DOE/RL-2011-47
Draft A

Proposed Plan for the Remediation of 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units

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

U.S. DEPARTMENT OF ENERGY
Richland Operations Office

P.O. Box 550
Richland, Washington 99352

DOE/RL-2011-47
Draft A

Proposed Plan for the Remediation of 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units

Date Published
December 2011

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

U.S. DEPARTMENT OF ENERGY | Richland Operations Office

P.O. Box 550
Richland, Washington 99352

APPROVED
By G.E. Bratton at 9:09 am, Dec 21, 2011

Release Approval   Date

Printed in the United States of America

River Corridor Remediation at the Department of Energy Hanford Site

DOE/RL-2011-47, Draft A
December 2011

Proposed Plan for the Remediation of 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units

U.S. Department of Energy, Richland Operations Office
U.S. Environmental Protection Agency
Washington State Department of Ecology

Public Comment Period

Month Day to Month Day, Year

Please read this Proposed Plan and review related documents in the Administrative Record.

Please submit your comments on this Proposed Plan by mail or e-mail on or before (Date).

See page X for more information about public participation and contact information.

INSIDE THIS PLAN:

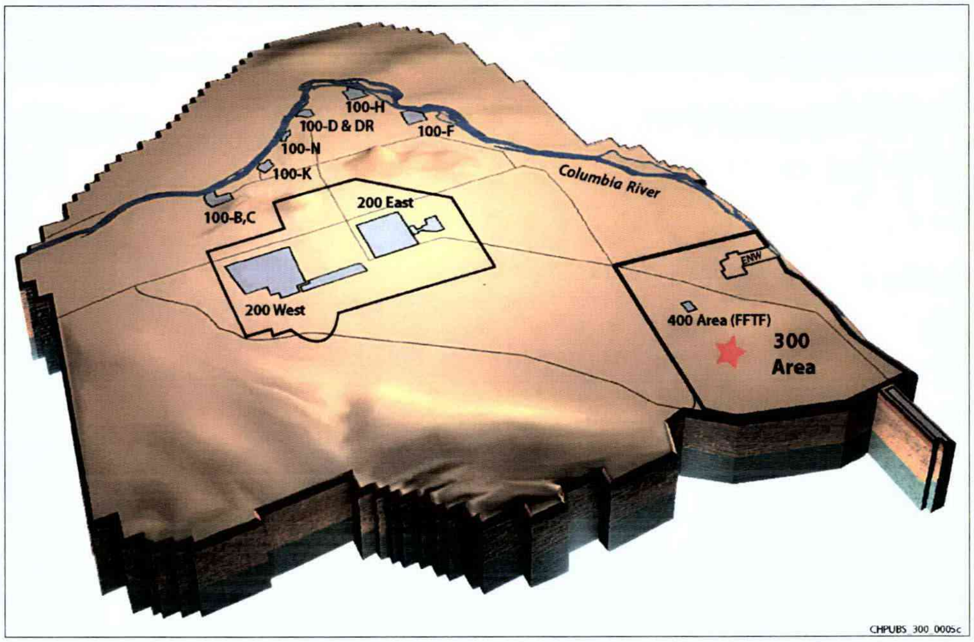


Figure 1. The 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units Within the 300 Area of the Hanford Site

The U.S Department of Energy (DOE) and U.S Environmental Protection Agency (EPA) invite comments from Tribal Nations and the public on this **proposed plan** for cleanup of the Hanford Site's 300-FF-1 and 300-FF-2 source **Operable Units** (OUs) and the 300-FF-5 groundwater OU located within the 300 Area (Figure 1) along the Columbia River near Richland, Washington (bolded text indicates terms that are defined in the glossary at the end of this document).

This proposed plan presents options considered for cleaning up the soil and groundwater contamination (called **remedial alternatives**) and recommends a **preferred alternative** for implementation.

The area of the Hanford Site that borders the Columbia River is referred to as the River Corridor (Figure 2). The River Corridor has been divided into six geographic areas. These six areas were selected to define manageable portions of the River Corridor that align with historical operations (e.g., uranium fuel rod preparation or reactor operations).

