000293	kilowatt hour
kilowatt	0.94782	British thermal unit per second	British thermal unit per second	1.055	kilowatt
Force/Pressure			**Force/Pressure**		
pounds (force) per square inch	6.894757	kilopascals	kilopascals	0.14504	pounds per square inch

Source: *Engineering Unit Conversions*, M. R. Lindeburg, PE., Third Ed., 1993, Professional Publications, Inc., Belmont, California.

REMEDIAL DESIGN/REMEDIAL ACTION WORK PLAN FOR THE 221-U FACILITY

1.0 INTRODUCTION

The U.S. Department of Energy (DOE) Hanford Site is a 1,517-km^2 (586-mi^2) Federal Facility located in southeastern Washington along the Columbia River (Figure 1-1). The Hanford Site is situated north and west of the cities of Richland, Kennewick, and Pasco, an area commonly known as the Tri-Cities. The region includes the incorporated cities of Richland, Pasco, and Kennewick, as well as surrounding communities in Benton, Franklin, and Grant counties. The Hanford Site was established during World War II, as part of the Manhattan Project, to produce plutonium for nuclear weapons. From 1943 to 1990, the primary mission of the Hanford Site was the production of nuclear materials for national defense.

The 200 West Area is a DOE-controlled area of approximately 8.3 km^2 (3.2 mi^2) near the middle of the Hanford Site (Figure 1-1). The 200 West Area is about 8 km (5 mi) from the Columbia River and 11 km (6.8 mi) from the nearest Hanford Site boundary. The area contains waste management facilities and former irradiated-fuel reprocessing facilities. The 200 West Area is located on an elevated, flat area, often referred to as the Central Plateau. There are no wetlands or floodplains in the 200 West Area.

The U Plant Area occupies approximately 0.76 km^2 (0.3 mi^2) within the 200 West Area. The U Plant Area includes the 221-U Facility, ancillary (or support) structures adjacent to the 221-U Facility, underground pipelines, soil waste sites, and the groundwater underlying the area (Figure 1-2). The groundwater beneath the U Plant Area has elevated levels of nitrates, technetium-99, and uranium due to past liquid discharges from the U Plant Area facilities and other 200 Area facilities. Monitoring and remediation of groundwater located under the U Plant Area are being addressed by the *Record of Decision for the 200-UP-1 Interim Remedial Measure*, EPA/541/R-97/048 (EPA 1997). The U Plant is referred to synonymously as the 221-U Facility Complex, or simply the 221-U Facility in many Hanford site documents.

The 221-U Building is a large, concrete structure nominally 247 m (810 ft) long, 20 m (66 ft) wide and 24 m (77 ft) high; approximately 9 m (30 ft) of this height is below grade. The concrete walls and floor range from approximately 0.9 m to 2.7 m (3 ft to 9 ft) thick. One large room extends the entire length with galleries on the other side of a dividing wall from this room. Covered processing cells reside below the deck in the large room. Because the building has this long, expansive room, it often is referred to as a "canyon building." Figure 1-3 is a cross-sectional sketch of the building.

1.1 PURPOSE

The *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1989) identifies the U Plant (a synonym for the 221-U Facility complex) as a Section 8.0 key facility. Section 8.0 describes the decommissioning process that must be undertaken for key facilities. During the disposition phase of decommissioning, a project design report is prepared for remedial design/remedial action activities. The project design report defines the project scope, schedule, and cost and provides descriptions of specific tasks required to reach the facility end state. The intent of the report is to identify the basis and provide direction for preparation of detailed work packages or procedures used for conducting the project tasks. Project design reports are not identified in the Tri-Party Agreement as primary documents; however, Section 8.7.3 of the Tri-Party Agreement states that the lead regulatory agency will have approval authority in part over the project design report to ensure consistency with the final decision document.

Although U Plant is subject to these Section 8.0 requirements, the record of decision (ROD) for the 221-U Facility (*Record of Decision for the 221-U Facility (Canyon Disposition Initiative), Hanford Site, Washington* [EPA 2005]) contains a requirement that a remedial design/remedial action work plan (RD/RAWP) be developed for the facility. As noted in the ROD, the RD/RAWP is a primary document under the Tri-Party Agreement subject to U.S. Environmental Protection Agency (EPA) and Washington State Department of Ecology (Ecology) approval.

This RD/RAWP meets the intent of both the 221-U Facility ROD requirement for development of an RD/RAWP and the Tri-Party Agreement Section 8.0 requirement for the development of a project design report. Additionally, this RD/RAWP meets the requirements of Tri-Party Agreement Section 7.0 for preparation of an RD/RAWP.

This RD/RAWP describes the design and implementation of the remedial action process for remediation of the 221-U Facility pursuant to the ROD. The remedial design element of this document discusses the engineering phase during which technical drawings, specifications, and necessary supporting documents are developed to meet the remedial action objectives (RAO) identified in the ROD (EPA 2005). The remedial action element of this document addresses the construction or field implementation process (e.g., partial demolition of the structure, and engineered barrier construction).

Figure 1-1. 200 East and 200 West Areas of the Hanford Site.

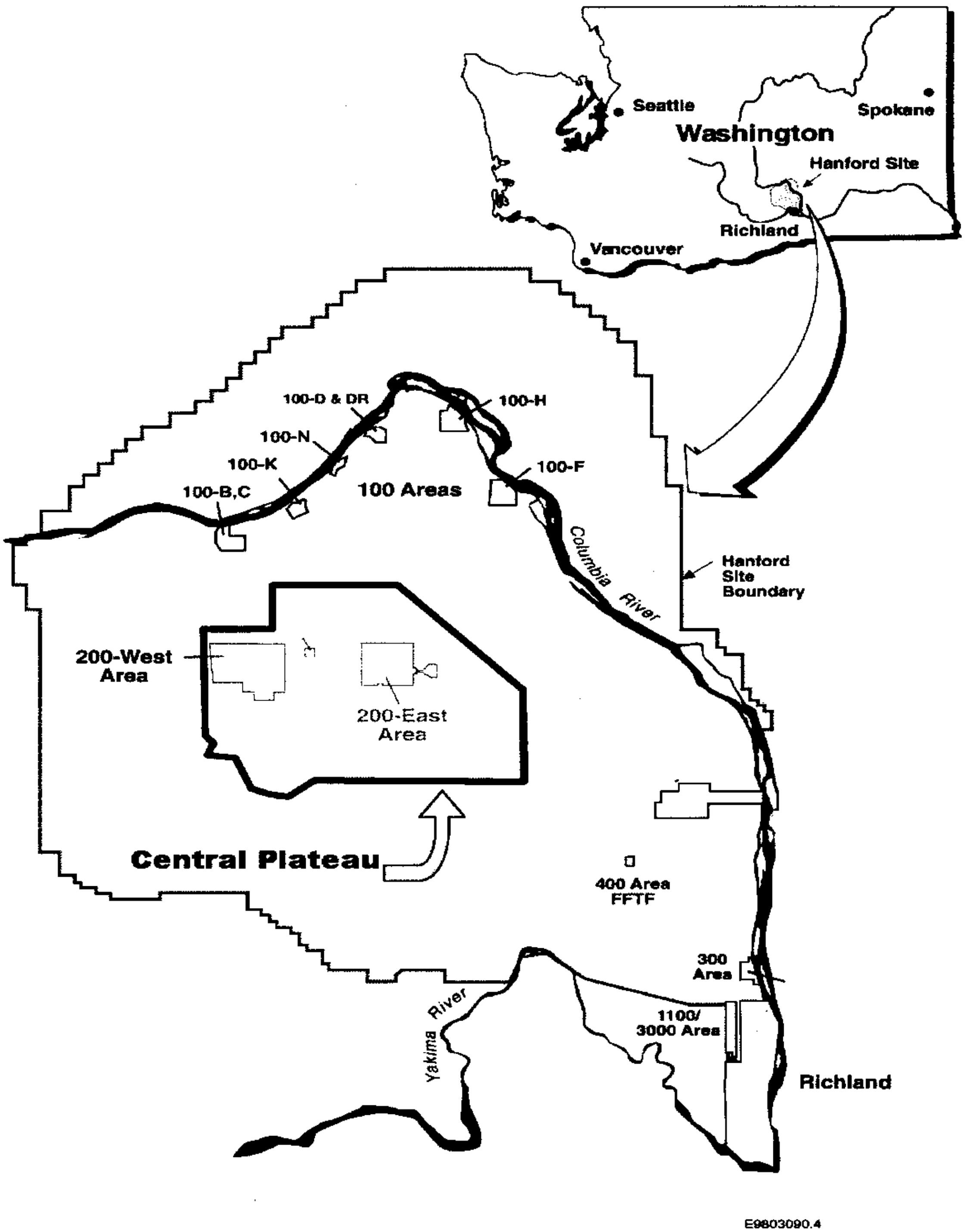


Figure 1-2. U Plant Cleanup Area.

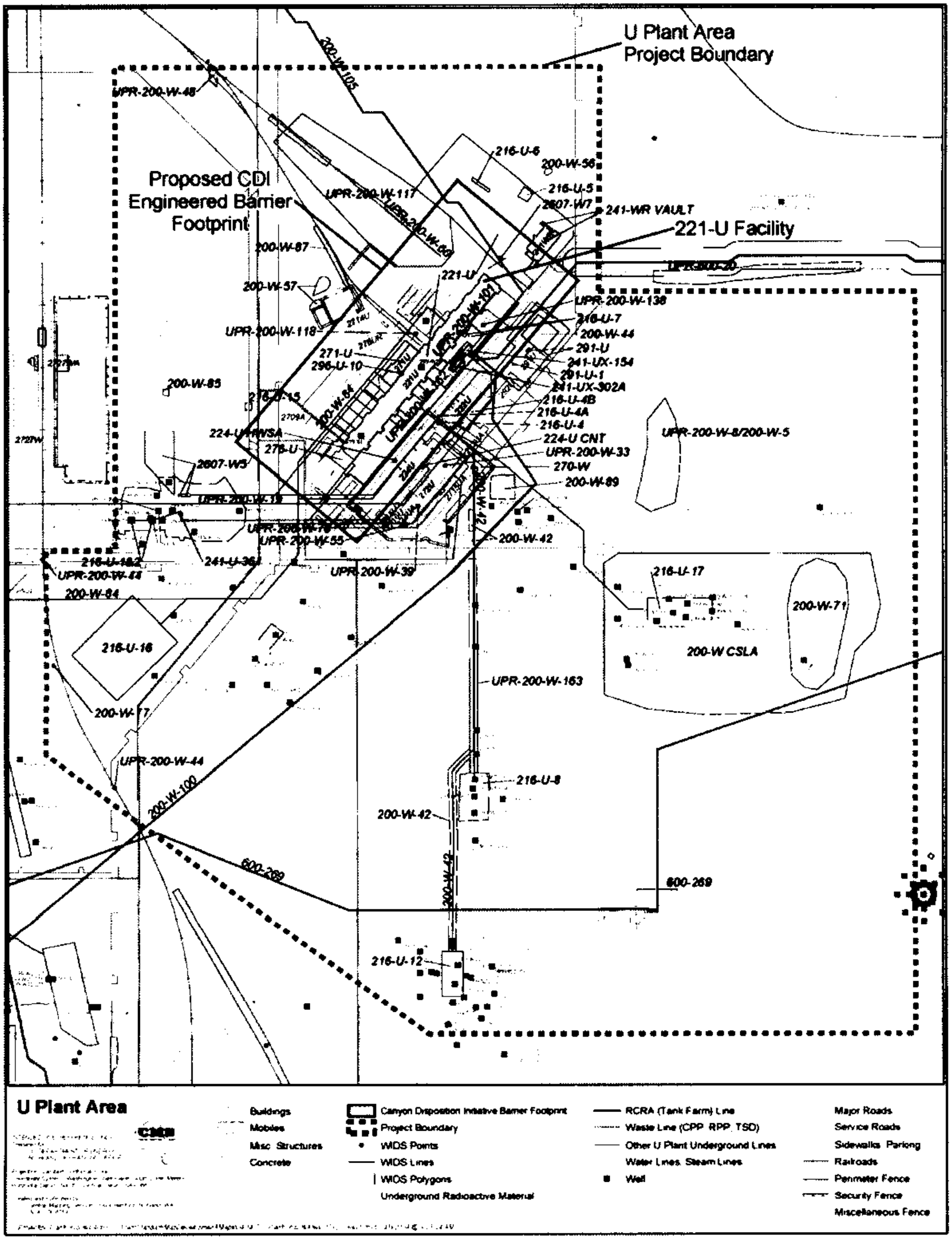
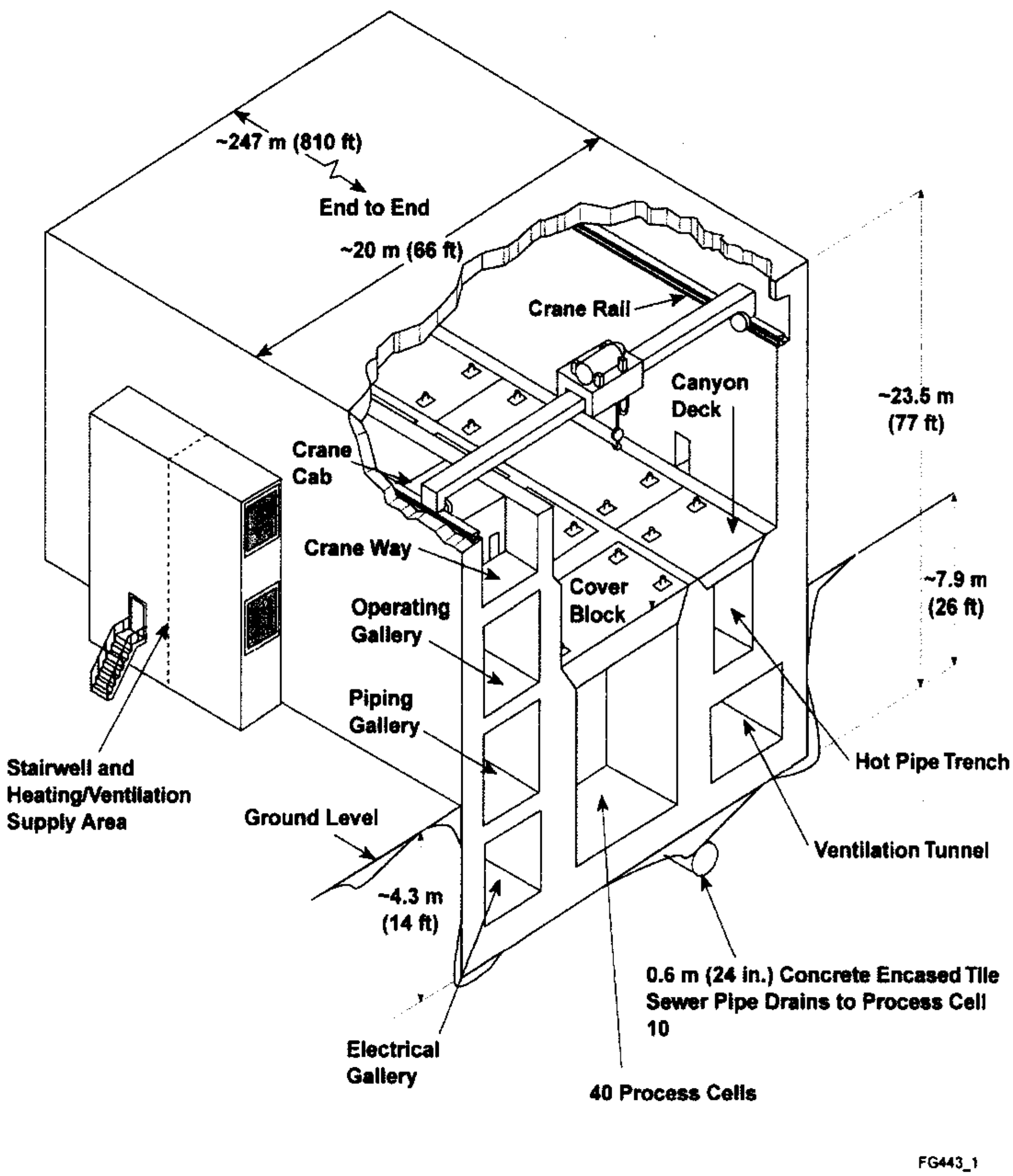


Figure 1-3. Cross Section of the 221-U Building.



1.2 SCOPE

This document discusses the remedial design and the remedial action associated with the 221-U Facility. A ROD (EPA 2005) was issued in October 2005, incorporating the actions and objectives outlined in the *Proposed Plan for Remediation of the 221-U Facility (Canyon Disposition Initiative)* (DOE/RL-2001-29) (proposed plan). The ROD documents the selection of a final 221-U Facility remedial action pursuant to the *Comprehensive Environmental Response, Compensation and Liability Act of 1980* (CERCLA) process and based on information summarized in the *Final Feasibility Study for the Canyon Disposition Initiative (221-U Facility)* (DOE/RL-2001-11) (final feasibility study) and 221-U Facility Administrative Record.

The 221-U Facility final feasibility study addressed five alternatives for remedial action:

- Alternative 0: No Action
- Alternative 1: Full Removal and Disposal
- Alternative 3: Entombment with Internal Waste Disposal
- Alternative 4: Entombment with Internal/External Waste Disposal
- Alternative 6: Close in Place – Partially Demolished Structure.

The selected alternative for remediation of hazardous substances at the 221-U Facility is Alternative 6. Under the selected alternative, equipment on the canyon deck will be consolidated into the process cells and hot pipe trench; equipment, process cells, and other open areas will be filled with grout, the structure will be partially demolished, and the remaining structure will be buried under an engineered barrier.

This RD/RAWP contains a schedule depicting durations required to implement the 221-U Facility remedial action. The cleanup work will be coordinated with other cleanup projects in the U Plant Area, as well as the 200 Area as a whole. The schedule is consistent with the current Tri-Party Agreement milestone to complete 200 Area remedial actions by September 30, 2024 (Tri-Party Agreement Milestone M-16-00).

1.3 PHASED DESIGN APPROACH

The remedial design for the 221-U Facility will be submitted to the regulatory agencies for review and approval using a phased approach, as defined in the EPA guidance document, *Remedial Design/Remedial Action Handbook*, EPA 540-R-95-059. Due to the lengthy duration and complexity of the project, a phased design approach is necessary. As portions of the design reach 90 % completion, they will be submitted to the regulatory agencies for review and approval. As necessary, this RD/RAWP will also be revised (or addenda prepared at logical points in the remedial design and remedial action planning process) and submitted for regulatory agency review and approval. The phased design approach is discussed further in Chapters 3.0 and 6.0 and is depicted in schedules provided in Chapter 3.0.

2.0 BASIS FOR REMEDIAL ACTION

This chapter describes the basis for the 221-U Facility remedial action (RAOs, cleanup levels, and ARARs). This chapter also provides a description of the selected remedy.

2.1 SELECTED REMEDY

Six different alternatives were evaluated for the remediation of the 221-U Facility, as documented in the 221-U Facility final feasibility study. The Tri-Parties (DOE, EPA, and Ecology) selected Alternative 6, Close In Place – Partially Demolished Structure, for implementation, as documented in the 221-U Facility ROD. The rationale for the selection and a summary of the construction component of the remedy are provided in Sections 2.1.1 and 2.1.2.

2.1.1 Summary of the Rationale for the Selected Remedy

The Tri-Parties selected Alternative 6 as the most appropriate remedial alternative based on the following:

- Alternative 6 satisfies the CERCLA threshold criteria;

- Alternative 6 represents the best balance of tradeoffs with respect to the CERCLA balancing and modifying criteria. In particular, Alternative 6 is more protective of remedial action workers and provides somewhat greater long-term effectiveness and permanence when compared to Alternative 1. It also provides somewhat greater long-term effectiveness and permanence than Alternatives 3 and 4 at a lower cost;

- Alternative 6 satisfies the statutory requirements as outlined by Section 121 of CERCLA.

Other benefits that the selected remedy provides include the following:

- Alternative 6 is consistent with the anticipated future use of the 200 Area at the Hanford Site (i.e., industrial);

- Alternative 6 is consistent with the overall cleanup approach for the 200 Area at the Hanford Site, as embodied in the Tri-Party Agreement and past waste management decisions in the 200 Area (i.e., permanent disposal of remediation waste in the Hanford Site Central Plateau Core Zone).

The selection of Alternative 6 was based on the evaluation conducted in the final feasibility study (DOE/RL-2001-11) and the public review of the proposed plan (DOE/RL-2001-29). The selected remedy in the ROD includes the following components:

- Removal of waste from vessels and equipment in the facility that, if stabilized in place, would contain levels of transuranic isotopes greater than 100 nCi/g, in accordance with this RD/RAWP, and eventual disposal of that waste at the Waste Isolation Pilot Plant (WIPP) in Carlsbad, New Mexico;

- Removal of liquids from the facility or treatment to remove liquids;

- Partial removal of contaminated equipment and piping from the gallery side of the 221-U Building, as needed to facilitate demolition activities, and disposal of this waste at the Environmental Restoration Disposal Facility (ERDF) located on the Hanford Site's Central Plateau between the 200 West and 200 East Areas or other approved facilities;

- Treatment, as necessary, to meet waste acceptance criteria at an acceptable disposal facility;

- Consolidation of contaminated equipment on the deck into the below-deck locations;

- Grouting, to the maximum extent practical, of internal vessel spaces, as well as cell, gallery, pipe trench, drain header, and other spaces within the facility;

- Demolition of the railroad tunnel, 271-U, 276-U, 291-U, and 292-U structures and the 291-U-1 and 296-U-10 stacks, and disposal of the resulting waste at the ERDF or other approved facilities, followed by stabilization of the former locations of these structures to support construction of the engineered barrier;

- Removal of roof and wall sections of the 221-U Building down to approximately the deck level and placement on or near the deck;

- Construction of an engineered barrier over the remnants of the canyon building (with the possible inclusion of inert rubble from the demolition of ancillary facilities as fill material);

- Planting of arid- and semiarid-adapted vegetation on the barrier to enhance evapotranspirative design of the barrier;

- Institutional controls to ensure that the remedy is protected and changes in land use do not occur that could result in unacceptable exposures to residual contamination;

- Postclosure care, including barrier inspection and maintenance;

- Ongoing barrier performance and groundwater monitoring to ensure effectiveness of the remedial action and to support 5-year remedy reviews.

2.1.2 Description of the Construction Component of the Selected Remedy

In accordance with the 221-U Facility ROD, the selected remedy for the 221-U Facility includes four primary components: demolition and barrier construction (the "construction" component), post-remediation care and environmental monitoring, institutional controls, and 5-year review. During the first component, the selected remedy will result in the treatment and encapsulation of wastes within the grouted, concrete structure of the lower portion of the canyon. The roof and upper walls of the canyon then will be demolished to approximately deck level, and the remains will be covered by a protective engineered barrier.

The construction component will consist of the following activities.

- Residual materials in vessels and equipment that would have transuranic isotope concentrations greater than 100 nCi/g after stabilization (such as the contents of a vessel in process Cell 30) will be removed and dispositioned prior to stabilization in accordance with the approved RD/RAWP. The material will be sent to the Hanford Site Central Waste Complex (CWC) for interim storage. This waste ultimately will be shipped to WIPP no later than September 30, 2024. Additional transuranic waste discovered during remedial activities will be removed and stored at the CWC and disposed of off the Hanford Site no later than September 30, 2024.

- Facility modifications will be made as necessary to support equipment removal and remediation activities. Such activities may include partial removal of contaminated equipment and piping from the gallery side of the 221-U Facility, cutting access openings into the canyon, refurbishment of the 221-U Facility roof covering (versus the underlying roof structure), refurbishment of railroad tunnel doors, and upgrades to the ventilation system to support work that will be performed within the facility as a part of the remedial action. Surface contamination will be addressed during these activities, as required.

- Demolition of attached structures (railroad tunnel, 276-U, 271-U, and the 296-U-10 stack) and impacted ancillary structures (291-U, 292-U, and the 291-U-1 stack) will be completed. The locations will be stabilized to support construction of the engineered barrier after removal of these structures. Dust and fugitive emissions associated with these actions will be controlled, such as by application of fixatives or spraying with water. Activities associated with this remedial action will not result in radioactive emissions that are greater than those reasonably achievable, and will not cause the total offsite dose resulting from Hanford Site emissions to exceed 10 mrem/yr. Details regarding emissions controls and monitoring can be found in Chapter 5.0 of this RD/RAWP.

- Existing contaminated equipment from the canyon deck will be size-reduced as necessary within the 221-U Facility and lowered into the process cells and hot pipe trench. However, size reduction activities will be minimized to the extent possible to limit worker exposure to contaminants.

- Cementitious grout will be pumped into the galleries, pipe trench, ventilation tunnel, cell drain header, process cells, and vessels containing residual materials to the maximum extent practical, to minimize the potential for void spaces and to reduce the mobility, solubility, and/or toxicity of the grouted waste. Grout amendments, such as fly ash or zeolite clays, and the cost-benefit of using a soil-cement grout mixture will be considered during final design for grouting activities to reduce the potential for leaching of radioactive isotopes, while maintaining desirable properties of Portland cement (e.g., a flowable, structural grout with good compressive strength).

- Waste generated during building preparation for demolition and from demolition of attached and impacted ancillary structures will be disposed of at the ERDF or other approved disposal locations. Inert rubble from other nearby CERCLA demolition activities, such as the ancillary structures, will be considered during remedial design for use as fill material in the engineered barrier.

- Surface contamination on the canyon walls, deck, and ceiling will be addressed (e.g., sprayed with fixatives) prior to initiation of canyon demolition activities. The upper part of the 221-U Facility will be demolished to approximately the level of the canyon deck and top of the canyon operating gallery. The concrete debris from building demolition will be placed on the canyon deck underneath the engineered barrier. Rubble or wall and ceiling sections that are minimally contaminated and do not contain hazardous waste may be used as fill alongside the canyon substructure under the barrier to limit impacts on soil borrow areas. Figure 2-1 shows a cross section of the facility prior to engineered barrier placement.

- The partially demolished building and concrete debris will be covered with an engineered barrier. See Figure 2-2 for an illustration of the extent of the engineered barrier. The footprint of the engineered barrier could be adjusted slightly to accommodate requirements for the remediation of nearby facilities, waste sites, and pipelines, as necessary. For example, coverage by the 221-U Facility engineered barrier also could be the preferred remedy for some facilities, waste sites, or pipelines as part of other ongoing CERCLA actions in the U Plant Area. For more detail, see the *Focused Feasibility Study for the 200-UW-1 Operable Unit* (DOE/RL-2003-23) and *Proposed Plan for the 200-UW-1 Operable Unit* (DOE/RL-2003-24). The main components of a typical engineered barrier are illustrated in Figure 2-3. The specific 221-U Facility engineered barrier design and layout will be developed during a later phase of remedial design.

- The remedial design shall minimize maintenance and reconstruction needs, and the barrier will be designed to minimize the potential for earthquake-induced deformations and to provide long-term containment and protection of the waste from water infiltration for a performance period of at least 500 years. Additionally, the engineered barrier shall be designed to prevent recharge rates greater than 3.2 mm/yr (long-term average) to ensure the remedy is protective of groundwater and the Columbia River.

- Application of water spray and fixatives and minimizing the size of spoils piles will be used to control dust associated with engineered barrier construction.

- When complete, the top of the engineered barrier will be seeded, and disturbed areas in the vicinity of the 221-U Facility. Seeding of the barrier will be conducted to stabilize barrier materials and improve evapotranspiration (ET) rates, which will reduce barrier recharge rates. Reseeding of adjacent disturbed areas will be for surface stabilization and for reclamation purposes consistent with the expected future industrial land use. Seed selection will be based on multiple factors including native vegetation suited to soil type, fire tolerance, drought resistance, benefits to local wildlife, planting success/survivability record, moderately deep-rooted, and value to Native Tribes.

The construction component of the remedy will be followed by the post-remediation care and environmental monitoring component to ensure the continued integrity and effectiveness of the construction component. Performance monitoring of the barrier will be conducted, thereby allowing various appropriate mitigative measures or best management practices (e.g., thickening of barrier, run-on/runoff water flow controls) to be implemented, if necessary, to mitigate or prevent percolating water from reaching the underlying waste. The final design of the engineered barrier will provide the specific details on engineered features to accomplish any performance monitoring.

Figure 2-1. Cross Section of the Partially Demolished 221-U Building.

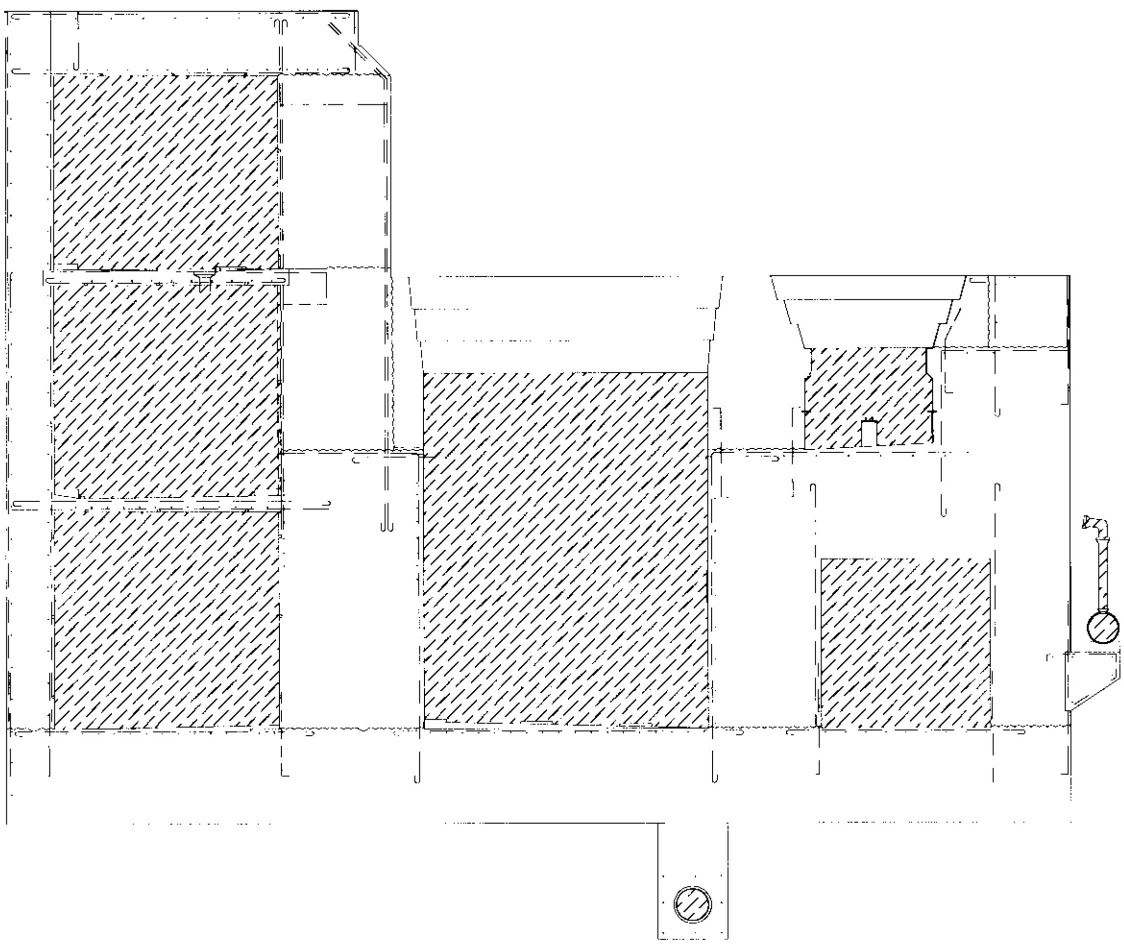


Figure 2-2. Approximate Footprint of the Engineered Surface Barrier for the Selected Remedy.

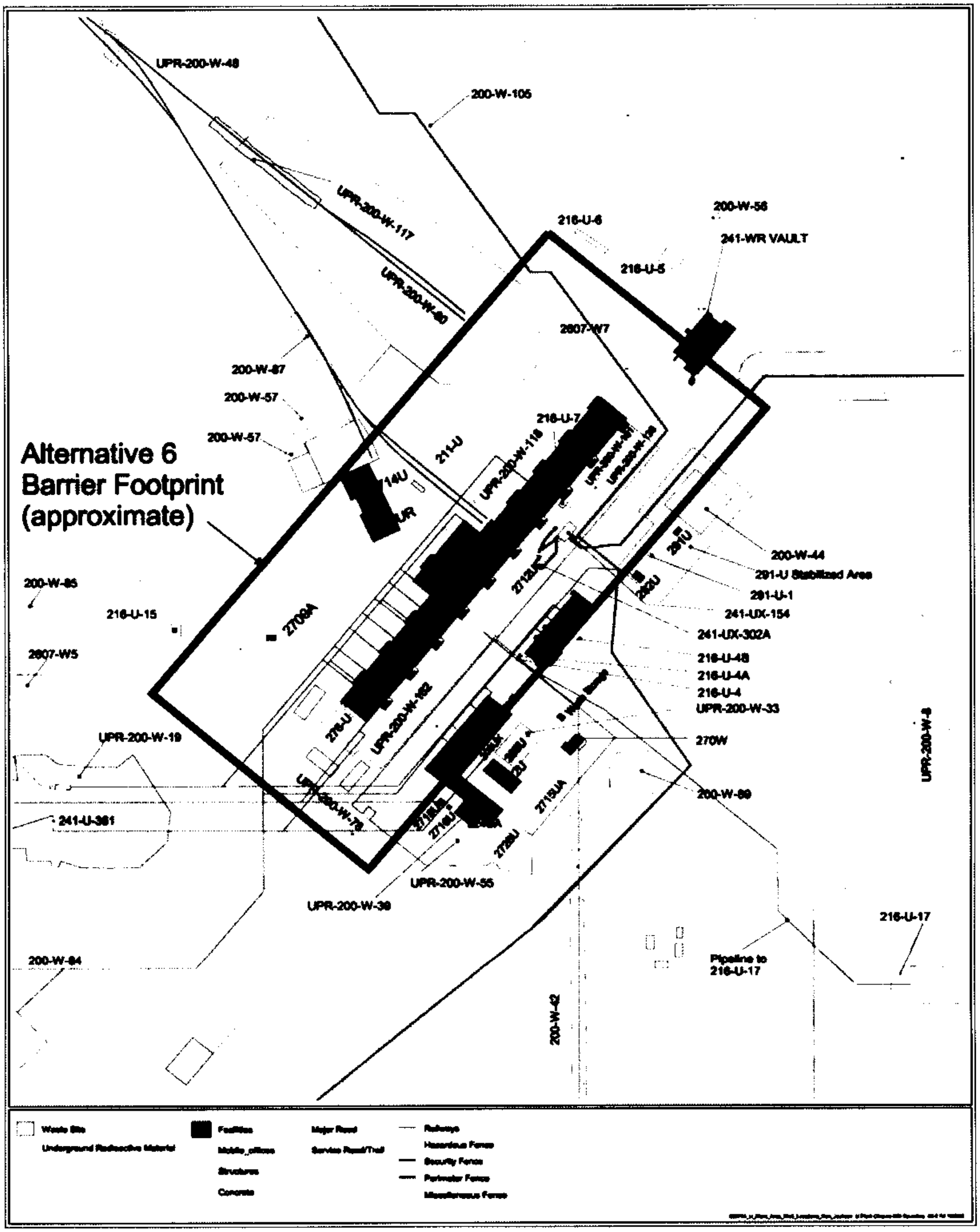
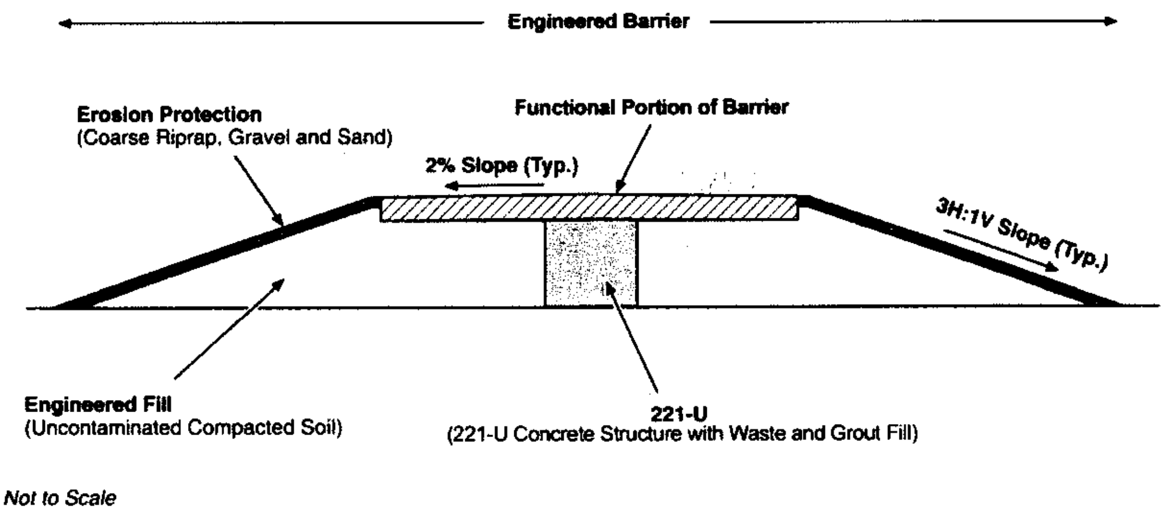


Figure 2-3. 221-U Facility Engineered Barrier Components.



2.2 REMEDIAL ACTION OBJECTIVES AND CLEANUP LEVELS

RAOs provide a general description of what the cleanup will accomplish. The RAOs are objectives for protecting human health and the environment. They were developed considering future land use, contaminants of concern, ARARs, and potential exposure pathways.
The preliminary remediation goals (PRGs) provide a numerical interpretation of the RAOs, and for the purposes of this document, are considered synonymous with the term "cleanup level."

2.2.1 Remedial Action Objectives

RAOs are site-specific objectives that define the extent of cleanup necessary to achieve the specific level of remediation at the site. RAOs for the 221-U Facility were developed based on protection of human health given the reasonably anticipated future land use and the conceptual site model, protection of the environment, protection of groundwater as a potential future drinking water source, protection of the Columbia River, ARARs, and worker safety.

The RAOs developed for the 221-U Facility are designed to be consistent with those developed for other components of the U Plant Area cleanup. The RAOs and the principal requirements for achievement of the objectives are discussed in the following bullets:

- **RAO 1:** Prevent unacceptable health and occupational risks to workers from physical, chemical, and radiological hazards posed by the 221-U Facility.
  - Protection of workers from physical, chemical, and radiological hazards will be achieved by mitigating hazards, extensive planning, use of mock ups, and worker training.

- **RAO 2:** Prevent unacceptable risk to human health, ecological receptors, or natural resources associated with external exposure to, ingestion of, inhalation of, and dermal contact with 221-U Facility contents at levels that exceed ARARs or risk-based criteria.

  - Protection of unacceptable risk to human health, ecological receptors, or natural resources will be achieved by waste encapsulation in grout, use of the substantial concrete structure for entombment of waste, and the construction of an engineered barrier over the remaining grouted structure.

- **RAO 3:** Prevent the migration of contaminants to surface water and through the soil column to groundwater such that no further degradation of groundwater occurs due to leaching from the 221-U Facility.[1]

  - Protection of groundwater will be achieved by waste encapsulation in grout, use of the substantial concrete structure for entombment of waste, and the construction of an engineered barrier over the remaining grouted structure.

- **RAO 4:** Minimize physical, ecological, or cultural impacts caused by remediation of the 221-U Facility or by use of the 221-U Facility as a disposal facility.

  - Protection from physical, ecological, or cultural impacts during remedial activities will be achieved by performing cultural and ecological resources reviews, removal and proper disposition at an approved disposal facility of waste not entombed, and revegetation of disturbed areas when remedial activities are completed.

2.2.2 Cleanup Levels for the 221-U Facility

Based on historical 200 Area operations and characterization information, a comprehensive list of potential contaminants was identified for the 221-U Facility. An initial set of contaminant-specific cleanup levels, or PRGs, was developed to define the specific cleanup goals that will result in achievement of the remedial action objectives. Meeting these PRGs and the ARARs and, by extension, achieving remedial action objectives can be accomplished by reducing concentrations (or activities) of contaminants to remediation goal levels or by eliminating potential exposure pathways/routes. As demonstrated using site-specific modeling, the selected 221-U Facility remedy uses containment and institutional controls to eliminate potential pathways of exposure to the contained contaminants.

2.2.3 Remedial Action Goals

Generally, CERCLA RODs establish remedial action goals (RAGs) for the selected alternative based on the PRGs identified in the supporting feasibility study. However, when a remedy is established that leaves contamination in place, the remedy is not based on cleaning up to RAGs, but rather on containing the contamination in such a fashion that it presents no unacceptable risk to human health or the environment. The remedy for the 221-U Facility is a containment remedy

[1] Protection of the Columbia River is achieved through protection of the groundwater. The 200 West Area is about 8 km (5 mi) from the Columbia River, and there is no surface water in the immediate vicinity of the 221-U Facility.

that relies not on meeting cleanup levels to manage risk, but rather on limiting or preventing exposure. Therefore, no RAGs were established for the 221-U Facility remedial action.

2.3 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

The regulatory requirements for the 221-U Facility, as applicable to the chosen remedial action alternative, will be followed for remedial design of the 221-U Facility. A detailed discussion of ARARs pertinent to the 221-U Facility is provided in the ROD (EPA 2005) and in Table 2-1.

Table 2-1. ARARs for the Selected Remedy. (7 Pages)

Authority	Requirement	Status	Synopsis of Requirement	Rationale for Use
Hazardous Waste Cleanup/Model Toxics Control Act of 1989, Ch. 70.105.D RCW	Model Toxics Control Act Cleanup Regulation, WAC 173-340 (as amended January 1996), Specific subsections: WAC 173-340-720 WAC 173-340-730 WAC 173-340-740 WAC 173-340-745 WAC 173-340-747 WAC 173-340-7490 WAC 173-340-7491 WAC 173-340-7492	Not applicable	Establishes the process and methods used to evaluate risk and develop cleanup standards for soil and other environmental media.	The substantive requirements are not applicable or relevant and appropriate to this type of containment remedy. As a containment remedy, there is no cleanup of contaminated soil or groundwater being performed. The remedy has been determined to be protective of human health and the environment for all exposure pathways. The remedy will contain the contamination; therefore, the contamination will not migrate to the soil, the vadose zone, or the groundwater.
Safe Drinking Water Act of 1974, 42 USC 300 et seq.	National Primary Drinking Water Standards, 40 CFR 141, Subpart G	Relevant and appropriate	Establishes maximum contaminant levels for drinking water.	The selected remedy needs to ensure that migration of contaminants from the 221-U Facility to groundwater does not cause further degradation of the groundwater.
"Water Pollution Control/Water Resource Act of 1971," RCW 90.48 and RCW 90.54	Surface Water Quality Standards for Waters of the State of Washington, WAC 173-201A	Not applicable	Sets water quality standards at levels protective of aquatic life.	The substantive requirements are not applicable or relevant and appropriate to this type of containment remedy. There is no nearby surface water in the vicinity of the 221-U Facility. Contamination will be contained and, therefore, will not migrate. The containment remedy has been determined to be protective of human health and the environment for all exposure pathways.
	"State Waste Discharge Permit Program," WAC 173-216	Relevant and appropriate	Identifies specific discharges prohibited under the program.	Relevant and appropriate to any stormwater discharged to an engineered structure as part of the selected remedy.

Table 2-1. ARARs for the Selected Remedy. (7 Pages)

Authority	Requirement	Status	Synopsis of Requirement	Rationale for Use
Clean Air Act Amendments of 1977, 42 USC 7401 et seq.	"National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities," 40 CFR 61, Subpart H Specific subsections: 40 CFR 61.92 40 CFR 61.93	Applicable	Requires that emissions of radionuclides to the ambient air shall not exceed amounts that would cause any member of the public to receive an effective dose equivalent of 10 mrem/yr. Emissions from point sources shall be measured.	Applicable to the selected remedy because the 221-U Facility is a point source of radioactive emissions.
	"National Emission Standards for Asbestos, Standard for Demolition and Renovation," 40 CFR 61, Subpart M Specific subsections: 40 CFR 61.145(a)(1) 40 CFR 61.145(a)(5) 40 CFR 61.145(c) 40 CFR 61.150(a-c)	Applicable	Requires facilities to be inspected for the presence of asbestos prior to demolition; defines regulated asbestos-containing materials; and establishes removal, handling, and disposal requirements.	The selected remedy requires demolition of structural elements of the 221-U Facility that contain regulated asbestos-containing materials.
	"National Emission Standards for Asbestos, Standards for Active Waste Disposal Sites," 40 CFR 61, Subpart M Specific subsection: 40 CFR 61.154	Applicable	Establishes operating requirements for landfills that handle asbestos-containing wastes.	Applicable because of disposal of asbestos waste.
"Washington Clean Air Act of 1967," RCW 70.94 and RCW 43.21A	"Radiation Protection - Air Emissions," WAC 246-247 Specific subsections: WAC 246-247-040(3) WAC 246-247-040(4) WAC 246-247-075	Applicable	Requires emissions to be controlled to ensure that emission standards are not exceeded. Requires emissions from non-point and fugitive sources of airborne radioactive material to be measured.	Applicable because fugitive, diffuse, and/or point source emissions of radionuclides to the ambient air will result from implementation of the selected remedy.

Table 2-1. ARARs for the Selected Remedy. (7 Pages)

Authority	Requirement	Status	Synopsis of Requirement	Rationale for Use
	"General Regulation for Air Pollution Sources," WAC 173-400 Specific subsection: WAC 173-400-040	Applicable	Requires sources of air contaminants to meet emission standards for visible, particulate, fugitive, odors, and hazardous air emissions. Requires use of reasonably available control technology.	Applicable to remedial actions at the site due to the generation of fugitive dust that will occur during demolition and other types of construction activities (e.g., construction of a barrier).
	Specific subsection: WAC 173-400-113	Applicable	Requires controls to minimize the release of air contaminants resulting from new or modified sources of regulated emissions. Emissions are to be minimized through application of best available control technology.	Although unlikely, the selected remedy may require use of a treatment technology (e.g., to treat generated waste to meet disposal facility acceptance requirements) that emits regulated air emissions. If such treatment is required, this requirement would be applicable.
	"Controls for New Sources of Toxic Air Pollutants," WAC 173-460 Specific subsections: WAC 173-460-030 WAC 173-460-060 WAC 173-460-070	Applicable	Requires specific controls for new regulated air emissions.	Although unlikely, the selected remedy may require use of a treatment technology (e.g., to treat generated waste to meet disposal facility standards) that emits toxic air emissions. If such treatment is required, this requirement would be applicable.
Atomic Energy Act of 1954, as amended, 42 USC 2011 et seq.	"Licensing Requirements for the Land Disposal of Radioactive Waste," 10 CFR 61, Subparts C and D	Relevant and appropriate	Requires that radioactive waste disposal systems be designed to limit the annual dose equivalent beyond the facility boundary to specified values.	Relevant and appropriate to low-level waste left permanently onsite under the selected remedy.

Table 2-1. ARARs for the Selected Remedy. (7 Pages)

Authority	Requirement	Status	Synopsis of Requirement	Rationale for Use
"Hazardous Waste Management Act of 1985," RCW 70.105	"Dangerous Waste Regulations," WAC 173-303 Specific subsections: WAC 173-303-016 WAC 173-303-017 WAC 173-303-070(3) WAC 173-303-073 WAC 173-303-077 WAC 173-303-170(3)	Applicable	Specifies how to identify dangerous waste. Establishes the management standards for solid wastes that are designated as dangerous or mixed wastes.	Applicable to identifying solid and dangerous wastes generated during 221-U Facility remedial actions. The management standards are applicable to the management and disposal of those wastes identified as dangerous/mixed waste.
	"Dangerous Waste Regulations," WAC 173-303 Specific subsection: WAC 173-303-140	Applicable or relevant and appropriate	Identifies dangerous wastes that are restricted from land disposal, describes requirements for state-only restricted wastes, and prohibits land disposal of restricted wastes unless treatment standards have been met. Incorporates Federal land disposal restrictions including provisions for treatability variances by reference.	Applicable to the disposal of dangerous and/or radioactive mixed waste that will be generated during implementation of the 221-U Facility selected remedy. They are ARARs to the in situ disposal of restricted waste pre-existing within the 221-U Facility. In accordance with the provisions of 40 CFR 268.44(h)(2)(i), "Land Disposal Restrictions," "Variance from a Treatment Standard," a treatability variance is granted for mercury associated with legacy waste in the facility.[a]
	"Dangerous Waste Regulations," WAC 173-303 Specific subsection: WAC 173-303-665	Applicable or relevant and appropriate	Specifies environmental performance standards, monitoring and testing, and postclosure care requirements for the disposal of waste in landfills.	The selected remedy will meet the alternative design standards of WAC 173-303-665(2)(j)(i) in lieu of the double liner and leachate collection and removal system provisions of WAC 173-303-665(2)(h) for waste disposed of within the 221-U Facility. A CERCLA ARAR waiver from the leachate detection provision of WAC 173-303-665(2)(j)(ii) is granted pursuant to 40 CFR 300.430(f)(1)(ii)(C)(3) because construction of a leachate detection system beneath the canyon is technically impracticable.[b]
"Solid Waste Management, Recovery, and Recycling Act of 1969," RCW 70.95	"Minimum Functional Standards for Solid Waste Handling" WAC 173-304 Specific subsections: WAC 173-304-190 WAC 173-304-200 WAC 173-304-460	Applicable	Establishes requirements for the management of solid waste.	Applicable to the onsite management and disposal of solid waste that will be generated during implementation of the selected remedy.

Table 2-1. ARARs for the Selected Remedy. (7 Pages)

Authority	Requirement	Status	Synopsis of Requirement	Rationale for Use
Toxic Substances Control Act of 1976, 15 USC 2601 et seq.	"Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions," 40 CFR 761 Specific subsections: 40 CFR 761.50[b][7] 40 CFR 761.61[c]	Applicable	Identifies requirements applicable to the handling and disposal of PCB remediation waste, including PCB remediation waste that is also radioactive.	The risk-based disposal option of 40 CFR 761.61(c) has been selected, and EPA has determined that the selected remedy will not pose an unreasonable risk of injury to health or the environment.
"Water Well Construction," RCW 18.104	"Minimum Standards for Construction and Maintenance of Wells," WAC 173-160 "Rules and Regulations Governing the Licensing of Well Contractors and Operators," WAC 173-162	Applicable	Establishes minimum standards for design, construction, capping, sealing, and decommissioning of wells. Establishes qualifications for well contractors and operators.	Applicable to the installation of wells that will be required for groundwater monitoring.
Archeological and Historic Preservation Act of 1974, 16 USC 469a		Applicable	Requires that actions conducted at the site not cause the loss of any archeological and historic data. Mandates preservation of the data and does not require protection of the actual facility.	Archeological and historic sites have been identified within the 200 Area; therefore, substantive requirements of this standard are applicable to actions that might disturb these sites.
National Historic Preservation Act of 1966, 16 USC 470	"National Register of Historic Places," 36 CFR 60 Specific subsection: 36 CFR 60.4	Applicable	Requires that historically significant properties be protected and that agencies undertaking projects evaluate impacts to properties listed on or eligible for inclusion on the National Register of Historic Places. Establishes the criteria for evaluating properties for the National Register.	The 221-U Facility has been determined to be a contributing property to the Manhattan Historic District. Mitigation activities already have been completed, and no further action is required.

Table 2-1. ARARs for the Selected Remedy. (7 Pages)

Authority	Requirement	Status	Synopsis of Requirement	Rationale for Use
Endangered Species Act of 1973, 16 USC 1531 et seq., subsection 16 USC 1536[c]		Applicable	Prohibits actions by Federal agencies that are likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat. If remediation is within critical habitat or buffer zones surrounding threatened or endangered species, mitigation measures must be taken to protect this resource.	Substantive requirements of this act are applicable if threatened or endangered species are identified in areas where remedial actions will occur.
Migratory Bird Treaty Act of 1918, 16 USC 703 et seq.	"Migratory Bird Treaty Act," 50 CFR 10-24	Applicable	Makes it illegal to pursue, hunt, take, capture, kill, possess, trade, or transport any migratory bird, part, nest, or egg included in the terms of the conventions between the United States and Great Britain, the United States and Mexico, and the United States and Japan.	Three species of birds protected under the "Migratory Bird Treaty Act" may nest on or near the 221-U Facility. If these bird species are impacted by the selected remedy, this act will be applicable. It is also applicable to endangered or threatened species that may be identified near borrow sites.

Table 2-1. ARARs for the Selected Remedy. (7 Pages)

Authority	Requirement	Status	Synopsis of Requirement	Rationale for Use
"Fish and Wildlife," RCW 77	"Department of Game Procedures," WAC 232-12	Relevant and appropriate	Defines the requirements that the Department of Game must take to protect endangered or threatened wildlife.	May be relevant and appropriate if endangered or threatened wildlife is identified near the 221-U Facility or borrow sites during wildlife surveys.

[a] The basis for the treatability variance is that it would be technically inappropriate to treat the mercury in the waste to the specified level or treatment standard due to (1) the location of the waste, (2) the risks to workers that would result from treating the waste to specified levels or standards, and (3) the planned alternative treatment that will be provided under the selected containment alternative.

[b] However, the engineered surface barrier that will be constructed will provide additional contaminant containment. This barrier will prevent or significantly limit the amount of water that can infiltrate into contaminated media, which, in turn, will reduce or eliminate leaching of contamination into the underlying vadose zone and groundwater. In addition, waste and debris in the facility will be grouted prior to barrier construction, providing an additional degree of protection against contaminant leaching. Performance monitoring of the barrier will be conducted to ensure that the barrier is performing as expected.

ARAR = applicable or relevant and appropriate requirement.
CERCLA = *Comprehensive Environmental Response, Compensation and Liability Act of 1980.*
CFR = *Code of Federal Regulations*
EPA = U.S. Environmental Protection Agency.
PCB = polychlorinated biphenyl.
RCW = *Revised Code of Washington*
WAC = *Washington Administrative Code*

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3.0 REMEDIAL ACTION APPROACH AND MANAGEMENT

Initiation of full-scale remedial action to accomplish the goals set forth in the 221-U Facility ROD will require completion of numerous interdependent tasks, which are illustrated in the schedule presented in this Section of the document. Remedial action approach and management elements including the bulleted items below are described in the following sections:

- Remedial Action Work Activities
- Project Schedule and Cost
- Change Management
- Project Team
- Remedial Action Planning
- Long-Term Monitoring, Maintenance, and Institutional Controls
- Attainment of Remedial Action Objectives
- CERCLA Closeout Documentation
- Reporting Requirements for Nonroutine Releases.

3.1 REMEDIAL ACTION WORK ACTIVITIES

The selected 221-U Facility remedy, as documented in the ROD, is Alternative 6, Close in Place – Partially Demolished Structure. The remedial action work scope includes performing structural demolition and barrier construction activities and furnishing necessary facilities, equipment, labor, materials, supplies, and tools. The following subsections provide a summary of the remedial action approach.

The selected remedy for the 221-U Facility includes four primary components: demolition and barrier construction (the "construction component"), post-remediation care and environmental monitoring, institutional controls, and 5-year review. The construction component of the remedy is further divided into a predemolition phase, a demolition phase, and a barrier construction phase. Prior to the predemolition phase are mobilization and site preparation, and hazard mitigation activities. Key activities associated with each phase are presented in the following sections.

3.1.1 Mobilization and Site Preparation

Mobilization and site preparation include the following activities, which are necessary to prepare the 221-U Facility for remediation:

Establishing site utility services as required;

Constructing roads, field support facilities, container survey stations, and decontamination stations. Hanford Site roadways are constructed of existing site materials, except the surface course, which is imported. Field support facilities provide a changing area, lunchroom, and construction offices at individual sites. The changing area includes lockers, benches, and storage for both clean and contaminated personal protection equipment.

3.1.2 Hazard Mitigation

Implementation of the selected 221-U Facility remedy will require the identification and mitigation of potential hazards to personnel and the environment. These remedial action predecessor activities are described in more detail in Section 6.3.

3.1.3 Predemolition Phase

To prepare the 221-U Facility for demolition, various canyon systems will have to be reactivated and/or upgraded, waste treated in and/or removed from the facility, and equipment consolidated into below-deck locations. The proposed schedule for completion of predemolition phase activities is presented in Figure 3-1. These activities are listed in the following bullets, and further detail regarding these activities is provided in Section 6.5:

- Reactivate and/or upgrade as necessary the 221-U Building cranes, electrical system/lighting, ventilation system, and railroad tunnel;

- Remove liquid from a process vessel in Cell 30 that, if stabilized in place, would contain levels of transuranic isotopes greater than 100 nCi/g, and treat as necessary to meet receiving facility waste acceptance criteria;

- Remove other liquids as practical, if found, from the facility or provide treatment to remove liquids;

- Size reduce (as necessary) and consolidate contaminated equipment located on the canyon deck into below-deck locations (e.g., into the process cells).

3.1.4 Demolition Phase

During the demolition phase of the 221-U Facility remedial action, canyon voids will be grouted, the railroad tunnel will be dispositioned, interior canyon building surface contamination will be addressed, and the external area surrounding the canyon will be prepared to provide access to canyon demolition equipment. Finally, the roof and upper walls of the canyon structure itself will be demolished to near deck-level. The proposed schedule for completion of demolition phase activities is presented in Figure 3-2. These activities are listed in the following bullets, and further detail regarding these activities is provided in Section 6.6:

- Partially remove contaminated equipment and piping from the gallery side of the facility, as needed to facilitate demolition activities;

- Grout, to the maximum extent practical, internal vessel spaces, as well as cell, gallery, pipe trench, drain header, and other spaces within the facility as well as demolition rubble, as necessary;

- Demolish the 271-U, 276-U, 291-U, and 292-U structures and the 291-U-1 and 296-U-10 stacks, and dispose of the resulting waste at the ERDF or other approved disposal facilities (or use the waste as barrier fill material if it is minimally contaminated and does not contain hazardous waste);

- Demolish the railroad tunnel buttresses to the degree necessary;

- Stabilize and/or fill depressions at the former locations of these structures to support construction of the engineered barrier;

- Demolish the roof and wall sections of the 221-U Facility down to approximately the deck level and use the resulting rubble as fill material for the engineered barrier.

3.1.5 Barrier Construction Phase

This function will consist of constructing the engineered barrier over the building, demolition debris, and nearby waste sites. This function will also involve restoring the excavated and disturbed sites (including laydown and equipment staging areas) to a grade consistent with the natural surface topography. The proposed schedule for completion of barrier construction phase activities is presented in Figure 3-3. These activities are listed in the following bullets, and further detail regarding these activities is provided in Section 6.7:

- Construct an engineered barrier in accordance with an approved remedial design over the building and demolition debris;

- Seed/plant the engineered barrier surface with native grasses and shrubs to stabilize barrier materials and improve ET rates;

- Seed the disturbed areas in the immediate vicinity of the 221-U Facility with native grasses and shrubs for surface reclamation purposes consistent with the expected future industrial land use.

3.2 PROJECT SCHEDULE AND COST

The remedial design for the 221-U Facility will be submitted to the regulatory agencies for review and approval using a phased approach, as defined in the EPA guidance document, *Remedial Design/Remedial Action Handbook*, EPA 540-R-95-059. Due to the lengthy duration and complexity of the project, a phased design approach is necessary. As portions of the design reach 90 % completion, they will be submitted to the regulatory agencies for review and approval. Schedule commitments associated with remediation of the 221-U Facility are shown in Figures 3-1 through 3-4. A summary of key milestones is provided in Table 3-1. The cost estimate for implementation of the selected remedy is provided in Table 3-2. This estimate was prepared as part of the final feasibility study (DOE/RL-2001-11). The estimate was prepared with an accuracy of –30 % to +50 % to support evaluation of remedial alternatives and selection of a remedy. This cost estimate will be revised and revisions included in future updates to this document as the remedial design progresses.

Table 3-1. Key Milestones for the 221-U Facility.

Activity	Completion Date
Facility reactivation design completion	September 30, 2015
Equipment size reduction 90 % design completion	September 29, 2016
Cell 30 vessel treatability study completion	March 30, 2017
Cell 30 waste 90 % design completion	November 30, 2017
Canyon grouting 90 % design completion	December 31, 2018
Non-canyon demolition 90 % design completion	January 2, 2020
Partial canyon demolition 90 % design completion	April 1, 2021
Engineered barrier 90 % design completion	April 1, 2022
Finalize O&M Plan	September 30, 2024

O&M = operations and maintenance.