The 300 Area, which is in the southern portion of the River Corridor includes 277 **waste sites** in the 300-FF-1 and 300-FF-2 source OUs. Of these waste sites, 122 waste sites have been identified for no further action (final closed or interim closed) based on previous investigations and remedial actions (Appendix A). Therefore, the remaining 155 waste sites are being recommended for additional remedial actions as presented in this Proposed Plan. In addition, this proposed plan addresses the localized groundwater contamination from uranium, tritium, hexavalent chromium, nitrate, gross alpha, trichloroethene, and cis-1,2-dichloroethene in the 300-FF-5 OU.

Input received from Tribal Nations and the public on this proposed plan will help DOE and EPA choose the best way to clean up the contaminated waste sites and groundwater in the 300 Area. Written comments can be submitted by e-mail or U.S. mail. Comments will be accepted during the 30-day public comment period. For specific information on how to participate, see the Community Participation section in this proposed plan.

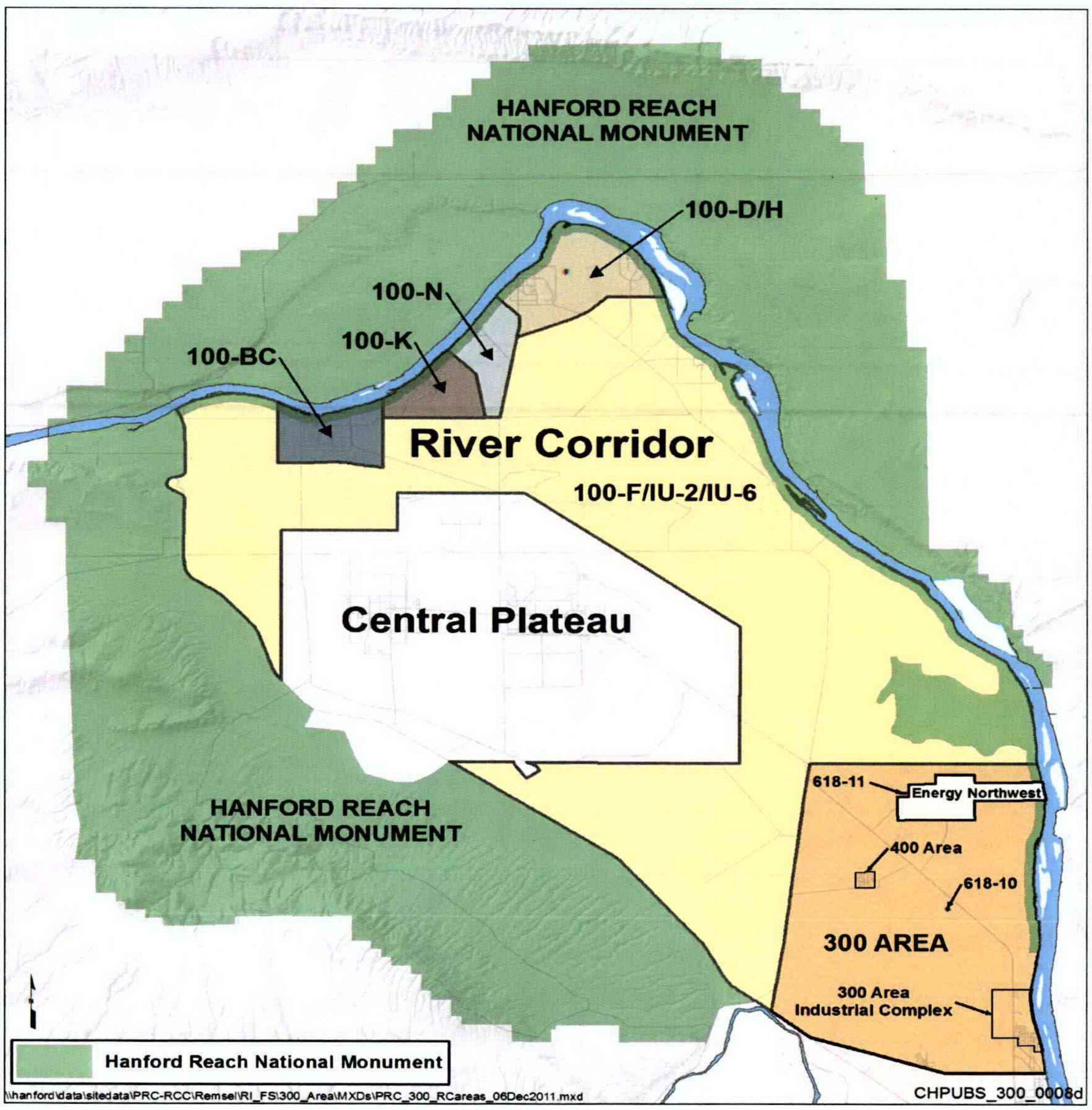


Figure 2. The Hanford Site River Corridor

Remedial Alternatives

As summarized in later sections of this proposed plan, and described in detail in the *Remedial Investigation/Feasibility Study Report for the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units* (DOE/RL-2010-99), the following remedial alternatives were considered:

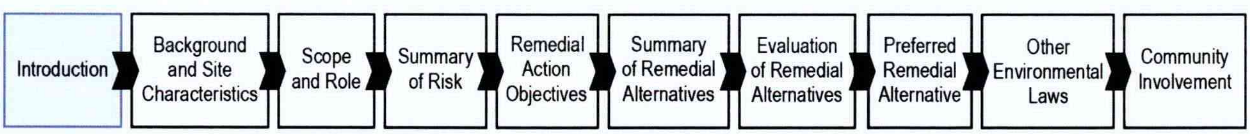
- Alternative 1—**No Action**
- Alternative 2—**Removal, Treatment, and Disposal (RTD),** and **Groundwater Monitoring**
- Alternative 3—RTD, Uranium Sequestration**,** and Groundwater Monitoring
- Alternative 4—RTD, Uranium Sequestration, Focused Deep RTD**,** and Groundwater Monitoring
- Alternative 5—RTD, Expanded RTD and Groundwater Monitoring

Preferred Alternative