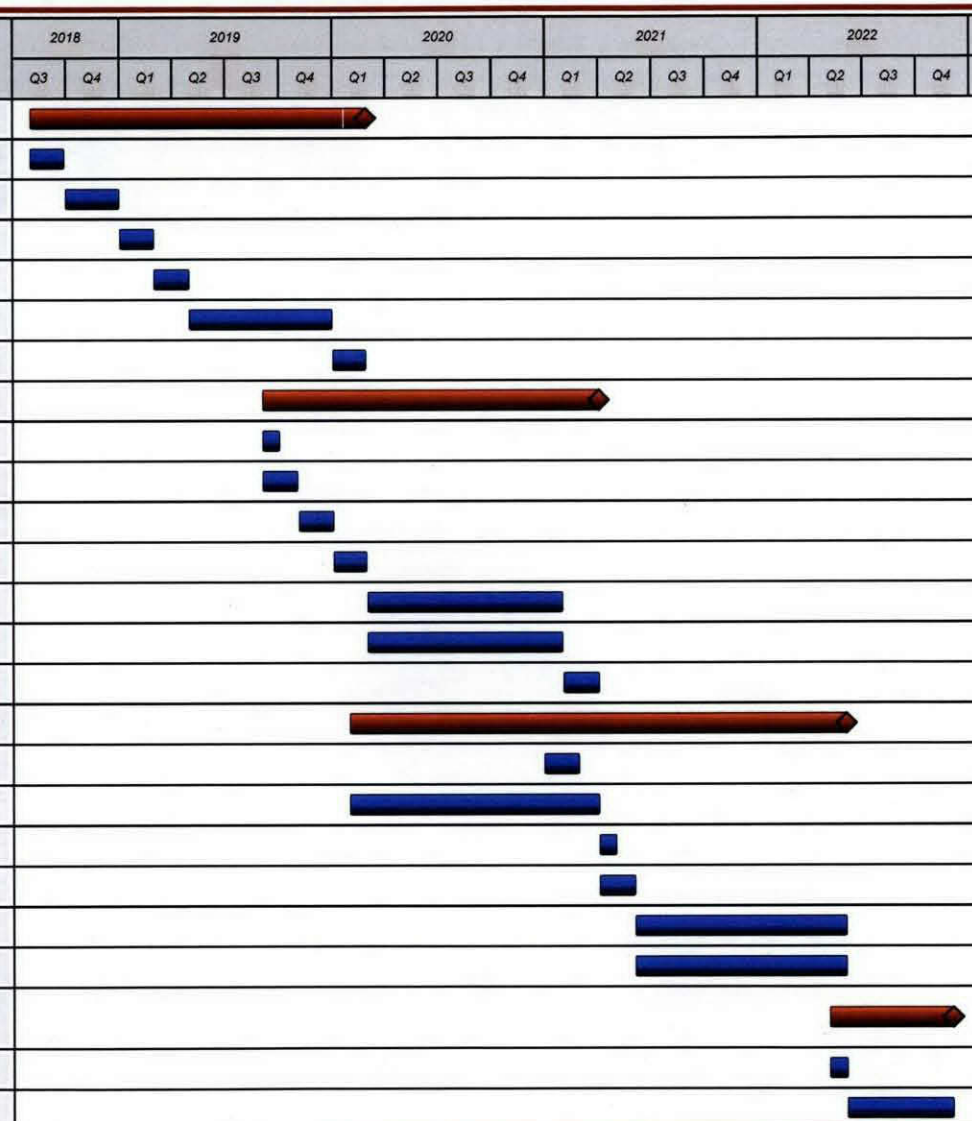
Figure 3-1. Schedule of Remedial Action Activities: Predemolition.

ID	Task Name	Start	Finish
1	***Facility Reactivation***	10/01/14	09/30/16
2	Complete Design	10/01/14	09/30/15
3	Railroad Tunnel	07/02/15	09/30/16
4	Setup Work Areas in Canyon	07/02/15	09/30/16
5	Electrical & Lighting	07/02/15	09/30/16
6	Crane - Load Test Upgrade	07/02/15	09/30/16
7	HVAC	07/02/15	09/30/16
8	***Equipment Size Reduction***	10/01/15	03/30/17
9	Conceptual Design	10/01/15	03/30/16
10	90% Design & Work Plan Preparation	03/31/16	09/29/16
11	Address High-Risk Items	09/30/16	03/30/17
12	Address Remaining Items on Deck	07/28/16	03/30/17
13	***Cell 30 Solution Disposition***	09/30/16	12/31/18
14	Treatability Study	09/30/16	03/30/17
15	Conceptual Design	11/30/16	03/30/17
16	90% Design & Work Plan Preparation	06/01/17	11/30/17
17	Purchase Equipment	12/01/17	03/29/18
18	Conduct Mock-up	03/30/18	07/31/18
19	Sample & Analysis	08/01/18	09/28/18
20	Package and Remove Waste	10/01/18	12/31/18
21	***Deactivation***	10/01/15	09/30/19
22	Work Plan Preparation	10/01/15	03/30/16
23	Field Execution	03/31/16	09/30/19

Schedule is dependent on successful negotiation of target funding.

Figure 3-2. Schedule of Remedial Action Activities: Demolition.

ID	Task Name	Start	Finish
1	***Grout Canyon***	08/01/18	02/27/20
2	Conceptual Design	08/01/18	09/28/18
3	90% Design and Work Plan Preparation	10/01/18	12/31/18
4	Procure Materials	01/02/19	02/28/19
5	Set Up Batch Plant	03/01/19	04/30/19
6	Grout	05/01/19	12/31/19
7	Remove Batch Plant	01/02/20	02/27/20
8	***Non-Canyon Demolition***	09/03/19	04/01/21
9	Update WIDS as Necessary	09/03/19	10/01/19
10	Conceptual Design	09/03/19	11/01/19
11	90% Design and Work Plan Preparation	11/04/19	01/02/20
12	Procure Equipment	01/03/20	02/28/20
13	Demolition	03/02/20	01/29/21
14	Dispose or Stockpile Debris	03/02/20	01/29/21
15	Stabilize Former Locations	02/01/21	04/01/21
16	***221-U Partial Canyon Demolition***	01/30/20	06/01/22
17	Conceptual Design	12/30/20	02/26/21
18	90% Design and Work Plan Preparation	01/30/20	04/01/21
19	Fix Contamination	04/02/21	04/30/21
20	Procure Equipment	04/02/21	06/01/21
21	Demolition	06/02/21	06/01/22
22	Dispose or Stockpile Rubble	06/02/21	06/01/22
23	***Stabilize Remaining Canyon Structure***	05/03/22	12/02/22
24	Update WIDS as Necessary	05/03/22	06/02/22
25	Stabilize Remaining Structure	06/03/22	12/02/22



Schedule is dependent on successful negotiation of target funding.

Figure 3-3. Schedule of Remedial Action Activities: Barrier Installation.

ID	Task Name	Start	Finish
1	***Construct Barrier***	04/02/21	09/30/24
2	Conceptual Design	04/02/21	10/01/21
3	90% Design and Work Plan Preparation	10/04/21	04/01/22
4	Procure Materials	04/04/22	12/01/22
5	Stabilize Barrier Base	12/02/22	02/01/23
6	Construct Barrier	02/02/23	07/31/24
7	Revegetate	08/01/24	09/30/24
8	***Prepare for O&M***	09/29/23	09/30/24
9	Prepare/Finalize O&M Plan	09/29/23	09/30/24

Schedule is dependent on successful negotiation of target funding.

Figure 3-4. Schedule of Remedial Action Activities: Post Remediation.

ID	Task Name	Start	Finish
1	***Implement LTS & Institutional Controls***	10/01/24	10/01/25
2	Establish Deed Restrictions, etc.	10/01/24	10/01/25
3	***Conduct O&M***	10/01/24	09/30/25
4	Prepare/Finalize Construction Completion Report	10/01/24	09/30/25
5	***5-Year Review***	10/01/25	09/30/26
6	Conduct CERCLA 5-Year Review	10/01/25	09/30/26

Schedule is dependent on successful negotiation of target funding.

Table 3-2. 221-U Facility Remediation Total Project Cost Summary.

Project Phase	Dollar Amounts
Capital Cost Summary	
Predemolition Phase	
Assessment activities	700,000
Design activities	4,500,000
Removal of sludge and liquids from equipment	1,300,000
Establish infrastructure	1,600,000
Modify 221-U Facility	16,500,000
Disposition of external legacy structures	20,900,000
Disposition of waste sites within footprint	0
Demolition Phase	
Building demolition, removal, and disposal	10,700,000
Fill galleries with waste and grout	1,400,000
Fill operating deck area with waste and grout	0
Construct engineered clean fill	7,400,000
Construct external leachate collection system	0
Place external contaminated soil fill	0
Barrier Construction Phase	
Backfill 221-U Facility excavation void	0
Construct engineered barrier	4,100,000
Construct erosion protection on sideslopes	3,100,000
Revegetate	50,000
Closeout activities	200,000
Demobilization	50,000
Establish groundwater monitoring	300,000
Total capital costs (Undiscounted)	**72,800,000**
O&M Cost Summary	
Monitoring and inspections (Total)	49,000,000
Engineered barrier replacement (year 500 only)	4,100,000
Total O&M Cost (Undiscounted)	**53,100,000**
Overall Cost Summary	
Project Total Costs (Undiscounted)	**125,900,000**
Net Present-Worth Totals	**67,400,000**

NOTE: Cost estimates have an accuracy of –30 % to +50 %. Present-worth costs are based on a 3.2 % real discount rate (*Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs* [OMB Circular No. A-94, Appendix C]) and a 1,000-year period of performance. Total undiscounted costs are 2001 dollars for a 1,000-year period of analysis. Costs have been rounded.

Within the framework of the Tri-Party Agreement milestones and available funding levels, detailed working schedules are being developed for the 221-U Facility remedial action activities at several different levels, consistent with the project work breakdown structure. Near-term (less than 1 year) work is usually planned and scheduled at a detailed activity level, using logic ties to establish and maintain a true critical-path schedule. Logic-driven, critical-path schedules, commonly referred to as the critical-path method, are used to manage and control the daily progress of the work and provide early warning of problem areas. Higher level project schedules are periodically reviewed and updated to reflect progress as measured against the near-term critical-path schedules.

Detailed scope, schedule, and associated budgets are established at the project level in a lifecycle baseline for the contract period and outlying years. The baseline is updated periodically and typically outlines the planned scope, schedule, and budget for the contract period.
The 221-U Facility baseline incorporates the scope, schedule, and budget to implement the selected 221-U Facility remedy.

3.3 CHANGE MANAGEMENT

Post-ROD planning and scheduling for remediation projects follow a distinct pattern consistent with the work package level of the project work breakdown structure. Planning elements at this level include development of the remedial design and solicitation of a remediation contractor (RC). Additional planning documentation includes, but is not limited to, field procedures, sampling and analysis plan, health and safety plan, technical specifications, safety analysis/hazard classification, and procurement documents. Some of the tiered planning documentation (e.g., site-specific investigations) may require review and approval by the lead regulatory agencies as specified in the Tri-Party Agreement. When reviews are required, DOE will provide the documentation to the lead regulatory agencies for review and approval. Summary briefings and discussions may be held at unit managers' meetings or other forums, as agreed. Issues will be identified and resolved in a timely manner to prevent or minimize impacts to schedules, including those for procurement.

3.4 PROJECT TEAM

The term "project team," in the strictest sense, means individuals working to accomplish a particular project. According to this definition, there are numerous members of the project team. For the purpose of this discussion, the project team will be limited to the regulatory agencies, the DOE, and the contractor.

3.4.1 Regulatory Agencies

The EPA and Ecology are co-lead regulatory agencies for the CERCLA remediation activities at the 221-U Facility. The regulatory agencies are responsible for overseeing the activities to verify that applicable regulatory requirements are met. Lead regulatory agency approval will be required on primary documents such as the RD/RAWP and 90 % remedial design packages (i.e., remedial design report).

3.4.2 Remedial Project Manager (U.S. Department of Energy)

The DOE is the government agency responsible for the remedial actions throughout the 221-U Facility and the remaining Hanford Site and, as such, has assigned remedial project managers to each remediation project. DOE project managers are responsible for the management of their assigned activities, including scope, budget, schedule, and contracts. The DOE is the lead agency responsible for ensuring that Federal and state ARARs are met during the remediation of the 221-U Facility.

The Remedial Project Manager also directs response efforts and coordinates other efforts for this remedial action per 40 CFR 300.120.

3.4.3 Remediation Contractor

The RC team is currently responsible for implementation of remedial actions in the 221-U Facility. The RC is responsible for implementing the remedial action. The project organization, in regard to the remedial action, is described in the subsections that follow and is shown graphically in Figure 3-5. With the exception of the DOE Remedial Project Manager, other roles and responsibilities are completed by the RC. Note: For each functional RC role, there is a corresponding oversight role within DOE.

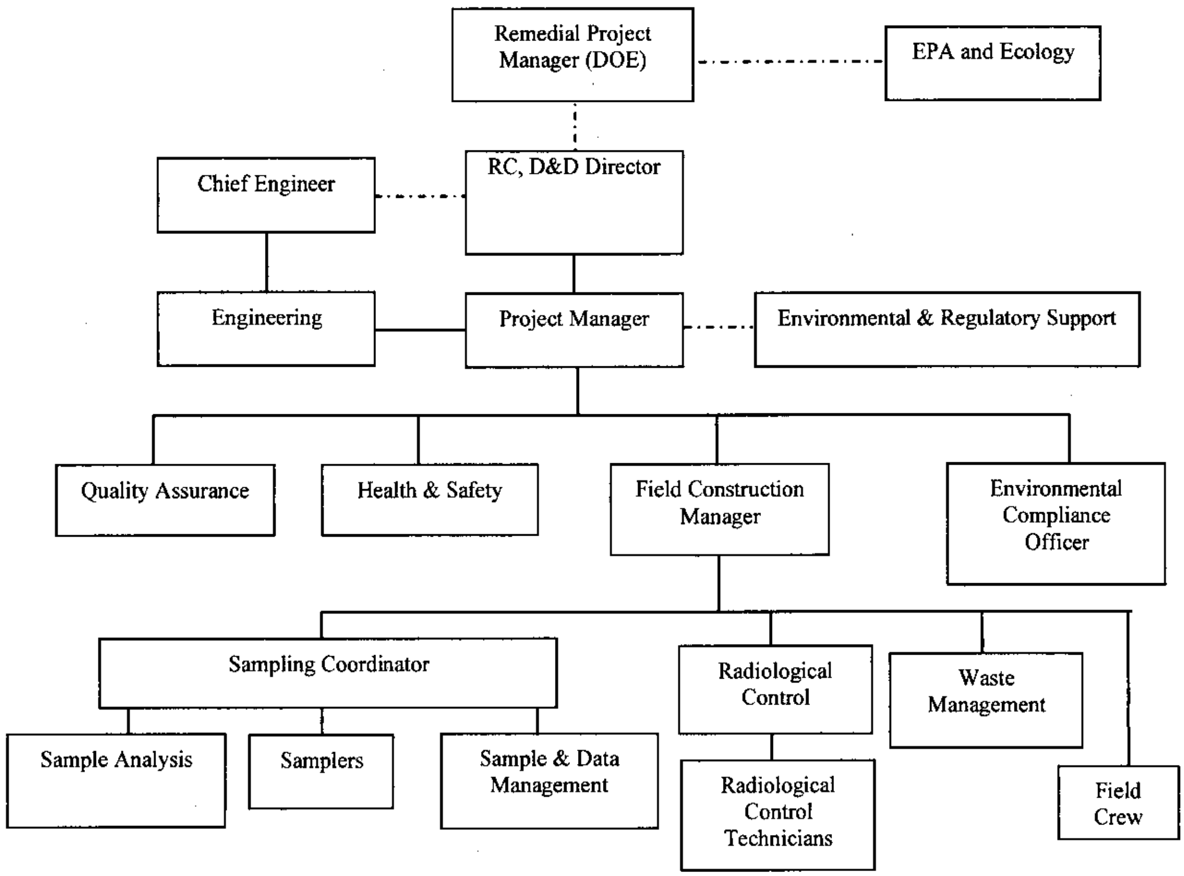
3.4.3.1 RC Decontamination and Demolition Director

The RC Director of Decontamination and Demolition (D&D) provides oversight for activities and coordinates with DOE, regulators, and primary contractor management in support of remediation activities. In addition, support is provided to the 221-U Facility Project Manager to ensure that the work is performed safely and cost-effectively.

3.4.3.2 221-U Facility Project Manager

The 221-U Facility Project Manager is responsible for direct management of sampling documents and requirements, design media, work plans, field activities, and subcontracted tasks. The 221-U Facility Project Manager ensures that the Field Construction Manager, Environmental Compliance Officer, Sampling Coordinator, and others responsible for implementation of regulatory documents are provided with current copies of these documents and any revisions thereto. The 221-U Facility Project Manager also works closely with the Engineering, Quality Assurance, Health and Safety organizations, and the Field Construction Manager to integrate these and the other lead disciplines in planning and implementing the workscope.
The 221-U Facility Project Manager also coordinates with, and reports to DOE-RL, the regulators, and remediation contractor management on remediation activities.

Figure 3-5. Project Organization.



3.4.3.3 Quality Assurance

The Quality Assurance Lead is matrixed to the 221-U Facility Project Manager and is responsible for quality assurance (QA) issues on the project. Responsibilities include oversight of implementation of the project QA requirements; review of project documents and design media, including drawings and specifications, DQO summary reports, sampling and analysis plans (SAPs), and the quality assurance project plan (Section 7.4); and participation in QA assessments on sample collection and analysis and other remediation activities, as appropriate.

The Construction Quality Assurance Officer has overall responsibility for implementing the Construction Quality Assurance Plan. Under the direction of the Construction Quality Assurance Officer, field inspectors perform inspections, tests, and observations in accordance with the Construction Quality Assurance Plan.

3.4.3.4 Health and Safety

The Health and Safety organization responsibilities include coordination of industrial safety and health support within the project as carried out through health and safety plans, job hazard analyses, and other pertinent safety documents required by Federal regulation or by remediation primary contractor work requirements. In addition, assistance is provided to project personnel in complying with applicable health and safety standards and requirements. Personal protective clothing requirements are coordinated with Radiological Control Lead.

3.4.3.5 Field Construction Manager

The Field Construction Manager has the overall responsibility for supporting the safety, environmental, QA, sampling, waste management, and radiological control staff in the planning, coordination, and execution of field remediation activities. Responsibilities also include directing training, mock-ups, and practice sessions with field personnel to ensure that the field actions are understood and can be performed as specified. The Field Construction Manager communicates with the 221-U Facility Project Manager to identify field constraints that could affect the remediation activities. In addition, the Field Construction Manager directs the procurement and installation of materials and equipment needed to support the field work.

3.4.3.6 Environmental and Regulatory Support

The Environmental and Regulatory Support Lead is responsible for the development of required regulatory documents. Responsibilities include development and documentation of the sampling DQOs and sampling and analysis plan, and remedial action work plans. The Environmental and Regulatory Support Lead also supports the Data Quality Assessment process and develops the final Remedial Action Report at the conclusion of the remediation activity.

3.4.3.7 Environmental Compliance Officer

The Environmental Compliance Officer provides technical oversight, direction and acceptance of project and subcontracted environmental work and develops appropriate mitigation measures with a goal of minimizing adverse environmental impacts. The Environmental Compliance Officer also reviews plans, procedures and technical documents to ensure that environmental requirements have been addressed, identifies environmental issues that affect operations and develops cost effective solutions, and responds to environmental/regulatory issues or concerns raised by DOE and/or regulatory agency staff.

3.4.3.8 Sampling Coordinator

The Sampling Coordinator's specific responsibilities include conversion of the sampling design requirements into field task instructions that provide specific direction for field activities. The Sampling Coordinator also provides oversight of the Sample and Data Management Organization and the Field Samplers, develops and oversees the implementation of the Letter of Instruction to the Sample Analysis Contractor, and oversees data validation.

The **Sample and Data Management Organization** selects the laboratories that perform the analyses. This organization also ensures that the laboratories conform to Hanford Site internal laboratory quality assurance requirements, or their equivalent, as approved by DOE, the U.S. Environmental Protection Agency, and the Washington State Department of Ecology. Sample and Data Management receives the analytical data from the laboratories, performs the data entry into the *Hanford Environmental Information System*, and arranges for data validation.

The **Samplers** collect samples, including replicates/duplicates and prepare sample blanks according to the sampling and analysis plan and corresponding field procedures and work packages. The Samplers also complete the field logbook and chain-of-custody forms, as well as any shipping paperwork. The Samplers also deliver the samples to the analytical laboratory.

The **Sample Analysis Organization** analyzes samples in accordance with established procedures and provides necessary sample reports and explanation of results in support of data validation.

3.4.3.9 Radiological Control

The Radiological Control Lead is responsible for the radiological/health physics support within the project. Specific responsibilities include conducting as-low-as-reasonably-achievable (ALARA) reviews, exposure and release modeling, and radiological controls optimization for remedial action work planning. In addition, radiological hazards are identified and appropriate controls are implemented to maintain worker exposures to hazards at ALARA levels (e.g., personal protective equipment). Radiological Control interfaces with the project health and safety representative and plans and directs radiological control technician support for remedial activities.

3.4.3.10 Waste Management

The Waste Management Lead communicates policies and procedures and ensures project compliance for storage, transportation, disposal, and waste tracking in a safe and cost-effective manner. Other responsibilities include identifying waste management sampling/characterization requirements to ensure regulatory compliance and interpreting the characterization data to generate waste designations, profiles, and other documents that confirm compliance with waste acceptance criteria.

3.4.3.11 Field Crew

The field crew consists of laborers, teamsters, and equipment operators who provide hands-on support for implementing the remedial action.

3.4.3.12 Engineering

All engineering and design work will be performed by qualified engineering staff in accordance with RC engineering procedures, or equivalent standards, using a graded approach. Engineering design processes will be integrated with the CERCLA environmental processes as described in DOE/RL-98-28, *200 Areas Remedial Investigation/Feasibility Study Implementation Plan-Environmental Restoration Program*. For example, the functional requirements for the project will be defined in the FFS/PP (DOE/RL-2001-11; DOE/RL-2001-29). The design will be documented in the remedial design report/remedial action work plan and other sublevel engineering documents.

3.4.3.13 Chief Engineer

The Chief Engineer has overall technical responsibility to the configuration baseline and quality of engineering within the RC D&D organization. The Chief Engineer reports directly to the RC D&D Director and provides administrative management of D&D engineering resources.

3.5 REMEDIAL ACTION PLANNING

Planning documentation to implement remedial actions includes the preparation of a set of field documents required to guide work being performed. Examples include analytical system work instructions, site support systems work instructions, radiation permits, and excavation permits.

3.5.1 Field Procedures

Field procedures (e.g., sampling and industrial hygiene) provide guidance to site workers during field work execution. The procedures define the scope, operations, progression of field work, personnel control requirements, radiological posting requirements, and guidance on the analytical system. The procedures also provide contingency plans, should unexpected conditions arise. The field operations must be executed in compliance with these field procedures.

3.5.2 Sampling and Analysis Plans

The *Sampling and Analysis Plan for 221-U Facility* (DOE/RL-97-68) provides direction for sampling to support waste characterization, worker health and safety, and site remediation. The SAP includes a quality assurance project plan that defines the strategy to control the quality and reliability of the analytical data and establish associated protocols for data management. Although the majority of the facility-specific sampling activities have been completed, additional facility characterization information may be required (e.g., characterization of process cells not previously accessed). Waste generated for disposal outside of the facility may also require characterization. Future sampling and analysis activities may be undertaken in compliance with the existing SAP (modified as necessary), or a new SAP will be prepared as needed (e.g., to support waste designation and waste management).

3.5.3 Health and Safety Plan

The 221-U Facility health and safety plan is prepared in conjunction with the activity hazards classification. This plan provides guidance to personnel on the site for health and safety concerns specific to the remediation site and action. Project field staff must comply with the health and safety plan at times. Unescorted site visitors are required to read and sign the health and safety plan before they enter the construction area, and have completed the required training as outlined in the health and safety plan. Escorted visitors are briefed on health and safety concerns and must be escorted by the site superintendent or designee at times when they are in the construction area.

3.5.4 Cultural and Ecological Resources

A comprehensive archaeological resources review of the 200 Area conducted in 1987 and 1988 included an examination of a stratified random sample of the undisturbed portions of the 200 West Area. No significant surface archaeological sites were reported during that inventory. The only evaluated pre-Hanford historic site is the old White Bluffs freight road that crosses diagonally through the 200 West Area. The road, which originated as an Indian trail, has played a role in Native American migration as well as Euro-American immigration, development, agriculture, and Hanford Site operations. This property has been determined to be eligible for the National Register of Historic Places, although segments of the road that pass through the 200 West Area are considered to be noncontributing.

Manhattan Project and Cold War era buildings in the 200 East and 200 West Areas have been evaluated for National Register of Historic Places eligibility under the provisions of the *Programmatic Agreement Among the U.S. Department of Energy, Richland Operations Office, the Advisory Council on Historic Preservation, and the Washington State Historic Preservation Office for the Maintenance, Deactivation, Alteration, and Demolition of the Built Environment on the Hanford Site, Washington* (DOE/RL-96-77).

Fifty-eight properties have been determined eligible for the National Register as contributing properties within the Hanford Site Manhattan Project and Cold War Era Historic District and recommended for individual documentation. The 221-U Building was determined to be a contributing property within the Historic District, but was not selected for mitigation. Historic artifacts identified within the structure have been documented in photographs and selectively tagged for preservation. The list of 221-U Facility items tagged for removal and curation is as follows:

- CP0001-Exhaust Sand Filter Model for Emission Control (271-U basement)
- CP0005-Fluorescent lights (221-U, Section 11, Operating Gallery)
- CP0006-Enunciator Panel (221-U, Section 11, Operating Gallery)
- CP0008-Beckman Ionization Chamber (221-U, Section 13, Pipe Gallery).

The 222-U Laboratory/Office Building and the 241-WR Vault were the only properties selected for mitigation within the 221-U Facility complex. No items were tagged for removal from these structures; however, photographs were taken, and a narrative description was documented in accordance with the Historic District Treatment Plan (DOE/RL-97-56). The 222-U Laboratory/Office Building has been demolished under a separate CERCLA action.

A current ecological resources review will be performed prior to execution of field activities at the 221-U Building. Ecological resources reviews are required to ensure that remedial activities will not impact sensitive species of plants or animals, if present. Typically, these reviews are performed by PNNL and are performed on an annual basis during ongoing remedial activities.

3.5.5 Mitigation Action Plan

A mitigation action plan defines the methods for protection and restoration of cultural and ecologically significant areas, and identifies the species inhabiting the remediation area. A mitigation action plan presents a framework for limiting disturbances to cultural and ecological resources during remedial action projects and identifies opportunities for site restoration and revegetation, as appropriate.

The CERLCA Remedial Action Area as shown in Figure 4-1 was reviewed for cultural and ecological resources. No cultural or ecological resources requiring mitigation or protection were found, as stated in Section 3.5.4; therefore, a mitigation action plan is not needed for remediation of the 221-U Facility. If conditions change during remediation (e.g., a nesting bird is identified in the area or a buried artifact is found), a mitigation action plan will be developed with input from stakeholders.

3.5.6 Vegetation Plan

This vegetation plan was built on the information provided in DOE/RL-96-32, *Hanford Site Biological Resources Management Plan*, and from other revegetation that has occurred across the Hanford Site.

Initial vegetation of the engineered barrier and revegetation of disturbed areas is addressed generically in this section. Site-specific conditions will be evaluated and adjustments made during future revisions to this RD/RAWP, as the design progresses. For the engineered barrier, a specific plant or plant mixture may be specified to ensure proper barrier performance. Consultations with Native American Tribes and the Natural Resource Trustee Council also will be made as appropriate for additional input.

The goal of restoration and/or reclamation is to provide initial vegetation for the engineered barrier and support areas to communities dominated by native plant species and to ensure the design performance of the engineered barrier. Shrubs such as sagebrush and rabbitbrush may be planted to provide habitat and structure for nesting birds. Native grasses and forbs that are adapted to the site conditions will be planted to provide an understory.

Native species of a Hanford genotype will be used for a majority of revegetation efforts, where practical. Sandberg's bluegrass and needle-and-thread grass (*Stipa comata*) have been collected on the Hanford Site and grown as an agricultural crop to provide a large quantity of seeds for revegetation. Seeds of other native plants, such as sagebrush, yarrow (*Achillea millefolium*), Carey's balsamroot (*Balsamorhiza careyana*), pine bluegrass (*Poa scabrella*), and snow buckwheat (*Eriogonum niveum*), also may be collected on the Hanford Site and will be added to the planting mixture as available and as appropriate to the area. Additional species that may be collected include scurf pea (*Psoralea lanceolata*) rhizomes and seeds of sand dropseed (*Sporobolus cryptandrus*). Additional seeds of other species may be provided by the Native American Tribes and the Natural Resource Trustee Council and combined with the species described above.

The methods used for seeding will vary, depending on soil type and conditions. For example, drill-seeding works best on soils with minimal amounts of rock while broadcast seeding or hydro-seeding may be preferable on rocky soils. Seeds that are uncleaned or of an unsuitable shape or size may be broadcast over the area before the other seeds are planted. The action of the planting and mulching equipment will help set the broadcast seeds. Areas that have been used for support facilities and haul roads may have excessively compacted ground, making the area unsuitable for planting. If necessary, the soils in these areas will be loosened by ripping the soil with heavy equipment. If a seed drill is not appropriate at these areas, broadcast seeding (with subsequent harrowing or disking) or hydro-seeding may be used to plant seeds.

3.5.7 Public Involvement Plan

This public involvement plan outlines the strategy to provide information and identify opportunities to involve tribal nations, stakeholders and the public during the remedial design and remedial action processes. The Tri-Party agencies recognize the importance of early, frequent and regular opportunities to involve the public and consider their input in Hanford cleanup decisions.

The following outlines the basic framework of informational/involvement activities planned for the remedial design stage of the project:

- Update the Hanford Advisory Board's River and Plateau committee on remedial action progress; the committee will identify the information to provide the full Board.

- Provide government-to-government consultations with the tribal nations during remedial design, periodically during remedial actions, and/or when pertinent information becomes available. The U.S. Department of Energy, Richland Operations Office will concurrently transmit documents to the Native American Tribes, the Washington State Department of Ecology, and the U.S. Environmental Protection Agency.

- Provide documents and brief representatives from the State of Oregon as outlined in their Memorandum of Understanding (MOU) with DOE.

- Provide a presentation to the Natural Resource Trustee Council (as needed or requested).

- Provide ongoing information on the project to the public through *Hanford Update* articles.

- Prepare a fact sheet to describe the 221-U Facility remedial action strategy that will be sent to members of the Tri-Party Agreement (TPA) highly-interested mailing list.

3.5.8 Procurement

Procurement activities include preparing requests for proposals, soliciting qualified RCs, awarding a subcontract, coordinating submittals, negotiating change orders, and receiving and controlling RC requests for payment.

3.5.9 Quality Control

Construction and remedial action quality control will be performed in accordance with the DOE-approved Remediation Contractor QA program. Such a program may include the following:

- A summary of responsibilities and authorities of the organizations and key personnel involved in the design and construction of facility remediation;

- The qualifications of the quality assurance personnel to demonstrate that they possess the training and experience necessary to fulfill their identified responsibilities;

- The observations and tests that will be used to monitor construction, and the frequency of the performance of these activities;

- The sampling activities, sample size, sample locations, frequency of testing, acceptance and rejection criteria, and plans for implementing corrective measures as addressed in the plans and specifications.

- Descriptions of the reporting requirements for quality assurance activities (including such items as daily summary reports, schedule of data submissions, inspection data sheets, problem identification and corrective measures reports, evaluation reports, acceptance reports, and final documentation) and descriptions of the provisions for the final storage of records, consistent with overall requirements of the contractor records management program.

3.6 QUALITY ASSURANCE REQUIREMENTS

Overall quality assurance for the RD/RAWP will be planned and implemented in accordance with 10 CFR 830, Subpart A, *Quality Assurance Requirements*; *EPA Requirements for Quality Assurance Project Plans* (EPA QA/R-5); and *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (SW-846). The quality assurance activities will use a graded approach based on the potential impact on the environment, safety, health, reliability, and continuity of operations. The SAP (DOE/RL-97-68) also contains a quality assurance project plan, which was used to support the sampling and characterization activities. Other specific activities will include quality assurance implementation, responsibilities and authority, document control, quality assurance records, and audits. These activities are discussed in the following sections.

3.6.1.1 Quality Assurance Implementation

Project-related activities will establish and implement appropriate quality assurance requirements. Conditions adverse to quality will be identified in nonconformance reports, audit reports, surveillance reports, and corrective action requests. Investigation and corrective actions in response to these adverse conditions will be completed in a timely manner.

3.6.1.2 Responsibilities and Authority

The contractor must perform quality engineering, design reviews, surveillance, and audits (as necessary) to achieve quality assurance objectives. The contractor also must ensure that the various contractors and design agencies establish programs to control design and quality assurance in accordance with applicable requirements.

3.6.1.3 Document Control

Technical documents (e.g., specifications and drawings) will be controlled in accordance with approved configuration management internal work requirements and processes. The responsible design agency will maintain control of the design documents through acceptance of the documents.

Construction documents (e.g., Inspection and Test reports, Field Design Change requests, Formal request for design clarification) will also be controlled in accordance with an approved document control program.

3.6.1.4 Quality Assurance Records

Each organization that maintains quality assurance records will be required to control the records in accordance with applicable contractor quality assurance requirements.

3.6.1.5 Audits/Assessments

Internal and external audits may be performed by the contractor's assessments, regulatory, and quality program organizations to ensure project compliance with the quality assurance program requirements.

3.6.1.6 Self-Assessments

Self-assessments may be conducted by project personnel to determine compliance in accordance with the requirements of the contractor's internal work requirements and processes.

3.6.1.7 Procurement Quality Assurance

Procurement of items and services necessary to perform remediation activities shall be specified and inspected in order to ensure they meet all applicable project and design requirements and are free from suspect/counterfeit materials.

3.7 LONG-TERM MONITORING, MAINTENANCE, AND INSTITUTIONAL CONTROLS

Closure of the complex for this remedial action will require institutional controls and maintenance of a monitoring system. Institutional controls can consist of both physical and legal barriers to prevent access to contaminants. In addition, certain activities will need to be prohibited so that the groundwater and Columbia River water quality are protected. Post-remediation care will include periodic inspections and maintenance to verify the success of the revegetation effort.

3.7.1 Establish Institutional Controls

Institutional controls are non-engineering instruments, such as administrative and/or legal controls, that are designed to prevent exposure to contamination by limiting land or resource use. Cleanup at the 221-U Facility site is based on the assumption that the remedy will effectively isolate contaminants and break exposure pathways. However, the land use will be restricted indefinitely due to an industrial land use designation for Hanford's 200 Area and the probability of residual contamination remaining after remedial actions that is above levels that would allow for unrestricted use. In addition, groundwater use will be restricted for the foreseeable future until drinking water standards are achieved. The groundwater is contaminated primarily with radionuclides from releases from other units in Hanford's 200 West Area. Human exposure to residual contamination must be limited to those levels calculated to be protective under the industrial exposure scenario. In addition, certain activities will be prohibited to ensure that the remedy is protected and that the groundwater and Columbia River water quality are protected as well. Hence, institutional controls are an integral part of the selected remedy.

The 221-U Facility operating safety basis, and the associated institutional controls, will be maintained and implemented in accordance with existing surveillance and maintenance documentation as appropriate and coordinated with initiation of the remedial action for the 221-U Facility. During and after the conduct of the remedial action, the 221-U Facility will be subject to a number of Hanford Sitewide institutional control requirements identified in Section 3.2 of DOE/RL-2001-41. In addition, the following 221-U Facility-specific institutional controls are required to be met as part of this remedial action through the time of completion of remedy construction:

1. Control access to prevent unacceptable exposure of humans to contaminants at the 221-U Facility until remedy construction is complete. Visitors entering any site areas are required to be badged and escorted at all times. A detailed map showing the extent of the 221-U Facility boundaries for land use control is shown in Figure 1-2.

2. No intrusive work shall be allowed at the 221-U Facility site unless the EPA and Ecology have approved the plan for such work and that plan is followed.

3. Well drilling is prohibited at the 221-U Facility except for monitoring, characterization, or remediation wells authorized by EPA and Ecology through approved documents.

4. Groundwater use at the 221-U Facility is prohibited, except for limited research purposes and monitoring and treatment authorized by EPA and Ecology through approved

documents. This prohibition applies until drinking water standards are achieved and EPA and Ecology authorize removal of restrictions. Decision documents for the 200-UW-1 source operable unit and 200-UP-1 groundwater operable unit as well as the Site-wide Institutional Controls Plan will contain the institutional controls and implementing details prohibiting well drilling and groundwater use in the U Plant Area and portions of the 200 West Area as defined in those decision documents.

5. Warning signs will be posted and maintained along access roads which caution site visitors and workers of potential hazards from the 221-U Facility.

6. In the event of any unauthorized access to the site, such as trespass, the incident(s) will be reported to the Benton County Sheriff's Office for investigation and evaluation of possible prosecution.

Except for item numbers 3, 4, and 7 below, the institutional controls will be maintained until the concentration of hazardous substances in the soil and groundwater are at such levels to allow for unrestricted use and exposure. The following 221-U Facility-specific institutional controls are required after completion of the remedial action:

1. Ensure the use of the 221-U Facility site as well as any activities at the site are restricted to industrial use only, consistent with the exposure assumptions used in establishing risk-based cleanup levels for radionuclides and the use of the Model Toxics Control Act Cleanup Regulation (MTCA) Method C to calculate industrial cleanup levels for chemicals. A surveillance program shall be maintained to document that risk-and ARAR-based cleanup levels (and the exposure durations upon which they are based) are not exceeded. The 221-U Facility site shall be prohibited from development and use for residential housing, elementary and secondary schools, child care facilities, and playgrounds.

2. Activities that would disrupt or lessen the performance of the engineered surface barrier shall be prohibited.

3. An effective vegetative soil layer shall be maintained to promote the succession of native plants as a feature of the evapotranspiration surface barrier and prohibit activities that would lessen the effectiveness of the vegetation, barrier, and run on/run off controls. These infiltration control measures shall be maintained unless (or until) it can be demonstrated that the proposed activity or change in maintenance will result in no negative impact on groundwater or river water quality from any potential release of contamination from the site, and EPA and Ecology approve the change.

4. No irrigation will be permitted for agriculture or landscaping on the 221-U Facility site. This infiltration restriction shall be maintained unless (or until) it can be demonstrated that the proposed irrigation will have no negative impact on groundwater or river water quality from any potential release of contamination from the site, and EPA and Ecology approve the change.

5. No intrusive work shall be allowed at the 221-U Facility site unless EPA and Ecology have approved the plan for such work and that plan is followed.

6. Well drilling is prohibited at the 221-U Facility site except for monitoring, characterization, or remediation wells authorized by EPA and Ecology through approved documents.

7. Groundwater use at the 221-U Facility site is prohibited, except for limited research purposes and monitoring and treatment authorized by EPA and Ecology through approved documents. This prohibition applies until drinking water standards are achieved and EPA and Ecology authorize removal of restrictions. Decision documents for the 200-UW-1 source operable unit and 200-UP-1 groundwater operable unit as well as the Site-Wide Institutional Controls Plan will contain the institutional controls and implementing details prohibiting well drilling and groundwater use in the U Plant Area and portions of the 200 West Area as defined in those decision documents.

8. Activities that would damage the monitoring system and its components (e.g., monitoring wells) is prohibited.

9. A record system or database that tracks locations and estimated quantities of residual contamination left in place shall be established and maintained.

10. The location of residual contamination shall be reported in deed notices and other informational devices. In addition, a copy of any material documenting the location and quantity of residual contamination shall be given to any prospective purchaser/transferee before any transfer or lease. Measures that are necessary to ensure the continuation of land use restrictions or other institutional controls (e.g., proprietary controls such as property easements or covenants) shall be taken before any transfer or lease of any property. EPA and Ecology must be notified at least 6 months before any transfer, sale or lease of any property subject to institutional controls required by a CERCLA decision document so that EPA and Ecology can be involved in discussions to ensure that appropriate provisions are included in the conveyance documents to maintain effective institutional controls. If it is not possible to notify EPA and Ecology at least 6 months before any transfer, sale or lease, then EPA and Ecology must be notified as soon as possible, but no later than 60 days before the transfer, sale or lease of any property subject to institutional controls.

11. The effectiveness of the institutional controls for this remedy must be reported annually, or on an alternative reporting frequency specified by EPA and Ecology. Such reporting may be exclusively for the 221-U Facility site or may be part of a Hanford site-wide report.

12. Warning and informational signs will be posted and maintained around the outside of the 221-U Facility site.

3.7.2 Groundwater Monitoring

This section provides a background on the hydrogeologic setting, existing groundwater contamination, and existing monitoring well networks in the vicinity of the 221-U Facility.

Based on the background information and projections of future conditions, a groundwater monitoring network configuration is proposed.

Key elements of groundwater monitoring activities include maintenance of groundwater monitoring wells, periodic replacement of monitoring wells, periodic groundwater monitoring, and annual reporting. The design, operation, and maintenance of the monitoring system will be optimized to coordinate with the monitoring requirements for the 200-UP-1 groundwater operable unit and the 200-UW-1 waste site operable unit. The design of the proposed groundwater monitoring network may change due to integration with the 200-UW-1 and 200-UP-1 Operable Unit groundwater monitoring requirements.

The 221-U Facility is located within the 200-UP-1 CERCLA Operable Unit. Much of the technical information gathered for the DOE/RL-92-76, *Remedial Investigation/Feasibility Study Work Plan for the 200-UP-1 Groundwater Operable Unit* is directly applicable to groundwater monitoring at the 221-U Facility. Hence, much of the detail of background and the physical setting of the facility are deferred to that document, with summary information presented here. Site-specific information is presented below.

3.7.2.1 Hydrogeologic Setting

The hydrogeology of the 200-UP-1Operable Unit, which includes the 221-U Facility geographically, is most recently discussed by Byrnes (2005). Most of that discussion is supported by analyses of greater detail, including those of DOE/RL-1993, and Williams et al. (2002).

3.7.2.1.1 Stratigraphy Beneath the 221-U Facility

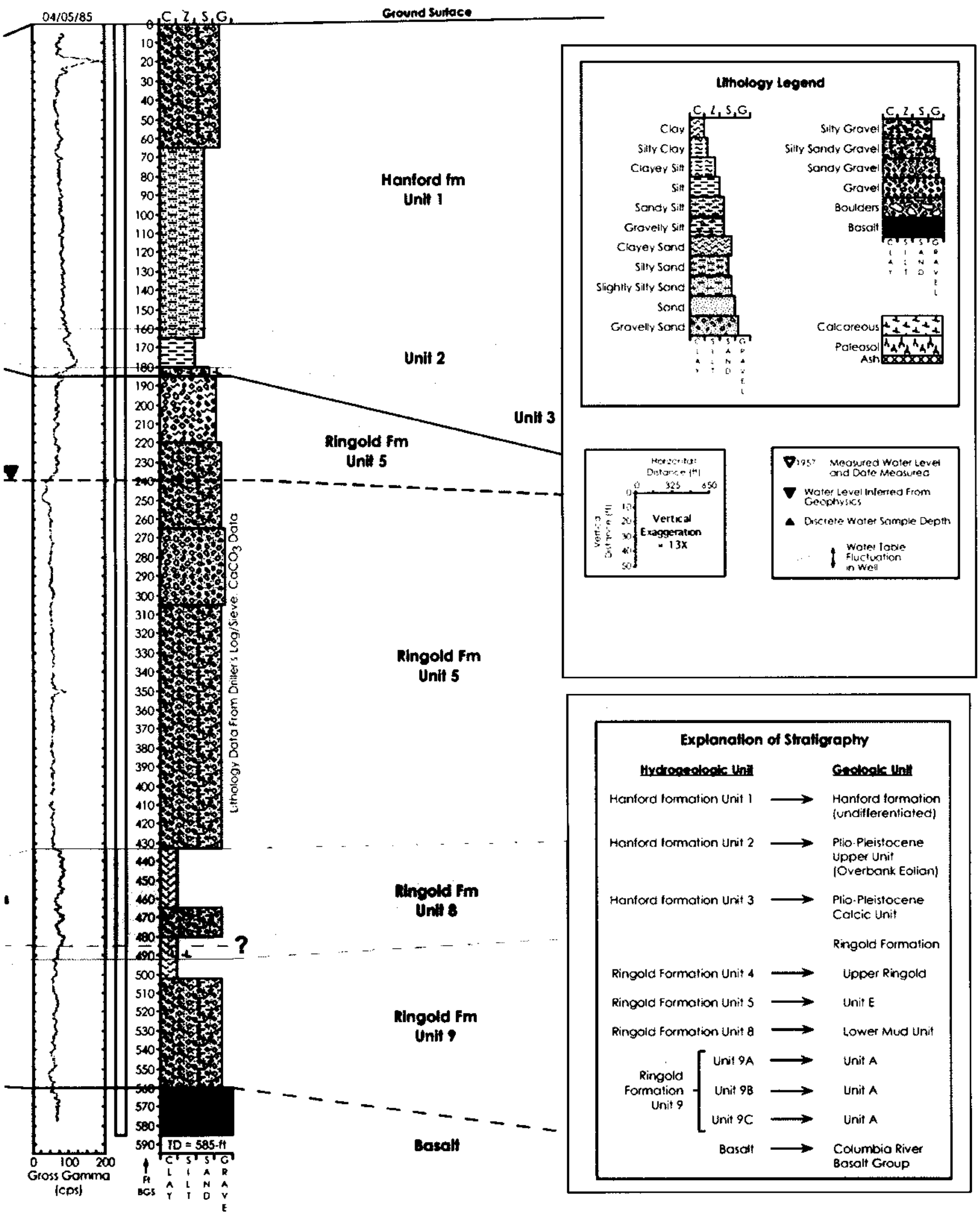
The stratigraphic description provided below is specific to well 299-W19-8, which is ~10 m (~33 ft) northwest of the 221-U Facility and should be considered generally representative of stratigraphy beneath the structure and its vicinity (Figure 3-6).

The top of the Elephant Mountain Member basalt is encountered at 171 m (560 ft) below ground surface (bgs) beneath the facility, and generally comprises the base of the unconfined (uppermost) aquifer across the Hanford Site. Immediately overlying the basalt is the Ringold Formation Unit 9 (also known as the geologic unit Ringold Unit A), mostly a silty, sandy gravel, which is moderately indurated, and approximately 21 m thick (150 to 171 m bgs) [68 ft thick (492 to 560 ft bgs)].

Ringold Formation Unit 9 is overlain by Unit 8, also known as the "lower mud unit." This stratum is dominantly clay and clayey silt 18.3 meter thick (from 132 to 150 m bgs) [60 ft thick (from 432 to 492 ft bgs)], but with an intervening layer of silty, sandy gravel from 142 to 146 m (465 to 480 ft) bgs. A calcareous horizon occurs near the base of Unit 9.

The Ringold Formation Unit 5 directly overlies Unit 8 at this location. This unit corresponds to the Ringold Formation Unit E, and consists of gravel with varying amounts of sand and silt. This is the thickest [75.3 m (247 ft)] designated unit beneath the 221-U Facility, reaching from 56.4 m to 132 m (185 ft to 432 ft) bgs.

Figure 3-6. Stratigraphy beneath the 221-U Facility as Represented by Well 299-W19-8 (After Williams, et al. 2002). See Figure 3-7 for location.



The Cold Creek Unit (units 2 and 3, collectively, in Figure 3-6), formerly known as the Plio-Pleistocene Unit, is approximately 7.6 m thick (49 m to 56.4 m) [25 ft thick (160 ft to 185 ft bgs)] and overlies the Ringold Unit 5. Beneath the 221-U Facility these units consist of silt (unit 2) and underlying silty gravel with calcareous layers near the base (unit 3). The occurrence of the Cold Creek Unit in the vicinity of the 221-U Facility is known to be variable in degree of consolidation/cementation and thickness (BHI-01203; DOE/RL-2002).

The Hanford formation Unit 1 extends from ground surface to 49 m (160 ft) bgs beneath the 221-U Facility. This stratum consists of approximately 30.5 m (100 ft) of silty sand overlain by about 18.3 m (60 ft) of silty, sandy gravel.

3.7.2.1.2 Groundwater Hydrology

Figure 3-7 illustrates the interpretation of the water table surface in the vicinity of the 221-U Facility, based on March 2007 water level measurements. The region north of the facility is somewhat more interpretive than elsewhere because of the dearth of wells in that area. The interpretation generally agrees well with modeled head from September 2006 (DOE/RL-2006-73).

The water table beneath the 221-U Facility is encountered at a depth of approximately 80 m (260 ft) bgs (based on March 2007 head data for well 299-W19-49). This places the water table within the silty, sandy gravel of the Ringold Formation Unit 5. The hydraulic gradient in the vicinity of the 221-U Facility varies from approximately 0.0013 beneath the 221-U Building to 0.0025 east of the facility about 305 m (1000 ft) (March 2007 water level data). In calculating groundwater travel times for wells near the 200-UP-1 pump-and-treat system, Erb and Kelty (DOE/RL-2006-73) provide an estimate of saturated hydraulic conductivity (K_s) of approximately15 m/day and use 0.1 to 0.12 for effective porosity. Applying these estimates to the calculated gradient for March 2007 in the formula:

$$\bar{v} = K_s i / n_e$$

(where $\bar{v}$ is average linear flow velocity of groundwater, K_s is saturated hydraulic conductivity, i is the hydraulic gradient, and n_e is the effective porosity), yields a range of average linear flow velocities from 0.16 to 0.38 m/day. An estimate of K_s of 4.2 to 4.5 m/day is given by Spane et al. (1999) is calculated for well 299-W22-79 near the 216-U-12 Crib, about 0.5 miles south of the 221-U Facility. Williams (in PNNL-16346, *Hanford Site Groundwater Monitoring for Fiscal Year 2006*) uses this estimate along with an effective porosity of 0.1 to 0.2 and gradient of 0.001 to calculate an average linear flow velocity of 0.027 to 0.05 m/day.

3.7.2.2 Monitoring Well Network

Rationale for selecting well locations for groundwater monitoring of the 221-U Facility is based on the need for a network which will:

- Provide adequate background water quality upgradient of the 221-U Facility
- Maximize the use of existing resources (existing wells)

- Allow differentiation between existing contamination (baseline) and any potential impacts by the 221-U Facility
- Accommodate minor changes in future flow direction, such as perturbations from low-flow pump and treat activities.

Using these criteria, a combination of four existing and two proposed well locations are selected as shown in Figure 3-7. The proposed upgradient well is located to monitor background conditions approximately midway between both ends of the 221-U Facility. Historic and current groundwater monitoring show several contaminant plumes impinging on the area surrounding the 221-U Facility. These include tritium, technetium-99, uranium, nitrate, iodine-129, and minor amounts of carbon tetrachloride. The highest concentrations of contaminants are southwest of the facility in the 216-U-1 and 216-U-2 cribs (DOE/RL-92-76; PNNL-16346). The existing well (299-W19-18) proposed as a background well is situated downgradient from this source and upgradient of the 221-U Facility, and will detect potential contamination originating at the cribs.

The three downgradient well locations are approximately 200 m (299-W19-36) to 450 m (299-W19-101) downgradient of the 221-U Facility. The intervals between the wells is partly a function of the existing locations (299-W19-101 and 299-W19-107) and the need for a third (proposed) monitoring point within the northern downgradient flow field of the facility (Figure 3-7). Aided by even minimal lateral dispersion, the distances of these three locations from the facility provide assurance that potential contamination will be detected. The fourth downgradient well (299-W19-36) is currently part of the 200-UP-1 pump-and-treat system, and is chosen to monitor the southern portion of the 221-U Facility, and to help establish background contamination levels due to other sources (e.g. existing plumes from other sources).

Interpretations from recent water level measurements (Figure 3-7) and modeled head values (DOE/RL-2006-73) both show that groundwater in the uppermost aquifer in the vicinity of 221-U Facility flows generally west to east. Perturbations to this pattern have occurred near the southern end of the 221-U Building as a result of the 200-UP-1 Operable Unit pump-and-treat activities to the southeast of the facility. Figure 3-8 illustrates a flow-net interpretation based on January 2005 modeled head conditions at the UP-1 pump-and-treat system just before shutdown of the system at the beginning of the rebound study (WMP-30847, *200-UP-1 Operable Unit Rebound Study Letter Report*). Pumping was maintained at a combined rate of approximately 189 liters per minute (lpm) [50 gallons per minute (gpm)] in three wells (299-W19-36, 299-W19-43, and 299-W19-39) for the previous 1 year prior to shutdown, producing the flow field illustrated in Figure 3-8. Outside of the immediate area of pumping, the flow field downgradient from the 221-U Facility is not substantially different from the static conditions shown in Figure 3-7, maintaining a general west-to-east direction. Beginning April 19, 2007, the pump-and-treat system was restarted at a rate of approximately 45 lpm (12 gpm). At this low rate of pumping the distortion of the natural flow field in the vicinity of the 221-U Facility is anticipated to be significantly less than that shown in Figure 3-8. Hence, no compromise in efficiency of the downgradient well network is expected from this operation.

Based on calculations presented above for average linear flow velocity for static conditions, groundwater travel times for conservative species (e.g., tritium) from directly beneath the source to the proposed monitoring wells would range from approximately 1.4 years (shortest travel time

Figure 3-7. Groundwater Horizontal Flow Net and Proposed Monitoring Well Locations Near the 221-U Facility.

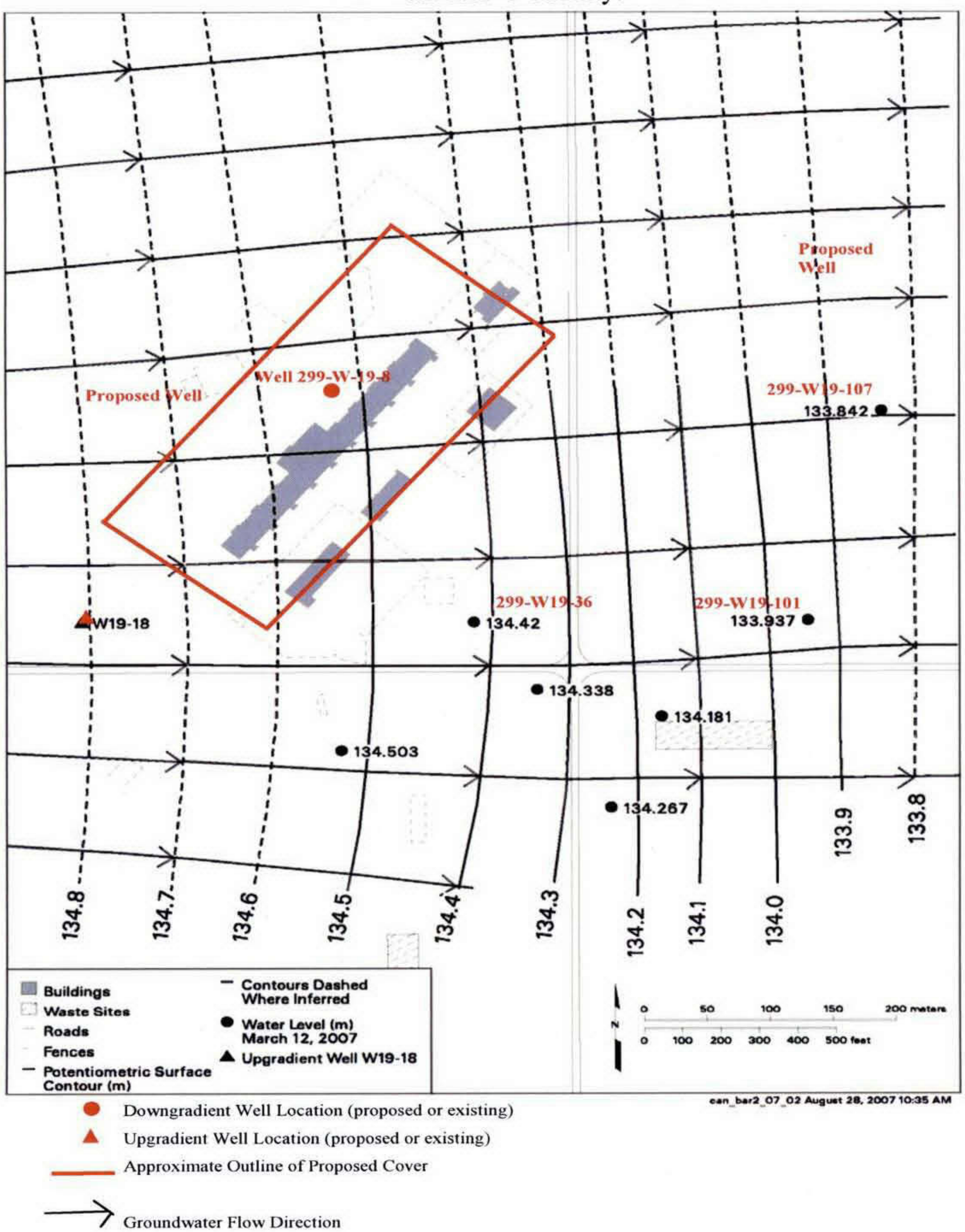
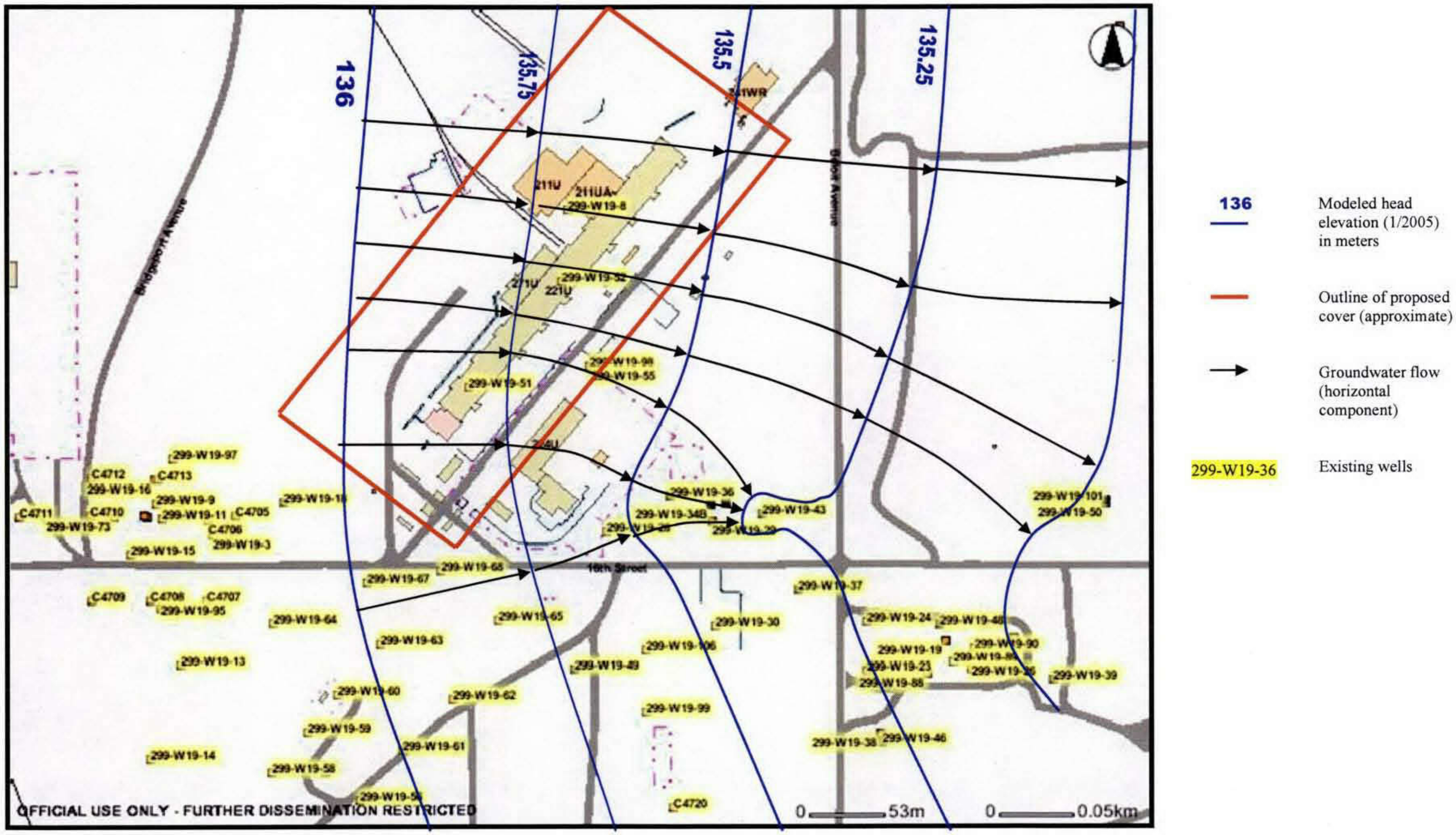


Figure 3-8. Groundwater Flow Interpretation in Vicinity of the 221-U Facility During Pump-and-Treat Activities for the 200-UP-1 Operable Unit. Contours are based on head values from Erb 2006.



for well 299-W19-36) to 41 years (longest travel time for well 299-W19-101). Compared with predicted transport times from source to groundwater for a covered source term (greater than 1000 years for all COPCs; [PNNL-15261, *Numerical Modeling of Contaminant Transport from Grouted Residual Waste in the 221-U Facility (U Plant)*]), the transport times from groundwater beneath the facility to the monitoring wells is short for conservative contaminants (e.g., tritium).

Detection of the conservative contaminants or indicator parameters above background levels would indicate possible contributions from a new source(s).

Groundwater in the 200 West Area continues to be a dynamic system, with future changes in pump-and-treat activities superimposed on a generally declining water table. As these changes occur, it will be necessary to periodically reevaluate the 221-U Facility monitoring network and make adjustments, as needed, to meet the objectives noted above.

3.7.2.3 Maintain Monitoring System

Performance monitoring of the barrier will be conducted to allow implementation of appropriate measures/best management practices, as necessary, to impede percolating water from reaching the underlying waste. The final design of the engineered barrier will provide the specific details on any engineered features to accomplish performance monitoring. Groundwater monitoring will be performed to monitor the effectiveness of the remedial action.

Groundwater monitoring for the 221-U Facility will be integrated and defined in a 221-U Facility O&M plan. This plan will encompass the 221-Facility and will integrate the monitoring needs associated with the various projects (such as 200-UP-1 Operable Unit groundwater monitoring, the U Plant Area, ancillary facilities) and other monitoring requirements for the selected remedy (such as barrier performance monitoring). Additional integration will be accomplished for the 221-U Facility specific to the institutional controls required with the selected remedy, as well as needs associated with these various other projects.

Post-remediation care will comply with the following functions as defined in WAC 173-303-665(6):

- Limit access to the environmental barrier.

- Maintain the integrity and effectiveness of the final cover (engineered barrier), including making repairs to the barrier, as necessary, to correct the effects of settling, subsidence, erosion, or other events.

- Maintain and monitor the groundwater monitoring systems.

- Prevent run-on and runoff from eroding or otherwise damaging the final cover (engineered barrier).

- Protect and maintain surveyed benchmarks.

(These functions were selected as being representative of the post-remediation requirements of other applicable regulations.)

Post-remediation care will consist mainly of periodic inspections to identify erosion, settling, or intrusion by burrowing creatures. Any of these items can lead to infiltration of the barrier. If settling is identified, the resultant depressions will be filled and reseeded as necessary.

Construction and initial maintenance will proceed for several years following closure of the facility. Cost estimates provided in the final feasibility study include a number of barrier surveillance and maintenance activities (e.g., quarterly visual inspections for barrier erosion, settlement, subsidence, displacement, cracking), but after a period of roughly 50 years, the facility is expected to be self-maintaining.

3.8 ATTAINMENT OF REMEDIAL ACTION OBJECTIVES

The selected remedy for the 221-U Facility will result in protection of human health and the environment. The remedial action will allow the site to be used consistent with the projected future industrial use of the 200 Area Central Plateau Core Zone. Future use of the site, while unlikely, could include light industrial activities (such as warehousing) in the vicinity of, but not on top of, the engineered barrier, so long as such activities do not impact barrier performance. The potential pathways of human and ecological exposure to facility contaminants will be severed primarily through use of an engineered barrier and institutional controls, as well as through the containment of contaminants in the grouted and the substantial concrete structure of the 221-U Facility. Threats to groundwater from these contaminants will be controlled through treatment by and encapsulation in grout within the remaining 221-U Facility structure, and through construction and maintenance of the engineered barrier.

3.8.1 Residual Risks Post-Achievement of Remedial Action Objectives

Acceptable human-health risk levels are attained through containment of residual contamination and severing of exposure pathways. The effectiveness of the remedy is protected by limiting land use to industrial activities that conform to institutional controls. The potential incremental cancer risk from contaminated soils, structures, and debris with respect to metals and organics is reduced from greater than 10^{-2} to at least as low as 1×10^{-5}. The potential incremental cancer risk from contaminated soils, structures, and debris with respect to radionuclides is reduced from greater than 10^{-2} to at least as low as 10^{-4} (approximate risk equivalent to 15 mrem/yr dose above background). Residual non-carcinogenic risks are reduced to acceptable levels by breaking the exposure pathways, and by macroencapsulation in grout.

3.8.2 Protection of Human Health and the Environment

The selected remedy protects human health and the environment through remedial actions to reduce or eliminate risks associated with exposure to contaminated structures, wastes, and debris. Implementation of this remedial action will not pose unacceptable short-term risks toward site workers that cannot be mitigated through acceptable remediation practices. Containment of contaminated structures, waste, and debris and the use of institutional controls will prevent exposure under anticipated future land use. Containment of contaminated waste and debris also will prevent further groundwater and surface water degradation. Because the objective of the selected remedy is to sever exposure pathways (including pathways to ecological receptors), the selected remedy is anticipated to be protective of ecological receptors.

3.9 CERCLA CLOSEOUT DOCUMENTATION

In support of completion of the 221-U Facility remedial action, a Remedial Action Report will be prepared for the facility. The report will provide the needed documentation for verification of the remedial action at the facility and to support the eventual deletion of the Site from the National Priorities List (40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan," Appendix B, "National Priorities List").

3.10 NONROUTINE RELEASES

This section describes actions that will be taken in the event of a nonroutine release during the conduct of the remedial action.

3.10.1 Reporting Requirements for Nonroutine Releases

The following reporting requirements apply for Federal hazardous substances that could be released during the remedial action activities.

40 CFR 302 requires immediate notification to the National Response Center on discovery of a release of a hazardous substance into the environment in excess of a reportable quantity.

40 CFR 355 requires immediate notification to the community emergency coordinator for the local emergency planning committee and to the State Emergency Response Commission for a release of a reportable quantity of an extremely hazardous substance, a comprehensive release of a reportable quantity of an extremely hazardous substance, or a CERCLA hazardous substance.

3.10.2 Nonroutine Release Response

In the event of a spill or release of a hazardous substance, appropriate spill or release response actions will be performed commensurate with the type and magnitude of the spill or release. If practicable, immediate measures consistent with applicable laws and regulations will be taken to reduce the potential for the spill or release to threaten human health and/or the environment. If cleanup cannot be performed within a reasonable time period, then the spill or release would be interim stabilized, if possible, and the site would be added to the *Waste Information Data System*. The site would be evaluated, and if a CERCLA and/or *Resource Conservation and Recovery Act of 1976* (RCRA) corrective action response action is warranted, then the waste site will be plugged-in to the 200-UW-1 Operable Unit ROD for eventual remediation.

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4.0 WASTE MANAGEMENT PLAN

Waste management activities will be performed for the 221-U Facility in accordance with the applicable ARARs identified in the ROD. The waste management requirements specified by the ARARs and other applicable guidance will be addressed in this section and in field procedures, as needed.

The selected remedy shall attain waste management ARARs except for RCRA landfill minimum technological requirements for leak detection. In addition, RCRA land disposal restrictions and polychlorinated biphenyl (PCB) requirements shall be satisfied by meeting the substantive requirements for a treatability variance and a *Toxic Substances Control Act of 1976* risk-based determination for the management of PCBs as described below.

The WAC 173-303-665(2)(h), "Dangerous Waste Regulations," "Landfills," requires new landfills to have two or more liners and a leachate collection and removal system. Under WAC 173-303-665(2)(j), an alternative design can be used if the following criteria are met: (1) the proposed alternative design and operation together with location characteristics will prevent the migration of any dangerous constituents into the groundwater or surface water at least as effectively as the liners and leachate collection and removal system; and (2) the alternative design will allow detection of leaks of dangerous constituents through the top liner at least as effectively.

The in-place disposal of waste currently in the 221-U Facility under the selected remedy will not include liners and a leachate collection and removal system and will satisfy these RCRA landfill minimum technological requirements by satisfying and waiving part of the substantive requirements for an alternative design at WAC 173-303-665(2)(j). Waste will be grout-encapsulated within the canyon, and an engineered barrier will be constructed to provide additional contaminant containment. Modeling predicts that no contaminants will migrate out of the grout and concrete monolith into the groundwater within 1,000 years. Computer-aided modeling has been performed to demonstrate that, once encapsulated in grout and contained within the canyon structure, contaminants currently identified in the 221-U Facility will not migrate into the accessible environment including the soils around or under the facility for the duration considered for normal liner performance. This approach will prevent the migration of any dangerous constituents into the groundwater or surface water at least as effectively as the liners and leachate collection and removal system. Details of this demonstration are provided in the final feasibility study (DOE/RL-2001-11).

The in-place disposal of waste currently in the 221-U Facility under the selected remedy, however, will not satisfy WAC 173-303-665(2)(j)(ii) alternative landfill minimum requirements for leak detection. This requirement is being waived in accordance with 40 CFR 300.430(f)(1)(ii)(C)(3), "Remedial Investigation/Feasibility Study and Selection of Remedy," because, from an engineering standpoint, it is technically impracticable to construct a leak detection system beneath the canyon building. (The bottom of the structure is approximately 9 m [30 ft] below grade.) Again, modeling predicts that no contaminants will migrate out of the grout and concrete monolith and to groundwater within 1,000 years. Performance monitoring of the engineered barrier will allow for application of mitigative or preventative action (e.g., increasing barrier thickness) to impede water from reaching the underlying waste. Additionally, groundwater monitoring will be performed to monitor the effectiveness of the remedial action.

Land-disposal-restricted waste that will remain in the facility includes liquid and sludge that exhibits characteristics (primarily toxicity, such as for mercury or lead) that cause the waste to be designated as dangerous waste. Under the selected remedy, in lieu of treatment pursuant to land disposal restriction provisions (e.g., to remove toxic characteristics or thermally treat mercury), alternative treatment will be provided to mitigate risk associated with disposal of this waste within the canyon. For disposal of waste currently located within the 221-U Facility, the selected remedy will satisfy RCRA land disposal restrictions by meeting substantive criteria for a treatability variance in accordance with 40 CFR 268.44(h)(2)(i), "Land Disposal Restrictions," "Variance from a Treatment Standard," because it will be technically inappropriate to treat mercury contained in sludge with the specified treatment method (incineration, retorting, or roasting) considering the limited incremental benefit when weighed against the significant increase in worker risk from radiological exposure. Under the selected remedy, alternative treatment (macroencapsulation with grout and ultimate containment within the 221-U Facility canyon structure) will be provided.

To meet *Toxic Substances Control Act of 1976* ARARs under the selected remedy, DOE will use the risk-based disposal option. EPA has made a risk-based determination for the purpose of demonstrating there is no unreasonable risk of injury to human health or the environment associated with the management and disposal of PCB remediation waste in the 221-U Facility, in accordance with the substantive requirements of 40 CFR 761.61(c), "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions," "PCB Remediation Waste." The determination was based on the small amount of PCBs identified in the 221-U Facility, the low volatility of the PCBs, and the protectiveness that will be provided via macroencapsulation of the PCBs in grout and in the concrete monolith of the canyon structure.

4.1 PROJECTED WASTE STREAMS

One or more of the following waste streams may be generated by the 221-U Facility remedial action for disposal outside the structures being remediated. The waste streams may fall into any combination of the following categories: radioactive, mixed, hazardous, dangerous, suspect radioactive, suspect dangerous, suspect mixed, and nonregulated:

- Miscellaneous solid waste (e.g., piping, soil, concrete, rubber, glass, paper, personal protective equipment, cloth, plastic, metal);

- Decontamination fluids and vessel fluids/heels;

- Equipment and construction materials (such as hand and power tools and machinery, sampling equipment, decommissioning materials);

- Nondangerous/nonradiological solid waste (e.g., paper, wood, construction debris, metal, plastic, glass).

4.2 WASTE CATEGORIES

Wastes will be separated into broad categories, as described in the following subsections. Depending on the levels of contamination encountered, some materials classified as contaminated may require special handling.

Low-Level Waste will be defined as any radioactive waste not designated as spent fuel, high-level waste, or transuranic waste. The low-level waste will include step-off pad wastes, soft waste, material used in decontamination, process items that have been partially decontaminated, and waste packages. This low-level waste will be mainly solid in form, although some liquid and sludge waste may be generated during the project activities. Low-level waste removed from the structures being remediated will be shipped to the ERDF (Figure 1-1). This waste also may be packaged and temporarily placed in storage within the 221-U Facility Remedial Action Area prior to shipment. The tentatively identified configuration of this remedial action area is shown in Figure 4-1.

Transuranic Waste will be wastes that after stabilization contain greater than 100 nCi/g of transuranic isotopes (e.g., the contents of a process vessel in Cell 30). This waste will be removed from the facility and dispositioned to the CWC for interim storage.

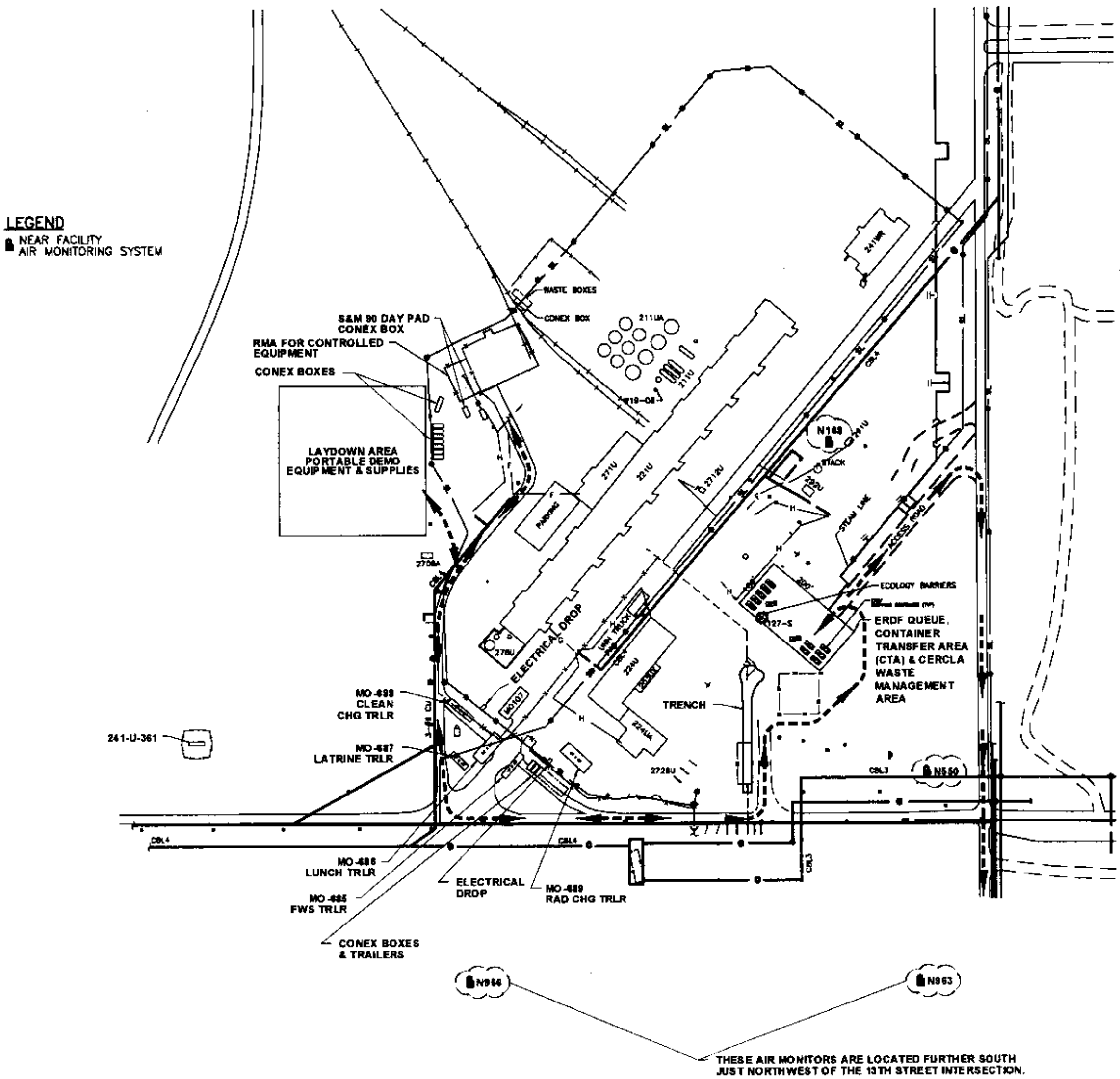
Dangerous Waste sources are expected to be from the use of acids and cleaning solutions in specific nonradiological, surface decontamination efforts, as well as mercury switches and lead-based paints. With a viable waste minimization program and the substitution of non-regulated material, the portion of this waste stream that has not become radioactively contaminated should be a minor source of dangerous waste. This regulated dangerous waste may be in either liquid or solid form.

Mixed Waste is another minor waste stream that can be expected. Hazardous substances that are shipped from the site will be classified as either dangerous waste or mixed waste (if radioactive). The source of this waste stream likely will be remaining contaminant residues (e.g., lead) on radioactively contaminated facility equipment and surfaces and the chemicals/materials used for decontamination.

PCB Waste may be in existing coatings on the facility's interior surfaces (e.g., walls, ceilings). In addition, light ballasts and other equipment may contain some level of PCBs. Consequently, some of the waste streams discussed above also may be contaminated with PCBs.

Non-Regulated Bulk Waste is expected (e.g., building rubble and radiologically released metal and concrete) resulting from the remediation of the 221-U Facility.

Figure 4-1. Tentatively Identified 221-U Facility Remedial Action Area.



4.3 ONSITE DETERMINATION

The preamble to 40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan," states that when noncontiguous facilities are reasonably close to one another and wastes at these sites are compatible for a selected treatment or disposal approach, CERCLA Section 104(d)(4) allows the lead agency to treat these related facilities as one site for response purposes and, therefore, allows the lead agency to manage waste transferred between such noncontiguous facilities without having to obtain a permit. The 221-U Facility site addressed by this final action ROD and ERDF are reasonably close to one another, and the wastes are compatible for the selected disposal approach. Therefore, the sites (ERDF and 221-U Facility) are considered to be a single site for response purposes.

4.4 WASTE CHARACTERIZATION

Waste generated as a result of project activities for disposal outside the structures being remediated will be or have been characterized in accordance with the SAP (DOE/RL-97-68) (or a new SAP as needed) and waste acceptance criteria.

4.5 WASTE DESIGNATION

Waste profiles and designations will be developed on an as-needed basis throughout the project. The characterization criteria identified in the SAP, Section 3.6.5.3 (or a new SAP as needed) will provide the rationale and strategy for conducting sampling and analysis activities in support of waste designation. The SAP contains sampling, analysis, and radiological survey requirements to support waste designation and disposal decisions during phases of the remedial action project. The characterization data will be used to prepare waste profile summaries for evaluations against waste acceptance criteria to determine appropriate disposal options.

4.6 WASTE MINIMIZATION AND RECYCLING

By using waste separation and segregation, waste generation can be kept to a minimum. Waste will be segregated at the 221-U Facility as generated, which will minimize the volume of regulated waste. Wastes will be separated into the following categories: low-level, transuranic, mixed, dangerous, PCB and non-regulated bulk.

Hazardous waste minimization will be considered in the selection of decontamination agents and solutions used in the 221-U Facility.

Materials will be recycled, reused, or reclaimed whenever practicable and economically feasible. Introduction of clean materials into a contamination area and contamination of clean materials will be minimized to the extent practicable. During phases of waste management, emphasis will be placed on source reduction to eliminate or minimize the volume of waste generated.

Materials released off site for disposal/recycle must be certified to be free of contamination in accordance with DOE guidance for nonreal property. Materials with no or de minimis levels of CERCLA hazardous substances are not considered CERCLA waste and, therefore, are not subject to the 40 CFR 300.440, "Procedures for Planning and Implementing Off-site Response Actions," offsite acceptability determination.

4.7 WASTE HANDLING AND STORAGE

Waste generated from the 221-U Facility remedial activities for disposal outside the structures being remediated will be stored in designated waste storage areas and identified by signs reading "CERCLA WASTE MANAGEMENT AREA." Incompatible wastes will be separated within the designated waste storage areas to prevent commingling of the wastes.

Packages containing radioactive waste will be staged in radiological materials areas for shipment to the ERDF or to the Central Waste Complex (CWC).

Waste storage will meet the ARARs identified in the ROD. Appropriate areas will be established, in which waste is staged and, if necessary, temporarily stored before shipment. These waste staging and storage areas reside within the CERCLA Remedial Action Area, as identified in Figure 4-1. The exact location(s) of such areas may differ from the locations depicted in Figure 4-1. These waste staging and storage areas are necessary for implementation of the remedial action.

Stored wastes shall be inspected weekly to verify container integrity, legibility of markings and labels, and proper placement of signs. Container inspections will be documented on the appropriate checklist. An inventory of the waste generated will be maintained. A waste specialist or designee will inspect waste containers as they are filled. Before any waste shipment, the containers must be properly sealed and checked for leaks or other damage. A final inspection will be performed at the time of shipment.

4.8 WASTE TREATMENT

Treatment of waste streams could be necessary to provide for safe transport and effective disposal, and to address land disposal restrictions. The waste treatment could occur onsite either at the 221-U Facility or the ERDF, as practical, in accordance with the substantive requirements of WAC 173-303 and the applicable disposal site waste acceptance criteria. Onsite waste treatments could include solidification, separation, elementary neutralization, amalgamation, size reduction, or repackaging, and will be implemented using the criteria identified or the process described below. In the event waste cannot be treated onsite, an offsite search will be conducted to determine whether the waste can be effectively treated offsite. Once an offsite location is found, an offsite determination will be requested.

4.8.1 Solidification

Solidification is a technique that physically limits the mobility of dangerous waste by reducing or eliminating free liquids in the waste.

The following criteria apply to meet treatment by solidification:

- The solidified waste must meet the paint filter liquids test, specified as Method 9095 of *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, document number SW-846 (EPA 1986a), for assessing the amount of free liquid in the waste. The waste specialist or designee must ensure that the solidification technique used can solidify waste in the container or tank to this standard. In most cases, this will mean ensuring adequate mixing of the waste with the solidification material.

- The waste must be solidified using a non-biodegradable solidification material.

4.8.2 Separation

Separation through decanting (solid-liquid systems) is the process of actively separating materials having differing specific gravities. The clarified supernatant is removed and the solids are preferentially concentrated in a smaller fraction of the liquid.

Separation through sedimentation or clarification is the settling out by gravity of solid particles suspended in a liquid.

Separation through oil skimming or phase separation is the equivalent of decanting, but for liquid-liquid systems where the liquid phases are immiscible and/or have differing specific gravities. The following criteria apply to meet treatment by separation:

- Ensure that ignitable or reactive waste treatment in tanks complies with WAC 173-303-640(9)(a), "Tank Systems."

- No processes that generate toxic or flammable gasses or volatilize dangerous waste materials directly to the air may be used.

4.8.3 Elementary Neutralization

Elementary neutralization means the process of neutralizing wastes that are dangerous wastes only because they exhibit the characteristic of corrosivity as defined by one or more of the following properties:

- An aqueous waste with a pH less than or equal to 2, or greater than or equal to 12.5;

- A liquid that corrodes steel at rates and under conditions specified in WAC 173-303-090(6)(ii), "Dangerous Waste Characteristics;"

- A solid waste that when mixed with an equal weight of water results in a solution, the liquid portion of which has either a pH less than or equal to 2, or greater than or equal to 12.5.

The following criteria apply to meet treatment by elementary neutralization.

- Elementary neutralization must be conducted in accumulation tanks or containers.

- The treatment residuals must exhibit either: (a) a pH of greater than 2 and less than 12.5 prior to onsite management or disposal, or (b) a pH that meets the requirements of a delegated municipality or local solid waste authority.

- Elementary neutralization must not pose a risk to human health and the environment.

- The resulting treatment residuals must be managed and disposed of in accordance with state and local regulations.

4.8.4 Mercury Amalgamation

Mercury amalgamation is the chemical process used to bind elemental mercury waste with another chemical for stabilization, and must meet the following criterion:

- Elemental mercury waste may be combined with a solid amalgam for waste stabilization prior to disposal. After treatment by mixing the amalgam and the elemental mercury, there can be no freestanding liquids.

4.8.5 Size Reduction

The selected remedial action requires consolidation of items on the 221-U Building canyon deck into below-deck locations. Some of the items may need to be disassembled or cut into smaller pieces to ensure that they will fit into the canyon cells/pipe trench or in an approved waste container; therefore, this is considered a treatment.

Consolidation will result in the encapsulation of wastes within the grouted, substantial structure of the canyon building. Additionally, removal of items from the canyon deck to below-deck locations will result in a reduction in the final height of the engineered surface barrier required to cover the partially demolished canyon structure at the conclusion of the remedial action.

4.8.6 Repackaging

Waste may need to be repackaged for a variety of reasons (e.g., due to void space issues or the need to remove a waste component from the already packaged container). Waste treatment may also occur offsite, and will receive prior offsite determination approval.

4.9 WASTE DISPOSAL

As stated previously, it is anticipated that most of the low-level and mixed low-level waste and debris from the remedial action that is shipped from the site will be disposed of at the ERDF, which is designed to meet RCRA minimum technical requirements for land disposal. The ERDF can also accept some asbestos and PCB waste. The criteria for ERDF's acceptance of waste are presented in the *Environmental Restoration Disposal Facility Waste Acceptance Criteria* (BHI-00139). Dangerous waste that does not meet the ERDF waste acceptance criteria will be disposed of at a permitted offsite facility, with an approved offsite determination.

Transuranic waste will be packaged and shipped to the CWC in accordance with the *Hanford Site Solid Waste Acceptance Criteria* (HNF-EP-0063) for future shipment to WIPP.

4.10 RETURNED SAMPLE WASTE

Screening and analysis of both solids and liquids may be conducted for the 221-U Facility, at offsite or onsite laboratories or at a radiological counting facility. Unused sample portions will be returned to the project for disposal with the remainder of the waste streams, and associated laboratory waste from offsite analyses will be managed by the applicable laboratory in accordance with contract specifications. Waste from field screening and onsite laboratories will be managed depending on whether it has been altered. Altered samples will be contained and disposed of at the 200 Area Effluent Treatment Facility, ERDF, or other appropriate facilities as authorized by the EPA, depending on waste designation. Unaltered liquid waste generated during sample screening and analysis that does not exceed collection criteria limits may be discharged to the ground near the point of generation; if it exceeds the collection criteria, it may be disposed of at the Effluent Treatment Facility, ERDF (if stabilized), or other appropriate facilities. Some liquids may be neutralized and/or stabilized to meet the disposal facility's waste acceptance criteria. Pursuant to 40 CFR 300.440, EPA approval is required before unused samples or waste can be returned from offsite laboratories. Approval of this RD/RAWP constitutes EPA remedial project manager approval for shipment of offsite and onsite laboratory sample waste back to the 221-U Facility.

4.11 EQUIPMENT AND CONSTRUCTION MATERIALS

Equipment and construction materials that become contaminated with CERCLA hazardous substances will be decontaminated either with a three-bucket wash or with a high-temperature and high-pressure wash and 82.2 °C and greater than 70.3 kgf/cm^2 (180 °F and greater than 1,000 lbf/in^2) in a wash basin capable of retaining rinsate, as needed. Water used for decontamination activities will be potable (e.g., Hanford Site potable water). Rinsate will be managed accordingly through applicable treatment, packaging, storage, and disposal. If contamination is determined to be fixed for any equipment or materials, the radiological control technician and task manager will make the decision to remove the contamination using more aggressive methods or to dispose of the equipment. If equipment is to be dispositioned, a declaration-of-excess form will be completed and the material will be packaged accordingly.

4.12 WASTE DISPOSAL RECORDS

Original copies of sampling records, waste inventory documentation, and waste container certification forms will be forwarded to the assigned waste specialist to be included in the waste file and to initiate waste tracking in the *Solid Waste Information Tracking System*. The completed waste files will be included in the receiving facilities' project file following final waste disposition.

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5.0 AIR EMISSIONS

The (Federal) *Clean Air Act of 1990* and RCW 70.94, "Public Health and Safety," "Washington Clean Air Act," require regulation of air pollutants. The 221-U Facility remedial action would have the potential to generate both radioactive and nonradioactive airborne emissions.

5.1 NONRADIOACTIVE EMISSIONS

Under WAC 173-400, "General Regulations for Air Pollution Sources," and WAC 173-460, "Controls for New Sources of Toxic Air Pollutants," requirements are established for the regulation of emissions of criteria/toxic air pollutants. The primary nonradioactive emissions resulting from this remedial action will be fugitive particulate matter. In accordance with WAC 173-400-040, "General Standards for Maximum Emissions," reasonable precautions must be taken to (1) prevent the release of air contaminants associated with fugitive emissions resulting from materials handling, demolition, or other operations; and (2) prevent fugitive dust from becoming airborne from fugitive sources of emissions. The use of treatment technologies that would result in emissions of toxic air pollutants that would be subject to the substantive applicable requirements of WAC 173-460 are not anticipated to be a part of this remedial action. Treatment of some waste encountered during the remedial action may be required to meet ERDF waste acceptance criteria. In most cases, the type of treatment anticipated would consist of solidification/stabilization techniques such as macroencapsulation or grouting, and WAC 173-460 would not be considered an ARAR. If more aggressive treatment is required that would result in the emission of regulated air pollutants, the substantive requirements of WAC 173-460-113(2) and WAC 173-460-060 and would be evaluated to determine applicability.

Emissions to the air will be minimized during implementation of the remedial action through use of standard industry practices such as the application of water sprays and fixatives and use of temporary confinement enclosures. These techniques are considered to be reasonable precautions to control fugitive emissions as required by the regulatory standards.

The Federal implementing regulations also contain requirements for managing asbestos material associated with demolition and waste disposal (40 CFR 61, Subpart M, "National Emission Standards for Asbestos").

5.2 EMISSIONS OF RADIONUCLIDES

In accordance with 40 CFR 61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities," radionuclide airborne emissions from the facility will be controlled so as not to exceed amounts that would cause an exposure to any member of the public of greater than 10 mrem/yr effective dose equivalent. The same regulation addresses point sources (i.e., stacks or vents) emitting radioactive airborne emissions, requiring monitoring of such sources with a major potential for radioactive airborne emissions, and requiring periodic confirmatory measurement sufficient to verify low emissions from such sources with a minor potential for emissions. Under state implementing regulations, the Federal regulations are paralleled by adoption, and in addition require added control of radioactive airborne emissions where economically and technologically feasible

(WAC 246-247-040, "Radiation Protection - Air Emissions," "General Standards," (3) and (4) and associated definitions).

The substantive aspect of these requirements, which is the employment of ALARA principles based on best or reasonable control technology, will be addressed by ensuring that applicable emission-control technologies (those successfully operated in similar applications) will be used when economically and technologically feasible (i.e., based on cost/benefit). Additionally, the substantive aspect of the requirements for monitoring fugitive or non-point sources emitting radioactive airborne emissions (WAC 246-247-075(8), "Radiation Protection - Air Emissions," "Monitoring, Testing and Quality Assurance") will be addressed by sampling the effluent streams and/or ambient air as appropriate using reasonable and effective methods.

5.3 RADIONUCLIDE AIRBORNE SOURCE INFORMATION

There is a potential for particulate radioactive airborne emissions to result from the remedial action activities. The potential radionuclide emissions were calculated for the remedial action activities. The emission calculations are divided into three parts. The first part is the minor emission activities such as canyon reactivation, size reduction of items on the canyon deck, and item consolidation activities, monitored through the 291-U-1 Stack. The second part involves a major emission activity while material is being removed from a process vessel in Cell 30, which also will be monitored from the 291-U-1 Stack, and the last part of the remedial action activity will result in minor fugitive emissions from grouting and demolition activities, which will be monitored using the near-facility monitoring system.

The primary radionuclides detected include Am-241, Pu-239, Pu-240, Np-237, Cs-137, U-234, U-235, U-238, and Sr-90. Other radionuclides listed in DOE/RL-2001-11 also may be encountered during the remedial action activities.

The distance to the Laser Interferometer Gravitational Wave Observatory receptor is 18,310 m east-southeast of the 200 West Area. This is the nearest public location where the hypothetical maximally exposed individual (MEI) might be located. Dose factors used specific to this location were taken from *Calculating Potential-to-Emit Radiological Releases and Doses*, HNF-3602, 2002. The following tables (Tables 5-1, 5-2, and 5-3) identify the unabated potential-to-emit from the remedial action, the best available radionuclide control technology resultant emissions, and the respective total effective dose equivalent (TEDE) values for the MEI based on the selected remedy.

Table 5-1. Dose Calculations for Canyon Reactivation and Size Reduction Activities.

Nuclide[a]	**Radionuclide Inventory (Ci)[b]**	**40 CFR 61, Appendix D, Release Factor**	**Unabated Release Rate (Ci/yr)**	**HEPA Filter Factor (Sand Filter – Based on a 99.95 % Efficiency)**	**Abated Release Rate (Ci/yr)**	**200 West Area ≥40 m (291-U-1 Stack) Dose-per-Unit Release Factor (mrem/Ci)**	**Unabated Dose to MEI (mrem/yr)**	**Abated Dose to MEI (mrem/yr)**
Am-241	1.80	1.0E-03	1.80E-03	2,000	9.00E-07	1.1E+01	1.98E-02	9.90E-06
Sr-90	108	1.0E-03	1.08E-01	2,000	5.40E-05	8.7E-03	9.40E-04	4.70E-07
						TEDE Totals:	2.07E-02	1.04E-05

[a] Am-241 and Sr-90 were used as worst-case isotopes for the calculations.
[b] Values were obtained from the *ALARA Review for the 221-U Characterization* (BHI-01240, Appendix A). The beta/gamma surface contamination level used was 1,500,000 dpm/100 cm^2 and the alpha surface contamination level used was 25,000 dpm/100 cm^2. It was estimated that approximately 40,000 cm^2 of contaminated surface was disturbed every hour, and that 4,000 hours of work that may disturb the surface would be completed within a year. The normal amount of work hours was doubled to account for any potential releases from undisturbed areas.

40 CFR 61, "National Emission Standards for Hazardous Air Pollutants."

HEPA = high-efficiency particulate air.
MEI = maximally exposed individual.
TEDE = total effective dose equivalent.

The TEDE to the MEI for canyon reactivation and size reduction activities is 1.04E-05 mrem/yr.

Table 5-2. Dose Calculations for Removal of Material from a Vessel in Cell 30.

Nuclide	**Radionuclide Inventory (Ci)[a]**	**40 CFR 61, Appendix D, Release Factor**	**Unabated Release Rate (Ci/yr)**	**HEPA Filter Factor (Sand Filter – Based on a 99.95 % Efficiency)**	**Abated Release Rate (Ci/yr)**	**200 West Area ≥40 m (291-U-1 Stack) Dose-per-Unit Release Factor (mrem/Ci)**	**Unabated Dose to MEI (mrem/yr)**	**Abated Dose to MEI (mrem/yr)**
Np-237	1.06E-01	1.0E-03	1.06E-04	2,000	5.30E-08	1.0E+01	1.06E-03	5.30E-07
Pu-239	1.45E+02	1.0E-03	1.45E-01	2,000	7.25E-05	7.0E+00	1.02E+00	5.08E-04
Pu-240	3.74E+01	1.0E-03	3.74E-02	2,000	1.87E-05	7.0E+00	2.62E-01	1.31E-04
Am-241	6.55E+01	1.0E-03	6.55E-02	2,000	3.28E-05	1.1E+01	7.21E-01	3.60E-04
Sr-90[b]	1.08E+02	1.0E-03	1.08E-01	2,000	5.40E-05	8.7E-03	9.40E-04	4.70E-07
						TEDE Totals:	2.01E+00	1.00E-03

[a] Radionuclide inventory includes curies currently present in the facility, as well as curies that may be introduced into the facility, and/or removed from the facility on a calendar year basis. Alpha isotopic values are taken from the *Disposition of Waste from Process Vessel in Cell 30 of 221-U* (D&D-33135), with a conservative increase of 50 %.
[b] An estimated value for Sr-90 was added to the calculation based on the surface contamination level information from the *ALARA Review for the 221-U Characterization* (BHI-01240, Appendix A).

40 CFR 61, "National Emission Standards for Hazardous Air Pollutants."

HEPA = high-efficiency particulate air.
MEI = maximally exposed individual.
TEDE = total effective dose equivalent.

The TEDE to the MEI for the removal of the material from the process vessel in Cell 30 is 1.00E-03 mrem/yr.

Grouting of the canyon, partial demolition of the canyon, and demolition of non-canyon structures (e.g., 292-U) will generate diffuse and fugitive emissions of radionuclides. Emissions and dose information related to these activities are provided in Table 5-3.

Table 5-3. Dose Calculations for Grouting and Demolition Activities.

Nuclide	Radionuclide Inventory (Ci)[a, b]	40 CFR 61, Appendix D, Release Factor	Abated and Unabated Release Rate (Ci/yr)	200 West Area <40 m Dose-per-Unit Release Factor (mrem/Ci)	Unabated and Abated Dose to MEI (mrem/yr)
Pu-239	2.32E-03	1.0E-03	2.32E-06	1.1E+01	2.55E-05
Pu-240	1.48E-04	1.0E-03	1.48E-07	1.1E+01	1.63E-06
Am-241	1.48E-04	1.0E-03	1.48E-07	1.7E+01	2.52E-06
Sr-90	1.08E+02	1.0E-03	1.08E-01	1.1E-02	1.19E-03
				TEDE Totals:	1.22E-03

[a] Alpha isotopic values are based on calculated ventilation tunnel inventories documented in *Disposition of Transuranic Contaminated Residual Materials at U Plant* (D&D-23017) and then multiplied by a factor of 4 to provide a bounding value for inventory that could be associated with demolition of the canyon and associated non-canyon structures.

[b] An estimated value for Sr-90 was added to the calculation based on the surface contamination level information from the *ALARA Review for the 221-U Characterization* (BHI-01240, Appendix A).

40 CFR 61, "National Emission Standards for Hazardous Air Pollutants."

MEI = maximally exposed individual.
TEDE = total effective dose equivalent.

The TEDE to the MEI for the grouting and demolition activities is 1.22E-03 mrem/yr.

5.4 EMISSION CONTROLS

Based on analysis of the potential emissions and analysis of available control technologies, the following controls have been selected for use during the remedial action.

5.4.1 Canyon Reactivation, Size Reduction, Material Removal (Cell 30 Vessel)

- Because the air flow will be going through the 291-U-1 Stack, the sand filter will be used as an emission control.

- Fixatives will be applied to contaminated walls, flooring, debris, and equipment, as needed, to minimize airborne contamination during the remedial action activities for fugitive emissions and dust within the canyon. Fixative application techniques may include spraying, brushing on, pouring, or some other method, as necessary.

- Operational limits for removable or smearable contamination levels will be established in the activity work packages and associated Radiation Work Plans. Fixatives or other controls will be employed if removable or smearble contamination levels (other than spot contamination) exceed 100,000 disintegrations per minute per 100 square centimeters beta/gamma or exceed 2,000 disintegrations per minute per 100 square centimeters alpha.

- Once they are staged, even inside the canyon, the waste packages will remain closed except during packaging and waste inspection activities.

- Vacuum cleaners and portable exhausters may be used to support the remedial action and will be equipped with high-efficiency particulate air (HEPA)-type filters.

- Temporary contamination-control structures may be used with or without a portable HEPA-type-filtered exhauster(s) during some portion of the remedial action activities, as needed.

5.4.2 Canyon Grouting; Demolition of Canyon Walls/Roofing and Ancillary Structures

- Water will be applied, as needed, during any demolition activities, for suppression of fugitive emissions and dust.

- Fixatives will be applied to contaminated structures and/or debris and equipment, as needed, to minimize airborne contamination during the remedial action activities for fugitive emissions and dust. Fixative application techniques may include spraying, brushing on, pouring, or some other method, as necessary.

- Fixatives or cover material (e.g., gravel) will be applied to disturbed contaminated soils associated with the remedial action, when field activities will be inactive for more than 24 hours.

- If the overnight sustained wind speed is predicted to be greater than 32 km/h (20 mi/h) based on the Hanford Meteorological Station morning forecast, fixative or cover material will be applied, as needed. This will allow the project enough time, if necessary, to prepare for the application of dust-control measures. If a fixative already has been applied, and contaminated items will remain undisturbed, further use of fixatives will not be needed. The fixatives or other controls will not be applied when contaminated items are frozen, or when it is raining or snowing, or other freezing precipitation is falling at the end of work operations.

- Once they are staged, the waste packages will remain closed except during packaging and waste inspection activities within the CERCLA remedial action area.

- Vacuum cleaners and portable exhausters may be used to support the remedial action and will be equipped with HEPA-type filters.

- Temporary contamination-control structures may be used with or without a portable HEPA-filtered exhauster(s) during some portion of the remedial action activities, as needed.

- Operational limits for removable or smearable contamination levels will be established in the activity work packages and associated Radiation Work Plans. Fixatives or other controls will be employed if removable or smearable contamination levels (other than spot contamination) exceed 100,000 disintegrations per minute per 100 square centimeters beta/gamma or exceed 2,000 disintegrations per minute per 100 square centimeters alpha.

5.5 AIR EMISSIONS MONITORING

5.5.1 Canyon Reactivation and Size Reduction Activities

The calculated unabated annual dose combined for the canyon reactivation and size reduction activity during the remedial action is below 0.1 mrem/yr TEDE to the MEI; therefore, this activity is not subject to continuous emissions monitoring as required by 40 CFR 61.93, "Emission Monitoring and Test Procedures." Periodic confirmatory measurement will be provided, however, as required by 40 CFR 61.93. The 291-U-1 Stack sampling equipment will be run continuously with at least quarterly samples collected for analysis to meet the periodic confirmatory measurement requirement.

5.5.2 Removal of Material from the Cell 30 Vessel

Stacks or vents with the potential to provide in excess of 0.1 mrem/yr effective dose equivalent to the MEI must be monitored as major sources in accordance with 40 CFR 61.93(b) emission monitoring and test procedures and WAC 246-247-075. The U Plant canyon exhaust stack (291-U-1) will operate as a major source during activities involving removal and packaging of waste from the Cell 30 process vessel. The existing stack has not been qualified or approved as compliant with the engineering and quality assurance requirements for effluent flow rate measurement and continuous emissions sampling as listed for a major source in the cited regulations. Upgrade of the existing stack to meet the requirements is not practical, from a cost/benefit or technical standpoint for the brief duration of work involving the Cell 30 vessel. Hence, a request for prior EPA approval will be processed for alternative effluent flow rate measurement procedures or site selection and sample extraction procedures. The request will demonstrate as required that:

1. It can be shown that the requirements of 40 CFR 61.93(b)(1) or (2) are impractical for the effluent stream.

2. The alternative procedure will not significantly underestimate the emissions.

3. The alternative procedure is fully documented.

It is expected that the existing methods and equipment related to the stack flow measurement and emissions sampling will be accepted as an alternative.

The cited regulations also require an annual inspection, and cleaning where necessary, of the emissions sampling equipment. This will be conducted during operation of the stack as a major source.

5.5.3 Canyon Grouting; Demolition of Canyon Walls/Roofing and Ancillary Structures

The calculated unabated annual dose combined for the grouting and demolition activity during the remedial action is below 0.1 mrem/yr TEDE to the MEI; therefore, this activity is not subject to continuous emissions monitoring as required by 40 CFR 61.93. Periodic confirmatory measurement will be provided, however, as required by 40 CFR 61.93. During the time the active canyon exhaust is routed through the 291-U-1 stack, the stack sampling equipment will be run continuously with at least quarterly samples collected for analysis to meet the periodic confirmatory measurement requirement. For the period(s) of time the stack fans are not operational, alternative monitoring techniques have been considered, and near-facility monitors are sufficient to meet the periodic confirmatory measurement requirement

Near-Facility Monitoring Stations N168, N550, N956, and N963 (Figure 4-1) will be used to monitor fugitive/diffuse emissions for the remedial action activities. The Hanford Site protocol established for near-facility monitors will be followed for data collection, sampling frequencies, sample analysis, and data reporting (*Environmental Monitoring Plan United States Department of Energy Richland Operations Office* [DOE/RL-91-50]).

Air monitor downtime will be minimized, and four designated air monitors shall be operated, as required. However, if a designated air monitor is out of operation for more than 48 hours during normal working times (excluding weekends and holidays, when work activities are not being conducted), where there is a potential for radiological emissions, the DOE, EPA, and Ecology will be notified. If two or more downwind, designated air monitors are out of operation during normal work operations, activities where there is a potential for radiological emissions shall be temporarily suspended until operation of at least two downwind, designated air monitors are restored or backup equipment is deployed and operational.

Additional monitoring for diffuse and fugitive emissions will be conducted and will consist of radiological surveys from the demolition and any excavation activities. Both alpha and beta/gamma surveys shall be performed for all removable contamination surveys and for soil surveys (direct readings).

Demolition and/or excavation activities will be stopped if removable or smearable contamination (other than spot contamination) with detection readings greater than 500,000 disintegrations per minute per 100 square centimeters beta/gamma or greater than 28,000 disintegrations per minute per 100 square centimeters alpha is encountered on the soil. Demolition and/or excavation in that area will not continue until an internal review of the work and encountered conditions has been performed and an internal determination has been made that no threat to personnel safety or the environmental exists, or until proper controls (i.e., removal and disposal, water, fixatives, or covers) have been put in place to mitigate any further potential for emissions, and the EPA, Ecology and RL have been contacted and briefed of the situation.

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6.0 REMEDIAL DESIGN

The construction component of the selected 221-U Facility remedy includes performing remedial design and construction activities and furnishing necessary facilities, equipment, labor, materials, supplies, and tools. The scope also includes engineering services to locate and detail proposed support areas (such as laydown areas, support facilities, and air monitors), and engineering support during field activities. The following subsections provide a summary of the construction component design elements for the selected alternative.

6.1 BUILDING CHARACTERIZATION

The nature and extent of contamination for Alternative 6, Close in Place – Partially Demolished Structure, was evaluated through the review of historical documents, operating history, and existing characterization data. The *Phase 1 Feasibility Study for the Canyon Disposition Initiative* (DOE/RL-1997-11) identified the need for further characterization of the 221-U Facility and legacy equipment on the canyon deck and in the process cells to support development and evaluation of alternatives in the final feasibility study. Near the completion of the Phase I feasibility study, the characterization needs and investigative strategy were developed and then documented in the *Data Quality Objectives Summary Report for the 221-U Canyon Disposition Alternatives* (BHI-01091) in September 1998. Implementation of the data quality objectives was developed and documented in the SAP (DOE/RL-97-68) in February 1998. Complete results of the environmental characterization effort are presented in the *Final Data Report for the 221-U Facility Characterization* (BHI-01565).

Additional characterization activities may be required for facility locations not previously characterized and/or for waste disposed of outside of the facility. Additional characterization activities will be undertaken in accordance with an approved SAP. The *Guidance for the Data Quality Objectives Process*, EPA/600/R-96/055, EPA QA/G-4 (EPA 2000), will be used to support the development of any SAP revisions or new SAP needed for the project. The data quality objectives process is a strategic planning approach that provides a systematic process for defining the criteria that a data collection design should satisfy. Using the data quality objectives process ensures that the type, quantity, and quality of environmental data used in decision-making will be appropriate for the intended application.

6.2 DESIGN DEVELOPMENT

Remedial design for the 221-U Facility remedial action includes design work, remediation cost estimating, drawings, and specifications required to procure an RC to perform the work. The extent of contamination has been developed and used to assess the performance requirements for the barrier (i.e., drainage flux) to demonstrate attainment of RAO 3.

The remedial design for the 221-U Facility will be submitted to the regulatory agencies for review and approval using a phased and graded approach. Due to the lengthy duration and complexity of the project, a phased design approach is necessary. As portions of the hard design for enduring features reach 90 % completion, they will be submitted to the regulatory agencies for review and approval. For activities that are controlled by standard procedures or simple work packages, summary level descriptions of scheduled work will be provided. As necessary, this

RD/RAWP will also be revised and submitted for review and approval. Refer to Figures 3-1 through 3-4 for additional information regarding design information and proposed dates of submittal.

Project plans (such as SAPs for collection of design samples) will define the data gathering requirements to verify worker health and safety. Project procedures will define the "how to" of obtaining data and controlling the site activities. Scope of work, design drawings, and specifications will provide the necessary tools to procure an RC. DOE will provide the remedial design to the lead regulatory agencies for review in phases as the details of design become available for the various remedial action activities required to complete the overall remediation of the 221-U Facility. Summary briefings and discussions may be held at the unit managers' meetings or other forums, as agreed. Issues will be identified and resolved in a timely manner to prevent or minimize impacts to schedules for issuing contract documents.

The following process will be followed to implement the above requirement and may be modified at the 200 Areas unit managers' meetings:

- DOE will provide the draft remedial design packages and design schedule to the lead regulatory agencies at the unit managers' meetings or will deliver the packages and schedule to the local field office.

- The lead regulatory agencies review period generally is 2 weeks. If the review period requires a longer schedule because of the complexity of the project, the DOE and the lead regulatory agencies will agree to the extended review period, as necessary. To minimize impacts to the schedule, the need for additional review time should be communicated early in the process.

- Review comments and issues will be identified and resolved in a timely manner. Review comments and issues, including responses or resolutions, will be documented in the unit managers' meetings, letters, or other forums, as agreed.

- If requested, the DOE will provide a copy of the final remedial design packages, with comments incorporated, to the lead regulatory agencies at the unit managers' meetings, will deliver the packages to the local field office, or will transmit the package electronically.

The scope, depth and rigor of application of requirements to a specific activity are determined by using a grading process. The purpose of grading is to select the controls and verifications to be applied to various items and activities consistent with their purpose, importance to safety, potential environmental impact, cost, schedule and potential impact on success of the project. The graded approach is integrated into the project through plans, procedures, design documents, work documents and other documents by defining levels of rigor and detail appropriate to the prescribed tasks.

During the phases of a project, cognizant personnel establish project approaches and assess project risk factors considering safety, environmental impact, project cost, schedule, regulatory requirement, etc. Decisions are reached relative to the need for formal design documentation and associated configuration control, e.g. detailed barrier design, versus establishment of work packages, either specific step by step, or generalized skill of the craft instructions.

The graded approach will be implemented to meet project requirements. Commercial design standards and practices will be followed wherever possible.

Following is a list of typical project/design inputs:

- Site walkdown
- Review of historical data
- Cultural/ecological review
- Hazard classification
- Sampling data
- Volume calculations
- Existing drawings
- Engineering test results for soil and building materials
- Grout formulation test results.
- Codes and Standards
- Past/Best practices

As appropriate, these inputs, and others that may be defined during remedial action planning, will be incorporated into the applicable project/design media (e.g., requirements documents, project drawings, technical specifications, work documents, statements of work, etc.) during the remedial design process.

6.3 HAZARD MITIGATION

Implementation of the selected 221-U Facility remedy will require the identification and mitigation of potential hazards to personnel and the environment. This section addresses these predecessor activities to remedy implementation.

6.3.1 Hazard Identification

The potential personnel and environmental hazards associated with the selected remedy are a combination of high hazards normally encountered during routine operations and hazards involving the nonroutine activities of large-scale demolition and construction operations. The hazards are both industrial and radiological in nature.

Industrial hazards associated with the selected remedy will be similar to those that are encountered on any large-scale construction and demolition project, including unique hazards associated with demolition operations that include crane operation, concrete sawing, and excavator operation. Typical hazards will include moving machinery, falling, tripping, cutting, sound exposure, and dust inhalation. The risk of injury due to these hazards is addressed in national Occupational Safety and Health Administration and Washington Industrial Safety and Health Administration safety regulations, as well as the Hanford Site-specific procedures that implement the codes. Compliance with the applicable safety codes, regulations, and procedures will mitigate the risk posed by industrial hazards.

High radiation areas and very high radiation areas will be encountered during equipment consolidation and waste removal activities. For example, approximately 25 % of the cells have equipment and materials that have high radiation levels that exceed 1,000 mrem/h. The maximum gamma dose rate in Cell 30 was 190,000 mrem/h (BHI-01565). In addition, the most significant radiological hazard anticipated during operational activities will be the generation of airborne contamination.

6.3.2 Hazard Control

Hazard mitigation will involve the implementation of physical and administrative controls that address protection of both personnel and the environment. Access to the worksite will be administratively controlled through use of a site-entry procedure. Physical controls may include installation of a perimeter fence, as necessary. The site-entry procedure will require either training or escorts for site visitors.

Initially, remedial activities will be conducted and controlled using surveillance and maintenance contractor O&M procedures and radiological work packages. These surveillance and maintenance contractor documents establish the frequency and activities necessary to monitor, control, and thereby preclude potential health and safety impacts and equipment failure. Surveillance and maintenance contractor documents also describe the preventive maintenance and instrument calibrations required to maintain the remaining active equipment. The radiation protection procedures, radiation work permits, and radiological condition assessments describe the radiological control activities such as posting, access control, work place air monitoring, and radiological surveys.

Access to the local work site will be controlled and maintained with barriers and signs warning personnel of the specific work site hazards. Heavy equipment will use audible warning signals when backing up. Personnel will wear hard hats, safety glasses, and safety shoes as a minimum and any additional safety equipment as required by job-specific requirements. Administrative controls will include the implementation of programmatic plans, procedures, job safety analyses, and applicable work permits to operate hazardous equipment and enter hazardous areas.

Specific hazard control activities will include, but not be limited to, readiness evaluations, hazard classifications, waste designations, waste profiles, a health and safety plan, and site-specific waste management instructions. Integral to these activities will be hazardous material and radioactivity surveys that will be undertaken prior to initiating significant action in the facility (e.g., crane upgrades, waste removal).

Mitigation of airborne contamination can be accomplished as needed with local exhaust ventilation of the decontamination equipment, personal protective equipment, the existing facility exhaust system, and/or administrative controls and physical controls. Decontamination or fixing of loose or smearable contamination will be performed prior to any removal/demolition activities, as needed. Radiological limits for worker protection are provided in 10 CFR 835, "Occupational Radiation Protection."

Nonroutine activities will require special procedures and equipment so that the risk of exposure is properly mitigated. Safety criteria will be determined on a case-by-case basis; however, criteria will require that exposures be ALARA. Administrative controls will include radiation work permits, exposure limits, and escort requirements. Physical controls will include barriers, postings, and personnel surveys. In accordance with site procedures, administrative and physical controls applicable to this project will be defined in job-specific work plans and procedures. Compliance with the job-specific work practices and procedures will ensure that personnel exposures do not exceed allowable limits.

During demolition activities, implementing a combination of procedural and physical controls will mitigate dispersion of contaminants. Procedural controls typically will consist of wind-speed restrictions on work activities. In addition, demolition techniques will be controlled to minimize contamination dispersion. Physical controls will include spray fixatives (e.g., water sprays and chemical coagulants), minimizing the size of the work area, guniting/grouting, and/or covering with clean fill. Radiation air monitoring during demolition will be performed on the work site perimeter to confirm the effectiveness of airborne contamination control.

The potential for water migration also will be mitigated by implementing a combination of procedural and physical controls. Procedural controls will consist of work restrictions during significant precipitation or wind events if the potential for contaminant migration exists. Physical controls will include a combination of temporary shelters and/or sealing products. Demolition activities will be scheduled to occur after contamination control measures have been implemented.

Personnel and equipment leaving the site present a risk of contaminant migration. This risk will be mitigated by procedural and physical measures. Work procedures will require equipment used on the site and exposed to dangerous/radioactive wastes to be decontaminated before the equipment is released. Personnel working at the site will wear proper protective clothing. Protective clothing exposed to dangerous/radioactive wastes will be controlled in accordance with Hanford Site procedures. Personnel leaving radiologically contaminated areas will require an exit survey before leaving.

6.4 DESIGN IMPLEMENTATION

The selected 221-U Facility remedy, as documented in the ROD, is Alternative 6, Close in Place – Partially Demolished Structure. The remedial action work scope includes performing structural demolition and barrier construction activities and furnishing necessary facilities, equipment, labor, materials, supplies, and tools. The following subsections provide a summary of the remedial action work activities.

The selected remedy for the 221-U Facility includes four primary components: demolition and barrier construction (the "construction component"), post-remediation care and environmental monitoring, institutional controls, and 5-year review. The construction component of the remedy is further divided into a predemolition phase, a demolition phase, and a barrier construction phase.

Before engineered barrier construction activities begin, numerous above- and below-ground utilities and interferences must be dispositioned. The conduct of predemolition and demolition activities includes furnishing labor, materials, equipment (except for ERDF bulk-waste disposal containers and other containers for radioactive/dangerous waste disposal), incidentals for demolition, removal, sorting, handling, industrial hygiene monitoring, size reduction, containerization, associated transportation, and storage of demolished materials in accordance with the contract documents.

6.5 PREDEMOLITION ACTIVITIES

To prepare the 221-U Facility for demolition, various canyon systems will have to be reactivated and/or upgraded, waste treated in and/or removed from the facility, and equipment consolidated into below-deck locations. These activities are described in more detail in the following sections.

6.5.1 Prepare Facility for Use

The building must be put in a safe condition for remedial activities. This will require radiological surveys, fixing or removing contamination, a building inspection for industrial safety concerns, and equipment repairs or upgrades.

6.5.2 Removal of Waste

Hazardous substances will be removed from all structures, with the exception of the 221-U Building. Hazardous substances including asbestos, PCBs, etc. will be removed and managed in accordance with the Waste Management Plan. Any material that meets the acceptance criteria for use as barrier fill will be segregated for later use during the barrier construction phase.

6.5.3 Establish Infrastructure

Implementation of the selected remedy will rely heavily on the existing 221-U Facility infrastructure. Mobilization activities, including preparation of staging areas, and some modification of the existing building, equipment, and utilities will be necessary.

The existing utilities will be used to support remedial activities, when possible. It is envisioned that the existing road network within the complex will be used, and water and electrical services will be modified as required to support the remedial activities and engineered barrier placement. The existing road network surrounding the 221-U Facility will adequately accommodate heavy equipment during demolition operations, as well as waste-hauling traffic to the ERDF. Additional spurs, off of paved roadways, will be constructed for heavy equipment access, as required. The railroad tunnel will be reactivated to support equipment access to the canyon and waste removal.

Temporary water lines may be installed, as required, for sanitary requirements, fire-suppression systems, decontamination operations, and dust control. Prior to the construction of the engineered barrier, water mains, process lines, and sewer pipelines located within the engineered barrier footprint will be isolated and sealed (or verified as previously sealed) at the outer edge of the engineered barrier. Main transformers that provide electric power to the 221-U Facility will remain operational until demolition operations require them to be relocated or removed. All transformers will be removed, or relocated, to outside of the perimeter of the engineered barrier prior to barrier construction. Temporary 480-V electrical lines and panels will be installed in the building, as required, for lighting, ventilation, and equipment operations.

The selected remedy will require administrative offices, change rooms, tool rooms, lunchroom, restrooms, and storage rooms. Mobile office units and 271-U will provide project support space. A construction perimeter fence will be installed as needed to control access into and out of the work zone. Existing telephone and electrical lines will be used to support office and clerical requirements. Existing Hanford Site fire protection and ambulance services will be adequate for emergency response.

Personnel staging areas will be provided for the support facilities. Equipment storage, decontamination areas, survey tents, container storage, and other staging requirements also will be included in the layout of support requirements.

6.5.4 Modify Facility

Facility modifications will primarily involve disconnecting and blanking utility and electrical lines where they are no longer required and installing temporary utilities that will be required to support planned actions. An engineering study (*221-U Facility Reactivation Engineering Study,* [CP-29430]) was developed to address ventilation, electrical, lighting, and crane requirements for the remedial action. This study concluded that limited modifications to the 221-U Facility are necessary to accomplish waste removal, equipment consolidation, and decontamination activities. The canyon cranes will be upgraded, the electrical and lighting systems will be enhanced, and the railroad tunnel will be reactivated to support waste removal and equipment consolidation activities.

The existing main bridge crane will be recertified for use to support equipment handling within the canyon. At the same time, modifications and repairs will be made to the cranes, to improve efficiency and facilitate safe working conditions.

Additional 480-V electrical service requirements will be installed, as necessary, to support portable ventilation requirements and selected decontamination equipment, such as air compressors for pneumatic tools and temporary greenhouse structures. In addition, 480-V electrical service may be installed to support decontamination/disassembly/size reduction operations.

The railroad tunnel will be reactivated for use. If required to support safe working conditions, a new roof covering may be installed to prevent precipitation from entering the building.

6.5.4.1 Canyon Reactivation

The following sections summarize the findings documented in the canyon reactivation engineering study.

6.5.4.1.1 Ventilation

The study determined that use of the existing ventilation system, supplemented with localized units to ventilate small working areas as needed, is the most favorable to waste handling, cost, and schedule considerations. The existing ventilation system is adequate for the reactivation activities that are non-intrusive (e.g., re-lamping and crane lubrication). Intrusive activities that disturb radioactive materials will likely require localized units to control airborne contaminants.

The following performance criteria have been developed to support the canyon reactivation design with respect to ventilation.

- Provide contamination control for canyon reactivation and demolition preparation activities.
- Maintain a safe working environment in the canyon during demolition preparation activities.
- Ensure environmental compliance of building exhaust in accordance with the Air Emissions chapter of this document.

6.5.4.1.2 Crane

Lifting process cell cover blocks weighing 32 tons and deck equipment disposition activities will require use of the existing bridge crane. Floor loading restrictions, heavy cover block weights, and the need for flexibility in crane use, effectively preclude an auxiliary crane from being used to lift cover blocks. Installation of a supplementary or replacement bridge crane is cost prohibitive due to the equipment size, limited access to the interior of the canyon for installation, and problems associated with assembling large pieces of equipment on the congested canyon deck.

The use of mobile lifting equipment that runs on tracks installed on the canyon deck could provide some flexibility in lifting capabilities to support equipment size reduction and consolidation activities. However, this alternative is not practical as a sole type of lifting device due to floor loading limitations, limited reach of the lifting equipment, and difficulties associated with track installation and lifting equipment maneuverability on the cluttered canyon deck.

Regardless of which primary lifting device is chosen, provision of supplemental lifting capability (e.g., forklifts and loaders) could expedite the work by performing the smaller lifts to support equipment size reduction and consolidation and material staging activities.

The following performance criteria have been developed to support the canyon reactivation design with respect to the crane.

- Provide lifting capability to package and remove waste from the canyon as needed.
- Provide lifting capability lift cell cover blocks and to disposition equipment into the canyon process cells.
- Provide lifting capability to assist canyon grouting.

6.5.4.1.3 Electrical Power

The existing power systems to the 271-U/221-U Buildings and the 291-U structures/equipment should be used in conjunction with new portable electrical stations to serve the north and south sides of the 221-U Building. The existing power systems are expected to be reliable for at least 10 years, based on engineering judgment.

Portable stations can be staged on the north and/or south sides to feed portable equipment inside and outside the canyon. The portable equipment will be useful for the demolition preparation and demolition phase as well. After transition to the demolition phase, the building's permanent electrical system will be isolated, and the portable stations will be the only source of power.

The following performance criteria have been developed to support the canyon reactivation design with respect to electrical power:

- Provide reliable electrical power to support demolition preparation activities;
- Provide power to the canyon ventilation system;
- Provide power for canyon grouting activities;
- Provide power for demolition activities;
- Portable power shall be rated for wet environments related to grouting and demolition processes.

6.5.4.2 Railroad Tunnel Reactivation

An engineering study (*U Canyon Railroad Tunnel Reactivation Study*, D&D-33637]) was developed to address the activities needed to reactivate the railroad tunnel to support waste removal and equipment consolidation activities. These activities include both work to reactivate the railroad tunnel and work to ensure access to the tunnel to bring in large equipment and remove equipment and waste is adequate. The activities needed to reactivate the railroad tunnel are presented in the following sections.

The following performance criteria have been developed to support the implementation of the railroad tunnel reactivation.

- Provide access to bring in equipment and remove equipment and waste from 221-U Building in support of demolition preparation activities
- Access must support safe manned operations utilizing standard materials transportation vehicles (e.g. trucks and forklifts).

6.5.4.2.1 Roll-up Door Reactivation

The roll-up door will be in working order upon completion of reactivation activities. A personnel access door similar to the one at T Plant will be installed to act as an emergency egress and facilitate entry into the tunnel without opening the entire roll-up door.

6.5.4.2.2 Tunnel Housekeeping

The tunnel interior will be cleaned of debris and unwanted material upon completion of tunnel housekeeping activities. Waste generated during these activities will be managed in accordance with the Waste Management Plan. Radiological surveys will be conducted prior to performing any housekeeping activities in and around the railroad tunnel. These surveys, along with initial characterization of the tunnel interior, will be used to establish radiological and industrial hygiene conditions, assist in work planning, and to assure proper radiological and industrial hygiene controls during work evolutions.

6.5.4.2.3 Drain Trough Disposition

Dimensions of the diamond plate that covers the drain trough will be verified and analyses performed to show that the plate will withstand the loads it would be subjected to during canyon remediation activities. The plate must withstand the weight of the 20,412 kg (45,000 lb.) remote-handled transuranic (RH-TRU) waste cask with trailer as it is backed over the trough while being positioned for canyon waste retrieval.

6.5.4.2.4 Truck Access

Truck access will be re-established and improved upon to allow large trucks to back into the tunnel. Trucks will be backed into the tunnel to off-load equipment into the canyon and receive waste from the canyon. The current vehicle access is too steep and at too sharp of an angle for large truck access. Improved access will lessen the grade to approximately 6 % to 8 % and lessen the angle of the road to the tunnel roll-up door. This angle will be established when preparing the work instructions for this activity.

6.5.4.2.5 Roof Inspection

Once the tunnel is safe for entry, an inspection of the roof interior will be performed. Any anomalies will be assessed for need of repair.

6.5.4.2.6 Lighting and Electrical Disposition

The tunnel electrical systems will be accessed and any identified electrical issues addressed. The tunnel will need lighting when in use for deliveries to the canyon deck and removing equipment and waste. Currently, no lighting is operational in the tunnel.

6.5.4.2.7 Camera Installation

Cameras will be installed in the tunnel to monitor activities from the project control offices. The cameras should view the tunnel entrance, the entrance to the canyon deck, and the length of the tunnel as viewed from the southern end. Two articulating cameras, similar to those mounted in the T Plant tunnel, should meet this need.

6.5.4.2.8 Portable Trailer Installation

A portable trailer be installed for radiological access control to the railroad tunnel. The trailer will also be used for controlling personnel access to, and monitoring activities within, the railroad tunnel. An area just west of the tunnel roll-up door will be leveled and a portable trailer, similar to the one used at T Plant, could be installed. The trailer will contain a change room and equipment for monitoring personnel exiting the railroad tunnel.

6.5.5 Cell 30 Liquid

An engineering study (D&D-33135) was developed to evaluate methods to remove residual material in a process vessel in Cell 30 of the 221-U Building. The process vessel contains liquid with elevated levels of transuranic isotopes that will be shipped to the CWC, and ultimately to WIPP. The vessel contains fewer than 757 L (200 gal) of crusted liquid with a pH less than 1.0. There are high concentrations of nitrates, transuranic isotopes (more than 200,000 nCi/g before stabilization), cesium, and strontium. A 30 mL sample bottle had a contact radiation dose rate of 17,500 mR/h. The in-cell dose rates are likely to be very high; most of the activities to handle the liquid will need to be accomplished remotely. Stabilization of this liquid likely will involve neutralization and solidification prior to packaging and shipment to the CWC. These activities will be undertaken only after completion of extensive work planning, preparation, and readiness evaluation. In addition, a treatability test plan will be developed to determine the viability of the proposed treatment process.

A system will be designed and installed that will allow mixing, rinsing, sampling, and removal of the liquid waste from the Cell 30 process vessel. The system will be designed with a self-contained, HEPA-filtered ventilation system. The waste will be packaged in WIPP-compliant packaging and shipped to the CWC for subsequent shipment to WIPP. The process vessel will be rinsed, grouted in place, and permanently entombed within the 221-U Building. The concentration of transuranic isotopes in the heel remaining in the process vessel after stabilization will be less than 100 nCi/g.

The conceptual system for the Cell 30 waste includes the following components:

- Jet Pump Module – Contains the jet pump pair, jet pump, potentially contaminated piping, valves, and instrumentation;

- In-vessel Module – Contains the charge vessel, mixer nozzles, wash nozzles, cameras and other components located inside the process vessel (in this context, “nozzles” can refer to open-ended pipes);

- Control Module – Contains non-contaminated control valves, piping, and instrumentation for controlling the system and the operator station;

- Off-gas Module – Contains the off-gas fan and HEPA filters for off-gas treatment prior to discharge to atmosphere;

- Compressor Module – Typically a rental compressor which should also include an accumulator.

In the application of ALARA principals, systems and components pressurized with hazardous waste will be confined within the process vessel and/or provided with ventilated enclosures.

Criticality restrictions for shipping will limit the number of fissile gram equivalents to less than 325 per shipping container. This will result in the generation of an estimated 30 drums for eventual shipment to WIPP.

The following performance criteria have been developed to support the design of the equipment and methods that will be used to remove the Cell 30 liquid:

- Establish a path forward for disposition of transuranic material in a process vessel stored in Cell 30 of the 221-U Building prior to final disposition of the canyon.

- Conceptually identify a process and associated equipment for removal of the transuranic material. The process must address nuclear and radiological safety considerations appropriate to the age and condition of the existing 221-U Building.

- Conceptually identify WIPP compliant packaging and appropriate shipping capability to transfer the waste to CWC for interim storage prior to shipment to WIPP.

- Equipment must be designed to support entrance to the canyon via the railroad tunnel, in-place assembly and shipment of the waste out of the facility via the tunnel.

6.5.6 Consolidate Contaminated Equipment in 221-U Building

A large volume of contaminated equipment resides on the canyon deck and in the process cells. Some of the equipment on the canyon deck will be reduced in size and volume as needed to facilitate consolidation into below-deck locations (the process cells and pipe trench). Minimizing size reduction activities will significantly reduce worker exposure.

An optimization study (*221-U Facility Canyon Equipment Size Reduction Engineering Study* [D&D-29932]) for dispositioning the canyon deck equipment concludes that extensive size reduction is not required to fit the equipment into the cells and pipe trench. Much of the size reduction will be for agitators and pumps with long tubular sections that can be sheared into shorter sections as required. There are also a number of work platforms and lifting fixtures which may require mechanical saws as well as shears for effective size reduction. In general, large vessels will not require size reduction when placed in the locations defined by this engineering study.

Size reduction for the identified equipment can be accomplished primarily using shears that can be mounted on the cranes and on a skid-steer loader. At least one of these shears should be capable of cutting approximately 15.2 cm (6 in.) diameter pipe. Hand-held equipment that could also prove helpful for any required size reduction includes abrasive cutters, mechanical saws, nibblers, and, if needed, the neodymium-yttrium-aluminum garnet laser could be considered. The skid-steer loader or perhaps a light fork lift would also prove helpful in handling the smaller, miscellaneous equipment that is on the canyon deck, especially once some of the major pieces of equipment have been placed into the cells, reducing deck congestion. Mobile lifting frames could be used to lift the smaller items into the skid-steer's bucket.

The large equipment will be dispositioned into the cells using the existing canyon cranes. A skid-steer loader or a light fork lift may prove helpful in handling the smaller, miscellaneous equipment. Mobile lifting frames may be used to disposition the smaller items.

Disposition of canyon equipment involves radiological and industrial hazards such as the following:

- Exposure to radiological contamination and elevated dose rates
- Fire hazards associated with cutting equipment
- Exhaust inhalation hazards from motorized equipment
- General industrial hazards (e.g., falls, trips, high temperature, noise).

The above hazards will be addressed through proper application of the work planning process. Administrative and engineering controls will be required to reduce worker exposure from external and internal exposure sources.

The following performance criteria have been developed to support the design of the equipment size reduction methodology for the 221-U Building:

- Establish a pathforward for size reduction of equipment currently located on the 221-U Building deck and subsequent consolidation of that equipment into the process cells for eventual grouting/disposition.

- Establish that the existing deck equipment can in fact fit into available cell space.

- Establish size reduction technologies and material handling processes most appropriate for the tasks.

6.6 DEMOLITION PHASE

During the demolition phase of the 221-U Facility remedial action, canyon voids will be grouted, the railroad tunnel will be dispositioned, interior canyon building surface contamination will be addressed, and the external area surrounding the canyon will be prepared to provide access to canyon demolition equipment. Finally, the roof and upper walls of the canyon structure itself will be demolished to near deck-level. These activities are described in more detail in the following sections.

6.6.1 Grout Canyon Voids

Cementitious grout will be pumped into the galleries, cell drain header, process cells, tunnels, trenches, and vessels containing residual materials to the maximum extent practical, to minimize the potential for void spaces and to reduce the mobility, solubility, and/or toxicity of the grouted waste. A cementitious grout will be developed using fillers and admixtures as needed to optimize mechanical, structural, and chemical properties while reducing the potential for leaching of radioactive isotopes. Addition of grout amendments such as fly ash or zeolite clays and the cost-benefit of using a soil-cement grout mixture will be considered during detailed design for grouting activities.

A plan (*U Plant Void Fill Analysis and Installation Plan* [D&D-33945]) was developed to evaluate the methods and sequence for grouting the lower portion of the 221-U Building structure. The engineering study concluded that the structure can be successfully filled with cementitious grout. Strictly formulated and controlled grouts can successfully fill voids and stabilize residual wastes to the maximum practical extent.

At least four grout formulations are expected to be needed to successfully grout the canyon. After the grout formulations have been developed and grout plants mobilized, large scale grout pours can be conducted in spaces such as the electrical gallery portion and north of Cell 3.

The most contaminated parts of the canyon will be grouted first to encapsulate residual waste. The cell drain header, process sewer, process cells, and the hot pipe trench will be grouted after the equipment on the deck has been dispositioned into the cells. Large vessels and equipment with accessible large voids can be grouted in place with a flowable grout (if necessary) as they are placed in the cells to reduce their buoyancy and prevent them from floating on the flood grout. The emplaced equipment will be sealed to the bottom of the process cells with high strength grout slurry to encapsulate waste and keep future lifts of grout from flowing under the equipment and floating the buoyant equipment. After equipment disposition, a single cover block will be left off each of the process cells, and the cells will be flood grouted with a low-heat grout. A non-aggregate, flowable grout will fill the top foot of the cell and the key cover block will then be replaced into the grout. The ventilation pipes between the cells and the ventilation tunnel will be plugged to keep flood grout from prematurely closing off the vent tunnel.

The ventilation system will be kept operational as long as possible for contamination control and worker comfort in the canyon. The bottom of the hot pipe trench will be grouted to encapsulate the worst contamination. Because the hot pipe trench is connected to the ventilation tunnel with ventilation pipes, the best option is to plug most hot pipe trench ventilation pipes with urethane foam material and seal selected 25.4 cm (10 in.) diameter riser pipes into the ventilation pipe to extend them above the deck level. This will allow grouting of the hot pipe trench without grout flowing into the ventilation tunnel. The few ventilation pipes with risers to the deck level can be left open to provide an outlet for trapped air as the ventilation tunnel is grouted later. This will permit filling the hot pipe trench with grout while preserving a few select air vents for eventual grouting of the ventilation tunnel. These ventilation pipes rising above the pipe trench will be grouted along with the ventilation tunnel.

The ventilation system will remain operational to reduce worker exposure to the contaminated canyon area. The galleries will be grouted from 271-U and the operating gallery with very few personnel present inside the 221-U Building canyon deck area.

The most likely source of grout for the 221-U Building will be a project-specific on-site grout batch plant. Evaluation of the prospective grout supplier's proposals will take into account the cost, operational flexibility and potential for using on site borrow or potential pozzolan stockpiles (e.g., ash/slag piles near 200 Area coal plants). A project-specific grout plant could be located near the rail spur, borrow areas, and the 221-U Facility.

High grout temperatures caused by cement hydration can be controlled by using a lean grout formulation with minimal heat of hydration and also by limiting the mass of grout pours to allow heat dissipation. Several grout formulations should be developed to completely fill large canyon voids. A discrete lift of high heat very flowable grout can be used to encapsulate waste and fill the bottoms of canyon voids. The largest mass of the void can be filled with a higher aggregate, less flowable fill. Such lean grout formulations may have problems with aggregate separation and will require significant formulation development. Voids remaining above the higher aggregate grout will be filled with the high-heat, flowable grout to fill remaining voids. Special urethane foams will be used to plug the pipes and other conduits where grout is not wanted to flow.

After each large volume grout pour, the grout pipelines can be pneumatically cleared and flushed with water that will be recycled and used to make more grout. The grout and flush lines connections should be sleeved, carefully controlled and monitored to keep contamination out of the lines. Excess water that cannot be recycled could be directed to the Hanford Site Liquid Effluent Treatment Facility for treatment.

Performance criteria have been developed for four grout formulations. These four grout types, are as follows.

- High strength equipment stabilization
- Flowable non-aggregate void filling slurry
- Low heat mass void fill
- Pipe plugging grout.

The performance criteria developed for the canyon grout are presented below.

- Provide a rigid core for the surrounding reinforced concrete structure to prevent potential future subsidence.

- To the maximum extent practical, fill voids and other preferred pathways that may increase the mobility of contaminants remaining in the structure.

- Provide the beneficial properties of cementitious fill that can limit the solubility and toxicity of the grouted waste.

- Identify methods, materials, and sequence of grouting that fill voids to the maximum extent, minimize personnel hazards, minimize contamination spread and minimize excessive structural stress to the existing canyon structure.

6.6.1.1 Grout Cell Drain Header

The cell drain header will be filled with cementitious grout as a part of the canyon cell grouting effort. This grouting will close off interconnections between the cells. Flowable grout will fill the 0.6-m (24-in.) diameter void space and encapsulate any contamination present in the pipe. Grout will be pumped into the cell drain header. Drainage openings in each process cell will act as air vents, and permit the grout to flow into the process cell drains.

6.6.1.2 Grout 221-U Building Process Cells

Following completion of legacy equipment consolidation activities, the canyon process cells will be filled with cementitious grout to encapsulate equipment in the cells and to provide support for the engineered barrier placed above. The flowable grout fill will be directed into equipment within the cells to minimize voids to the maximum extent practical. Grout will be pumped in lifts at a controlled rate to maintain loading on the cell walls to a structurally safe level and to disperse the heat of hydration over an acceptable time period. Placement of the final lift of grout will be carefully controlled to minimize the potential for void spaces under the cover blocks.

6.6.1.3 Grout 221-U Building Galleries

The three 221-U Building galleries contain piping, electrical runs, and instrumentation. Some equipment in these galleries contains low levels of radiological and chemical contamination, as well as asbestos. The 221-U Facility ROD states that contaminated equipment and piping in the galleries will be partially removed as necessary to facilitate remedial action demolition activities. The ROD contains an illustration indicating that legacy equipment will be removed from the canyon operating gallery, and that the operating gallery will be partially demolished, leaving only a heavily-reinforced, thick concrete stub wall, which divided the operating gallery from the canyon deck, above the canyon deck level. Following issuance of the ROD, the assumption that the operating gallery would be partially demolished was further evaluated in the *221-U Facility Demolition Study* (D&D-29971). The demolition study concluded that the equipment in the three canyon galleries should be grouted in place and the operating gallery left intact to lower worker exposure to hazardous working conditions that would exist if gallery piping and equipment were manually removed, to lower dust emissions that would be associated with partial demolition of the operating gallery, and to lower significantly the cost of demolition. Any contaminants that might be left within the galleries would be effectively encapsulated within the grouted monolith of the remediated canyon and buried beneath the engineered barrier. As documented in the demolition study, leaving the operating gallery intact and grouting the gallery equipment in place will not significantly raise the final facility elevation or that of the engineered barrier.

Each of the three canyon galleries will be filled with cementitious grout to encapsulate equipment inside and to provide support for the engineered barrier placed above. The galleries likely will be filled from lowest elevation (electrical gallery) to highest elevation (operating gallery). Grout will be pumped at a rate to maintain loading on the gallery walls to a structurally safe level and to disperse the heat of hydration over an acceptable time period. The flowable grout fill will be pumped under low pressure to fill voids.

6.6.1.4 Grout Hot Pipe Trench

The hot pipe trench is assumed to be contaminated. The trench contains intertwined piping that runs at varying elevations in the hot pipe trench, leaving some room for placement of canyon deck equipment that is only a few feet tall. If needed, some of the piping could be size reduced in place to make additional room for long thin pieces of legacy equipment from the canyon deck. After completion of legacy equipment consolidation activities, the trench will be filled with cementitious grout.

6.6.1.5 Grout Ventilation Tunnel

Once the 221-U Building ventilation is disabled, the ventilation tunnel will be grouted to eliminate voids in the building structure. Free-flowing cementitious grout will be used to fill the ventilation tunnel to the maximum extent practical. The grout will be placed at a controlled rate to allow time for heat dissipation during grout curing. It is estimated that the ventilation tunnel will require approximately 2,300 m^3 (3,000 yd^3) of grout.

6.6.2 Disposition Railroad Tunnel

The tunnel, which allowed train access into Cell 3, extends approximately 46 m (150 ft) westward from the northwest side of the canyon building. The tunnel is a reinforced concrete structure with a soil cover about 1.5 m (5 ft) thick. There are unreinforced wing-wall retaining structures at the end of the tunnel. The tunnel is assumed to have light surface contamination that can be fixed in place with fixative application.

The portion of the railroad tunnel that extends beyond the external wall of the canyon will be dispositioned. The tunnel walls and retaining structures will be left in place or demolished, as necessary to support follow-on demolition and disposition activities, and the remaining depression will be backfilled with grout or fill materials to improve demolition equipment access to the 221-U Building.

6.6.3 Fix Contamination on 221-U Building Interior Surfaces

Surface contamination on the canyon walls, canyon decks, and ceiling will be addressed to prepare the canyon for the start of demolition activities. Likely methods of addressing surface contamination are to cover the surface with fixatives or grout before demolition of the upper canyon structure begins.

6.6.4 Modify External Area

The following modifications will be performed to support partial demolition of the 221-U Building. The legacy structures that are physically attached to 221-U Building and structures remaining within the engineered barrier footprint must be removed. The remediation status of waste sites within the footprint of the engineered barrier will be verified to ensure that these sites have either been remediated in accordance with an applicable decision document or that the decision document identifies the selected remedy as burial beneath an engineered barrier. In addition, electrical and water utilities within the footprint of the engineered barrier will be isolated, blanked, and/or re-routed.

6.6.4.1 Demolish the 276-U Solvent Recovery Facility

The 276-U Solvent Recovery Facility, attached to the southwest end of the 221-U Building, is composed of walkways, vessels, and associated piping set in an open-concrete basin. Demolition will involve removing the walkways, vessels, and aboveground piping. The concrete basin and underground piping will be left in place. Pipe penetrations associated with this structure will be cut, sealed, and capped. Drains will be sealed with concrete. Contaminated concrete surfaces will be decontaminated, or the contamination will be fixed.

6.6.4.2 Demolish the 271-U Office Building

This building is a concrete framed structure built against the northwest face of the 221-U Building. It consists of a basement, three floors above the basement, and a reinforced concrete slab roof. The 271-U Building has nominally 0.3 or 0.6 m- (1 or 2 ft-) thick walls. The building perimeter walls are of concrete masonry supported on the basement walls, and there are interior masonry walls inside the building. The third floor served as a chemical makeup area with floor slabs up to 0.3 m (1 ft) thick that support chemical vessels. Additional building features to be included in the demolition are the 296-U-10 roof stack, an elevator, a second floor vault, and mechanical equipment in the basement. This building can be taken down using conventional demolition equipment. It is anticipated that rubble resulting from the demolition of this structure will be consolidated into the building's basement. This rubble can be grouted or compacted with soil as a base for the engineered barrier.

6.6.4.3 Disposition Remaining Structures, Piping, Wells, and Waste Sites

The 291-U and 292-U aboveground structures and the 291-U-1 Stack will be demolished as part of the 221-U Facility remedial action. Details of the demolition methodology and emission controls will be developed as the remedial design progresses. The former locations of these structures then will be stabilized to support construction of the engineered barrier. Prior disposition (by other projects) of any other aboveground structures within the footprint of the engineered barrier will be verified to ensure that remedial or removal actions are implemented as required.

Piping, wells, and waste sites within the footprint of the engineered barrier will be dispositioned by other projects prior to placement of the engineered barrier. Completion of these disposition activities will be verified as part of this remedial action.

6.6.4.4 Prepare Working Area Adjacent to 221-U Building

The areas adjacent to the 221-U Building will be prepared (e.g., shaped and compacted) to provide a firm working area for canyon structure demolition equipment access.

6.6.5 Partially Demolish the 221-U Building

The preceding paragraphs describe actions required to prepare the 221-U Building for partial demolition. Equipment within the building will have been dispositioned, void spaces filled with grout, contamination on exposed surfaces inside the canyon addressed, and the surrounding area prepared to support canyon demolition. Waste generated during building preparation for demolition will have been emplaced at the ERDF or other approved facilities. This section describes the actions required to partially demolish the 221-U Building.

An engineering study (D&D-29971) was developed to examine the technical, environmental, regulatory, nuclear safety, and financial feasibility of demolishing the canyon down to approximately the deck level. The basis for this study included engineering investigations and preliminary evaluations of alternatives along with the results of an informal value engineering session. The study provides recommendations regarding demolition alternatives and final facility configurations of the demolished canyon shell. The conclusions of the study are summarized in the following paragraphs. The demolition techniques described in the following paragraphs may be modified as detailed design progresses.

The engineering evaluation for the demolition of the upper portion of the canyon structure concluded that the facility should be demolished to the 225.7 m (740.5 ft) deck elevation above mean sea level. The operating gallery should be grouted with existing equipment in place. The best method for demolishing the structure is to take down the upper structure with large excavators using concrete cutting jaws. The rubble can be consolidated on the deck and surrounding soil to provide a firm foundation for the engineered barrier.

The selected final structure configuration minimizes worker exposure to hands on demolition hazards. This configuration also has the lowest demolition cost of the alternatives evaluated. This final deck elevation results in moderate capping cost compared to other final structure configurations. In situ grouting of the operating gallery equipment provides an effective means of dispositioning the equipment in a manner that is protective of human health and the environment.

The 221-U Building roof and walls can be demolished with heavy excavators using a universal processor cutting head. These excavators can work from approximately the deck level to break the structural concrete walls and roof. The broken concrete will be left on the deck and consolidated into a working surface and foundation for the engineered barrier. Drilling and controlled blasting with light loads of high velocity explosives may be used to shatter and delaminate the concrete and rebar if the structural concrete is too hard and thick to break efficiently with the excavator jaws. Drilling boreholes and filling with expanding grout is also a viable alternative to weaken thick concrete sections.

The 271-U Building, 276-U Feed Tanks, and railroad tunnel can be readily demolished with standard excavators or the heavy excavator planned for use on the 221-U Building.

Performance criteria developed to support design of the canyon demolition are presented below.

- Lower the canyon structure to a final configuration that provides a stable base for the engineered barrier and is responsive to the language in the approved ROD.

- Conduct the demolition with the minimum potential impact to worker safety and the environment using established/proven technologies responsive to cost and schedule.

6.6.6 Disposition Demolition Waste

Demolition activities in the U Plant Area will encompass the 221-U Building, ancillary structures addressed in the 221-U Facility ROD, and other nearby CERCLA demolition activities. In accordance with the 221-U Facility ROD, the resulting demolition rubble will be managed in the following manner.

- Waste generated during building preparation for demolition and from demolition of attached and impacted ancillary structures will be disposed of at the ERDF or other approved disposal locations.

- Inert rubble from other nearby CERCLA demolition activities, such as the ancillary structures, will be considered for use as fill material in the engineered barrier.

- 221-U Building rubble or wall and ceiling sections that are minimally contaminated and don't contain hazardous waste may be used as fill along side the canyon substructure under the barrier to limit impacts on soil borrow areas.

Demolition waste is defined in WAC 173-304 as "solid waste, largely inert waste, resulting from the demolition or razing of buildings, roads and other man-made structures. Demolition waste consists of, but is not limited to, concrete, brick, bituminous concrete, wood and masonry, composition roofing and roofing paper, steel, and minor amounts of other metals like copper. Plaster (i.e., sheet rock or plaster board) or any other material, other than wood, that is likely to produce gases or a leachate during the decomposition process and asbestos wastes are not considered to be demolition waste for the purposes of this regulation." Inert wastes are defined in WAC 173-304 as "noncombustible, nondangerous solid wastes that are likely to retain their physical and chemical structure under expected conditions of disposal, including resistance to biological attack and chemical attack from acidic rainwater."

Rubble resulting from demolition activities undertaken pursuant to CERCLA decisions other than the 221-U Facility ROD must be inert to be considered for use as barrier fill material. Such rubble will be screened for radiological contamination (e.g., radiological surface contamination levels greater than those listed in 10 CFR 835, Appendix D) and to ensure such waste is noncombustible, nondangerous solid waste that is likely to retain its physical structure under the expected conditions within the engineered barrier. Processing related waste (e.g., vessels and piping), liquids, hazardous waste, non-inert materials (such as wood and metals like copper), and asbestos-containing materials in this rubble will be excluded from consideration for use as barrier fill material. Separation of inert rubble from non-inert rubble will be undertaken only as determined to be economically practical.

Much of the rubble resulting from the demolition of the 221-U Facility (the 221-U Building, attached structures, and other ancillary structures demolished pursuant to the 221-U Facility ROD) will be consolidated on the 221-U Building canyon deck and surrounding soil as barrier fill material. Only inert and uncontaminated rubble and materials will be used as fill outside the footprint of the functional portion of the barrier. However, minimally contaminated rubble (i.e., that which qualifies as low-level radioactive waste as defined in DOE O 435.1 and which is could be disposed of in ERDF), which does not contain hazardous waste, will be used as barrier fill material atop and along side the canyon substructure and beneath the functional portion of the barrier.

Rubble disposition efforts will strive to support waste minimization and pollution prevention objectives and will promote use of building rubble in the barrier design to minimize the amount of clean fill or other material necessary to be cost effective and limit the size of existing borrow sites to protect natural resources.

6.7 BARRIER CONSTRUCTION PHASE

This function will consist of constructing the engineered barrier over the building, demolition debris, and nearby waste sites. This function will also involve restoring the excavated and disturbed sites (including laydown and equipment staging areas) to a grade consistent with the natural surface topography. Additional information regarding engineered barrier design considerations is provided in Section 7.0.

6.7.1 Engineered Barrier Components

The engineered barrier for this remedial action consists of three parts: engineered fill, engineered barrier (the functional portion of the barrier), and erosion protection.
This application of an engineered barrier is unique in that the top of the barrier is approximately 10.7 m (35 ft) above the surrounding grade. This affects the seismic event factors used for barrier design and consequently the barrier layout as described below.

A preliminary two-dimensional stability analysis was completed for the engineered barrier. The controlling factor for this analysis was to select a barrier layout that can remain functional after enduring a design seismic event. This analysis was key in determining the physical layout of the engineered barrier geometry. Briefly, the analysis finding was that the engineered barrier must be as flat as possible. Therefore, the functional portion of the barrier is sloped at a nominal 2 %. In addition, the barrier must extend out far enough from the 221-U Building that a potential crack (estimated to be 5 cm [2 in.] or less), due to movement in the 3 horizontal to 1 vertical (H:V) side slope (e.g., from a seismic event), will be outside the area requiring infiltration protection from the barrier. Detailed design information for the engineered barrier will be developed during the final design phase.

Performance criteria developed to engineered barrier design are as follows.

- The engineered barrier will be designed to prevent recharge rates greater than 3.2 mm/yr long-term average in order to mitigate, or eliminate, the potential for contaminants to migrate to groundwater.

- The engineered barrier will provide the required containment during a minimum 500-year life.

- Construct the engineered barrier with the minimum potential impact to worker safety and the environment using established/proven technologies responsive to cost and schedule.

6.7.1.1 Engineered Fill

The engineered fill will be clean, compacted, granular material, which will be placed in lifts. Its source is assumed to be a Hanford Site borrow pit within 24 km (14.9 mi) of the 221-U Building. Borrow materials for the engineered barrier will be taken from approved areas of the Hanford Site including, but not limited to, Area C (fine grained soils) and the ERDF (sand and gravelly sand). Soil properties for these and other borrow sites can be found in PNNL-15464. The use of demolition rubble, suitable for use as compacted soil fill material in the engineered barrier, will be considered during the final design phase to decrease the amount of borrow materials needed. The approximate extent of the engineered fill and engineered barrier is shown in Figure 2-2. Final design of the engineered fill will determine the compaction requirements and the material specifications.

Where fill material consists mostly of rubble or very large particles, finer grained fill soils may gradually settle into the open pores or spaces of the coarser material, which eventually may cause localized subsidence. To counteract subsidence, graded filters may be required. These filters likely will consist of commercially available gravels, with the gradation selected on the ability to bridge the openings in the previously placed material.

6.7.1.2 Engineered Infiltration Barrier

The engineered barrier will be designed to control potential contaminant migration by preventing water infiltration, as well as minimize potential human and biotic exposures due to biotic and unintentional human intrusion. To accomplish this, the engineered barrier, in combination with the remaining grouted, substantial concrete substructure, will effectively break the pathway for direct contact with contaminants. The upper portion of the barrier will consist primarily of a fine soil, such as a silt or silt-loam, which will be specifically selected for its ability to hold and store infiltrating water for eventual evaporation and plant transpiration. The lower portion of the barrier will consist of engineered or grading fill that will form the basic shape/slope of the barrier, provide a stable subgrade for constructing the overlying layers, and provide the balance of the barrier thickness. The barrier will be vegetated to control soil erosion and promote transpiration. The total volume of material that will be required for the engineered barrier will be determined during final design.

6.7.1.3 Erosion Protection

The top of the engineered barrier will be sloped at a nominal 2 %; the top layer will be vegetated and likely will consist of pea gravel admix. Therefore, once vegetation is established, erosion from precipitation and wind should not be a concern. To reduce the volume of the engineered fill while providing stability during a seismic event, it is likely that a 3H:1V side slope will be selected for the engineered fill. This slope will require placement of a basalt riprap-type layer for erosion protection. The erosion protection layer may include gravel and sand filter layers to carry the runoff safely to the outer toe of the engineered barrier.

6.7.2 Revegetate Site

The excavations from demolition activities will be backfilled, and fill contours will match adjacent contours. Areas disturbed by demolition activities will be prepared for surface restoration. As required under the industrial land use for the 200 Areas, the majority of restoration will be application of an approved native seed mixture with input from various interested local tribal nations.

6.7.3 Clean Up Complex

Before leaving the complex, the demolition contractor will clear the site of unnecessary project-related equipment and materials.

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7.0 ENGINEERED BARRIER DESIGN CONSIDERATIONS

Engineered barriers are designed to isolate wastes from the environment (i.e., air, waterways, groundwater, plants, animals, and humans). The degree of isolation is based on acceptable risk factors to receptors that are consistent with established land and groundwater use. Factors to be considered in preparation of surface barriers include, but are not limited to, the following:

- Effects of arid climate conditions on performance
- The potential impacts of long-term climatic changes on long-term engineered barriers
- Toxicity, mobility, and volume of contaminants to be contained
- Land and waste form compressibility and settlement
- Depth of waste below the ground surface and depth to groundwater
- Barrier material engineering and chemical properties including, but not limited to, permeability, moisture retention, grain size, and leachability.

A typical engineered barrier design employs natural geologic materials that can contribute a variety of important functions to the overall barrier performance, such as precipitation storage, drainage, biointrusion control, side-slope stability, and erosion control. At the Hanford Site, suitable engineered barrier materials (e.g., fine- and course-grained soil) are available at approved borrow-source locations. Other materials such as pea gravel and basalt riprap may need to be imported from offsite locations.

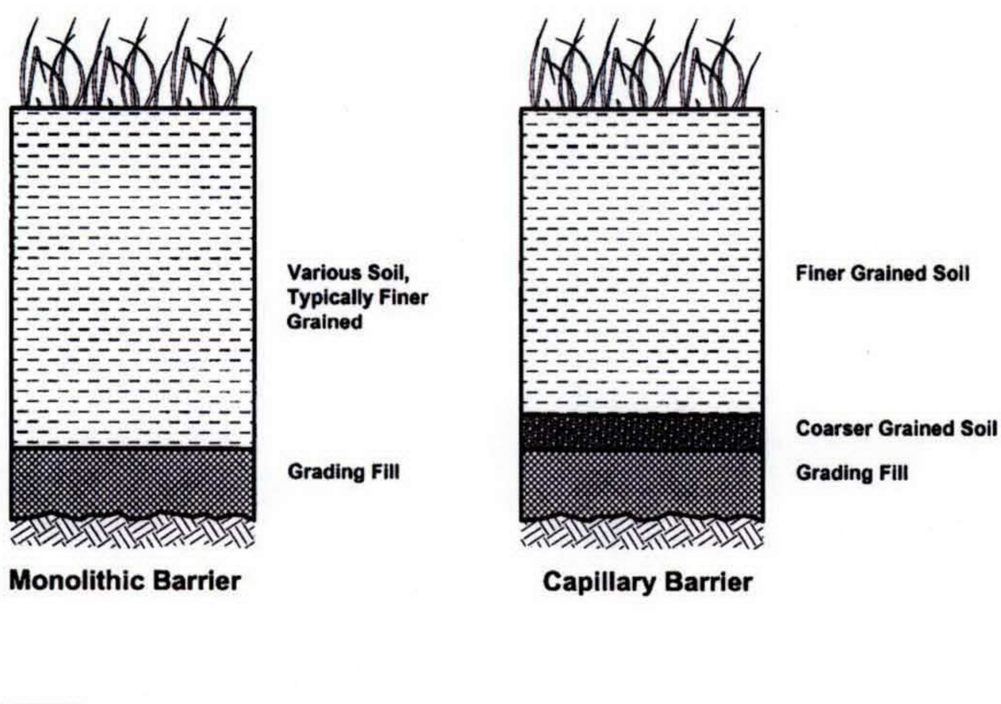
The remedial design analysis of the barrier system will be based on the best available data for the specific geologic conditions near the 221-U Facility. Runoff/discharge controls for expected meteorological patterns, including storms and snowfalls, also will be addressed during remedial design. The remedial design analysis also will include consideration of lessons learned and technical progress from the ongoing site-wide studies of the composite effects of leaving waste on the Hanford Site (composite analysis work). The infrastructure to support sophisticated modeling of subsurface transport of contaminants and barrier performance is being continuously improved and compared to data from field demonstrations and actual installed barriers (*Water Balance Measurement and Computer Simulations of Landfill Covers* [Dwyer 2003]).
The remedial design efforts will take advantage of updates in the modeling tools and data sources as they become available.

7.1 USE OF A SIMPLE EVAPOTRANSPIRATION BARRIER

While barrier design technology does not yet have a long history, important progress in understanding barrier performance in semiarid and arid climates is occurring (e.g., *Alternative Cover Assessment Project Phase I Report* [Publication No. 41183]; *Technology Overview Using Case Studies of Alternative Landfill Technologies and Associated Regulatory Topics* [ITRC 2003]; "Evaluation of Evapotranspirative Covers for Waste Containment in Arid and Semiarid Regions in the Southwestern USA" [Scanlon et al. 2005]; "Multiple-Year Water Balance of Soil

Covers in a Semiarid Setting" [Fayer and Gee 2006]). Ongoing design and modeling work across the United States and at the Hanford Site indicates there is great promise for simple ET barriers patterned after natural analog sites (i.e., sites where the naturally deposited soil types and layers are evaluated and used as a basis for the barrier design). In semiarid and arid climates, such as at the Hanford Site, the simple ET-type barriers appear to provide a high level of protection over a long time period (greater than 1,000 years) against excessive water infiltration into a covered waste site. Additionally, such barriers typically are of significantly simpler design (as compared to prescriptive RCRA Subtitle C compacted clay barriers), can be designed and constructed at lower costs, do not develop desiccation cracks during normal wetting and drying cycles (unlike compacted clay barriers), and require minimal maintenance. As a result, it is highly likely that the final design of the 221-U Facility barrier will include the use of a simple ET barrier (e.g., monolithic fill or capillary barrier; Figure 7-1).

Figure 7-1. Conceptual Monolithic and Capillary Barrier Designs.



However, because detailed design of the 221-U Facility barrier has not yet begun, the type or thickness of barrier to be employed has not been finally determined. Because the barrier surface will be abruptly elevated above the surrounding terrain, there is an increased potential for wind and water erosion, and an additional allowance in functional barrier thickness may be required. Water storage and other hydraulic properties of candidate soils need to be evaluated to determine the amount (thickness) of soil needed for anticipated weather patterns. To bound the cost of these uncertainties, cost information provided in this RD/RAWP relies on information developed for the final feasibility study (DOE/RL-2001-11), which assumed the use of a modified RCRA Subtitle C barrier to support development of cost and material need projections. Because the modified RCRA Subtitle C barrier is much more complex than a monolithic fill or capillary barrier, using the cost data for a modified RCRA Subtitle C barrier design will provide an upper bound to the estimate. As barrier design proceeds, this RD/RAWP will be revised to reflect updated design information.

Section 4.2 of the final feasibility study describes various barrier design concepts at length. Even though the study establishes that the use of a simple ET barrier could be substantiated for the 221-U Facility, it defers to a version of the modified RCRA Subtitle C barrier design based on guidance given in an earlier feasibility study (*Focused Feasibility Study of Engineered Barriers for Waste Management Units in the 200 Areas* [DOE/RL-93-33]). Subsequent studies and reports (several noted above) have demonstrated that, in semiarid and arid climates, a simple monolithic or capillary ET barrier can perform better than a multilayered barrier that uses a clay layer as a redundant component.

7.2 FACTORS TO CONSIDER IN DESIGNING BARRIER LAYERS

As stated previously, it is highly likely that the final design of the 221-U Facility barrier will include the use of a simple ET barrier similar to that shown in Figure 7-1. Of the simple ET barriers, a monolithic barrier has one major advantage over barriers that contain multiple layers: its ability to functionally self-heal after subsidence or after a seismic event. Not only is the monolithic barrier better able to accommodate differential settlements or subsidence relative to that of a multi-layered barrier, but also a single fine-soil layer simplifies construction and maintenance, eliminates the need for graded filters or a drainage layer at the base of the functional barrier to divert interflow water laterally, and has a lower cost.

Generally, a capillary ET barrier will provide greater water storage capacity for a given thickness of fine-soil than a monolithic barrier; however, a capillary ET barrier relies on maintaining the planar textural interface between the graded filter layers and the fine-soil. This planar interface can be disrupted by differential settlements, subsidence, or eluviation of soil particles into the underlying soil horizon. This is an important consideration for applications with void space or solid wastes that are susceptible to subsidence. If the capillary break is compromised, the performance of the barrier diminishes.

Given the same soil type, to have an equivalent water storage capacity, the monolithic barrier will require additional soil thickness relative to that of a capillary barrier. If the thickness of the soil required for water-holding capacity exceeds the rooting depth of surface vegetation, then the water removal capacity of plants diminishes. However, the additional thickness can also be advantageous in providing increased intruder protectiveness. Shrubs that are native to the Hanford Site, when mature, can have a rooting depth in excess of 180 cm (71 in.) ("Soil Water Withdrawal and Root Characteristics of Big Sagebrush" [Sturges 1977]). Therefore, a monolithic barrier could be 180 cm (71 in.) thick, and the native plant community would still be able to remove water stored within the fine-soil profile via plant transpiration.

Several analytical studies have been performed recently that used computer modeling and simulations to predict the performance of a 100 cm- (39 in.-) thick silt-loam capillary barrier at the Hanford Site. These models used input data specific to the Site (e.g., weather, plant community, soil properties). One study, developed for the Integrated Disposal Facility at the Site, concluded that if the capillary barrier has mature native vegetation, it would have a long-term average recharge rate of 0.1 mm/yr (*Recharge Data Package for the 2005 Integrated*

Disposal Facility Performance Assessment [PNNL-14744]). This is well below the 3.2 mm/yr recharge rate noted in Section 2.1.2 of this RD/RAWP as the performance goal for the barrier. However, the analysis (modeling) was based on using a source of silt-loam soil that is no longer available to the Hanford Site. A replacement source of silt-loam soil was recently sampled and tested and has been found to have a slightly lower water storage capacity (*Hydrology and Vegetation Data Package for 200-UW-1 Waste Site Engineered Surface Barrier Design* [PNNL-15464]). Because a monolithic barrier would have to be slightly thicker than a capillary ET barrier to achieve the same level of performance using the same soil, having to use a soil that has a slightly lower water storage capacity would require an additional increase in thickness. Moreover, with the increased potential for wind erosion due to the 221-U Facility barrier surface being abruptly elevated above the surrounding terrain, to achieve a life expectancy of 500 or even 1,000 years, an even greater increase in thickness may be required for the 221-U Facility monolithic barrier over that of the Integrated Disposal Facility capillary barrier design, which will be at grade.

To reduce wind and precipitation impact erosion, the top 30 cm (12 in.) of the ET barrier likely will have pea gravel blended into the silt-loam. Through wind tunnel tests, the addition of 10-mm (3/8-in.) diameter pea gravel blended at 15 weight % into the top 30 cm (12 in.) of the silt-loam soil reduces the amount of soil loss appreciably without significantly affecting moisture retention or plant propagation capabilities of the silt-loam (*Soil Erosion Rates Caused by Wind and Saltating Sand Stresses in a Wind Tunnel* [PNL-8478]). As the surface deflates, more and more of the pea gravel becomes exposed, forming a "desert pavement" that armors the surface against further erosion. (As the gravel admixture is merely a supplement to the silt-loam, it is not considered as a separate layer in either the capillary or monolithic barriers.) In blending the pea gravel within the top 30 cm (12 in.) of the barrier, the natural process of the soil and any resultant desert pavement being turned over or tilled by burrowing animals and insects is approximated.

In addition, because wind and water erosion potential is a function of the surface slope, the silt-loam surface should be as flat as possible while still allowing for drainage during extreme precipitation events. The slope of the functional portion of the barrier will be set to a nominal 2 % grade, which is steep enough to provide for coherent drainage from the covered area, yet shallow enough to limit exposure of the surface to wind shear (DOE/RL-93-33).

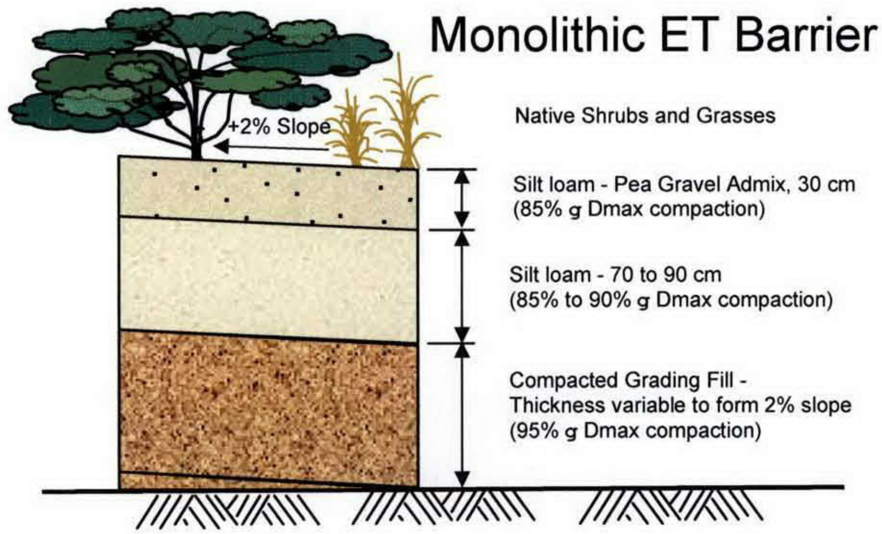
With everything above being considered, it is anticipated that the fine-soil layers of a monolithic ET barrier for the 221-U Facility disposition would be in the realm of 120 cm- (47 in.-) thick. Table 7-1 presents the typical design layers of the functional portion of an engineered monolithic ET barrier that is being considered for application at the 221-U Facility (as depicted in Figure 7-2).

Vertical cutoff barriers (redundant low permeability layers) or capillary breaks are important design features that will be evaluated during remedial design.

Table 7-1. Typical Layers of the Functional Portion of an Engineered Monolithic Evapotranspiration Barrier.

Layer No.	Thickness, cm (in.)	Layer Description	Specifications	Function
1	30 (12)	Silt-loam with pea gravel admix	Silt-loam containing 15 wt. % pea gravel and limiting compaction to 80 % to 85 % relative density as determined by standard Proctor test. The pea gravel typically is blended with the silt with a pug mill prior to placement to produce a homogeneous layer. However, it may be possible that placement of a thin layer of pea gravel and subsequent tilling could produce the same results.	The silt-loam material was identified for optimal water retention properties and should provide a good rooting medium for cover vegetation. Relative density of the silt-loam should be maintained below 85 % to facilitate plant growth. The pea gravel has proven in wind tunnel and precipitation impact tests to minimize wind and water erosion of the silt-loam without significantly affecting its moisture retention or plant propagation capabilities.
2	90 (36)	Silt-loam	Silt-loam compacted to approximately 85 % relative compaction as determined by standard Proctor test. A maximum of 90 % relative compaction also will be specified to augment root penetration.	Same as Layer 1. Collectively, Layers 1 and 2 provide a sufficiently thick soil layer to store water inputs from precipitation events for subsequent removal by evapotranspiration processes. Layers 1 and 2 also provide an adequate rooting depth for the native Hanford Site plant community.
3	Variable	Engineered (or grading) fill	Clean, granular material compacted to 95 % to 98 % relative compaction as determined by standard Proctor test.	This layer forms the basic shape/slopes of the barrier and provides a stable subgrade for constructing the overlying layers. Engineered or grading fill will provide the balance of the thickness of the barrier.

Figure 7-2. Typical Cross Section of the Functional Portion of an Engineered Monolithic Evapotranspiration Barrier.



7.3 TECHNICAL SPECIFICATIONS AND DESIGN DRAWINGS

Technical specifications for the engineered barrier will be prepared to support solicitation of an RC. Construction of the barrier will require transportation of materials and revegetation. Each technical specification will establish quality and workmanship requirements and define how quality is measured.

Design drawings will be prepared to support solicitation of an RC for barrier construction and, together with the technical specifications, make up the technical requirements of the remedial action activities. A typical engineered barrier cross section that might be employed at the 221-U Facility is provided as Figure 7-3. A cross section of the functional portion of a typical monolithic fill engineered barrier is provided as Figure 7-2. A cross section of a typical side slope erosion protection layer is provided as Figure 7-4. It should be noted that the side slopes will be designed in accordance with the guidance given in the *Design of Erosion Protection for Long-Term Stabilization: Final Report* (NUREG-1623). Actual materials and thicknesses will be determined during detailed design and could be different from that shown herein.

Figure 7-3. Typical Cross Section of an Engineered Barrier.

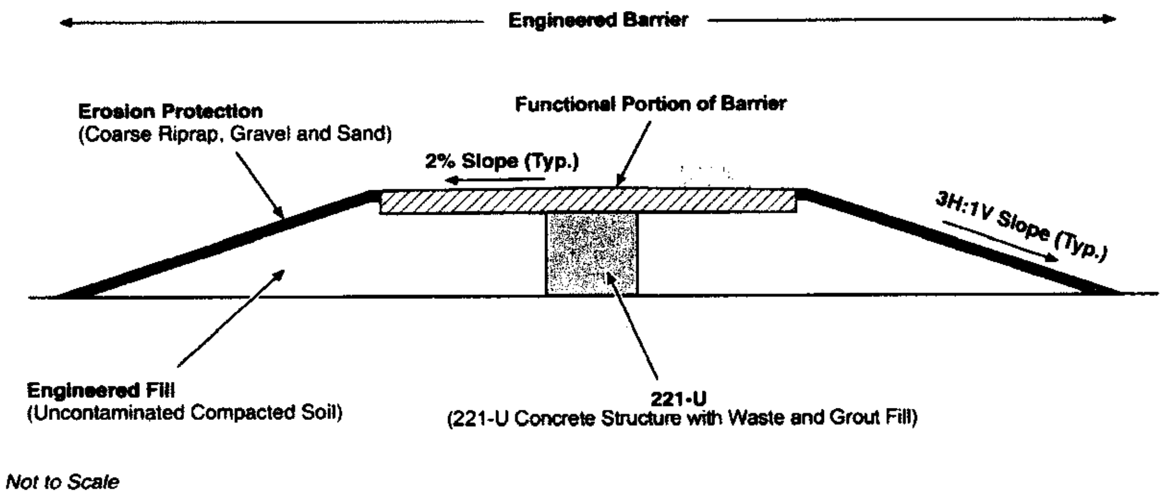
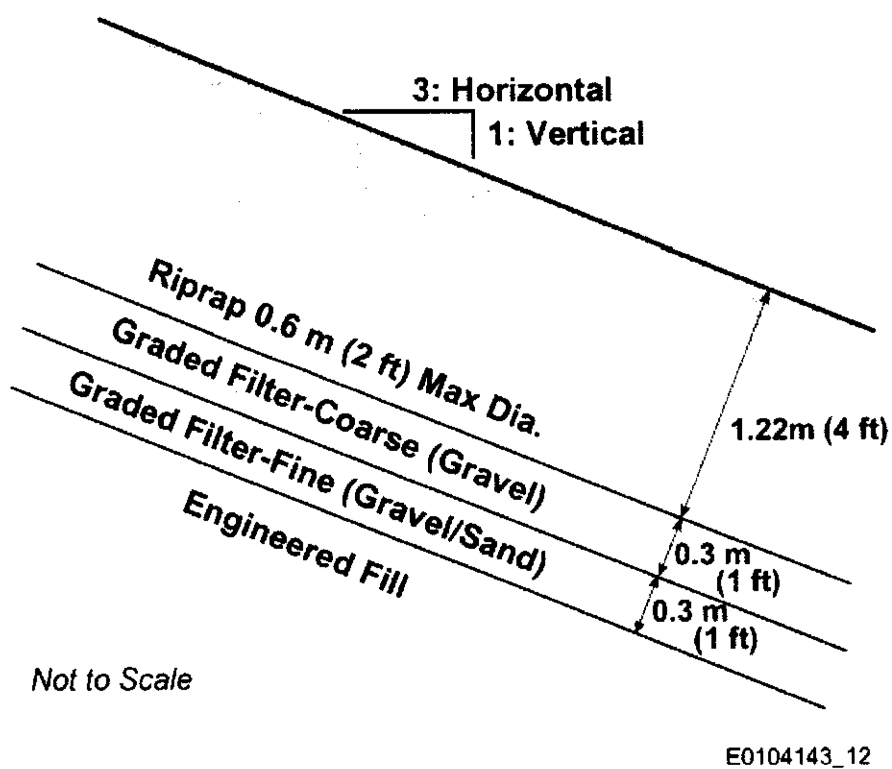


Figure 7-4. Cross Section of a Typical Erosion Protection Layer at the Sideslope of the Barrier.



7.4 CONSTRUCTION QUALITY ASSURANCE PLAN

A construction quality assurance plan will be developed and implemented to ensure that the barrier is constructed in accordance with the design and specifications. This plan will be in compliance with Tri-Party Agreement Section 7.8 and with the *Technical Guidance Document: Construction Quality Assurance for Hazardous Waste Land Disposal Facilities,* OSWER Policy Directive No. 9472.003, EPA/530-SW-86-031 (EPA 1986c).

7.5 DESIGN LIFE

The performance period for the remediated 221-U Facility is 1,000 years. For cost estimating purposes, the barrier was assumed in the final feasibility study (DOE/RL-2001-11) to have a design life of 500 years, necessitating replacement in kind after 500 years to achieve the 1,000-year performance period. However, barrier reconstruction/replacement at 500 years is a conservative assumption and may not be required. Natural analogs and recent barrier design work suggest that such reconstruction is not likely to be required if a simple evapotranspirative barrier design is implemented with proper erosion protection measures incorporated into the design (e.g., gravel admix on the surface, riprap side slopes). Performance expectations are that a barrier that mimics natural analogs will work with nature and behave as the analog does. Because simple ET barrier designs are likely to be very similar to natural soil structures, minimal maintenance should be required.

Construction and initial maintenance will proceed for several years following partial demolition of the facility. Cost estimates provided in the final feasibility study include a number of barrier surveillance and maintenance activities (e.g., quarterly visual inspections for barrier erosion, plant community survival, settlement, subsidence, displacement, cracking), but after a period of roughly 50 years, the facility is expected to be self-maintaining.

7.6 ENGINEERED BARRIER COMPONENTS

The engineered barrier components described in this RD/RAWP are of a monolithic ET barrier concept. As 221-U Facility barrier design work proceeds, this RD/RAWP will be revised to reflect updated design information.

The functional portion of the engineered barrier has a minimum surface slope of 2 % for drainage, and uses evapotranspiration to remove water stored within the fine-soil layer of the barrier. The thickness of the barrier is based on the water storage capacity of the fine-soil and anticipated weather patterns for the Hanford Site. A cross section of the functional portion of a typical engineered barrier is shown in Figure 7-2. Note that simple ET designs mimic natural analogs and generally are self-healing if subsidence occurs. In contrast, complex multilayer barriers with clay or asphalt layers could tend to develop cracking from subsidence, seismic movement, or wetting/drying cycles.

Any geosynthetics used in the construction of the engineered barrier are used as construction aides and are not to be considered as a functional portion of the barrier because the long-term (500-year) performance of geosynthetics could not be extrapolated from existing data.

7.7 BARRIER STABILITY ANALYSIS

Appendix D of the final feasibility study (DOE/RL-2001-11) addresses barrier stability, including erosion protection, seismic design, and acceptable factors of safety. The engineered barrier used in the stability analyses is a 24 m (80 ft) high barrier that would have been required if remedial action Alternatives 3 or 4 had been selected for the 221-U Facility. The barrier was assumed to be a modified RCRA C barrier for the purposes of cost and material need estimations required in the final feasibility study. The finished environmental barrier for the selected remedy (Alternative 6) will be roughly 11 m (35 ft) high and likely will be a simpler ET barrier, such as shown in Figures 6-2 and 6-3. The stability analysis results provided in Appendix D of the final feasibility study are considered bounding for the lower barrier required under the selected alternative. Analyses specific to the lower barrier required for the selected alternative will be completed as remedial design proceeds.

7.8 FINAL DESIGN PACKAGE

The design of the 221-U Facility engineered barrier will draw on ongoing barrier design and modeling work across the United States and at the Hanford Site. The analysis will include evaluation of the effects of extreme storm events, range fires, and other natural phenomena that might occur during the life of the barrier and that might have an effect on performance. The design and size of the functional portion of the barrier and the size of the barrier footprint will be driven primarily by the need to provide a barrier to intrusion into the grouted waste remaining onsite at the conclusion of the 221-U Facility remedial action. However, the 221-U Facility barrier is being identified in other Hanford Site CERCLA response action documentation as a potential remedy for nearby contaminated soil sites. As a result, barrier design may need to factor in provision of a barrier function at these adjacent sites, resulting in expansion of the final barrier footprint.

A design package consisting of final technical specifications, calculations, Construction Quality Assurance Plan, and "issued for bid" drawings stamped by a Registered Professional Engineer licensed in the state of Washington will be completed before the initiation of engineered barrier construction activities.

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8.0 REFERENCES

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

10 CFR 61, Subpart C, "Performance Objectives," Title 10, *Code of Federal Regulations*, Part 61, Subpart C, as amended.

10 CFR 61, Subpart D, "Technical Requirements for Land Disposal Facilities," Title 10, *Code of Federal Regulations*, Part 61, Subpart D, as amended.

10 CFR 830, Subpart A, "Quality Assurance Requirements; EPA Requirements for Quality Assurance Project Plans (EPA QA/R 5); and Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW 846)", as amended.

10 CFR 835, "Occupational Radiation Protection," Title 10, *Code of Federal Regulations*, Part 835, as amended.

10 CFR 835, Appendix D, "Surface Contamination Values," Title 10, *Code of Federal Regulations*, Part 835, Appendix D, as amended.

36 CFR 60, "National Register of Historic Places," Title 36, *Code of Federal Regulations*, Part 60, as amended.

40 CFR 61, "National Emission Standards for Hazardous Air Pollutants," Title 40, *Code of Federal Regulations*, Part 61, as amended.

40 CFR 61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities," Title 40, *Code of Federal Regulations*, Part 61, as amended.

40 CFR 61, Subpart M, "National Emission Standards for Asbestos," Title 40, *Code of Federal Regulations*, Part 61, Subpart M, as amended.

40 CFR 141, "National Primary Drinking Water Regulations," Title 40, *Code of Federal Regulations*, Part 141, as amended.

40 CFR 141, Subpart G, "National Primary Drinking Water Regulations: Maximum Contaminant Levels and Maximum Residual Disinfectant Levels," Title 40, *Code of Federal Regulations*, Part 141, Subpart G, as amended.

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

40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan," Title 40, *Code of Federal Regulations*, Part 300, as amended.

40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan," Appendix B, "National Priorities List," Title 40, *Code of Federal Regulations*, Part 300, as amended.

40 CFR 302, "Designation, Reportable Quantities, and Notification," Title 40, *Code of Federal Regulations*, Part 302, as amended.

40 CFR 355, "Emergency Planning and Notification," Title 40, *Code of Federal Regulations*, Part 355, as amended.

40 CFR 761, "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions," Title 40, *Code of Federal Regulations*, Part 761, as amended.

50 CFR 10-24, "Migratory Bird Treaty Act," *Code of Federal Regulations*, as amended.

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