Based on the results of the detailed and comparative evaluation of the five remedial alternatives, the preferred alternative is Alternative 3—RTD and Uranium Sequestration at Waste Sites and Groundwater Monitoring. Uranium sequestration is a process that can be used to immobilize uranium in soil into a stable and non-soluable form. This alternative protects human health and the environment while meeting the statutory requirements for cost effectiveness, use of permanent solutions, preference for treatment, and compliance with **Applicable or Relevant and Appropriate Requirements (ARARs)**. Following consideration of input from Tribal Nations and the public on the preferred alternative and other remedial alternatives presented in this proposed plan, a **Record of Decision (ROD)** identifying the alternative selected for implementation will be issued by DOE and EPA.

Proposed Plan Outline

This proposed plan is divided into ten sections, as shown in the following graphic. The graphic is included just before each new section to indicate where the new section fits within the overall organization of the proposed plan.



Introduction

This proposed plan describes the remedial alternatives considered and the preferred alternative proposed for the **remediation** of the waste sites in the 300-FF-1 and 300-FF-2 source OU and the 300-FF-5 groundwater OU. The two source OUs together consist of 277 waste sites which have been grouped into the 300-FF-1 or 300-FF-2 OU based on similarities in the types of liquid wastes and primary contaminants they received as well as the subsequent distribution of those primary contaminants in the subsurface. The 300-FF-5 groundwater OU consists of the contaminated groundwater that is associated with any of the waste sites in the source OUs. The Hanford site cleanup is implemented through an agreement between the DOE, EPA and State of Washington Department of Ecology.

These agencies are referred to as the Tri-Party agencies under the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al., 1989), which is commonly called the **Tri-Party Agreement**. The roles of these agencies are described below:

- DOE. As the lead agency and the party responsible for conducting the **remedial investigation (RI)** and selecting the preferred cleanup alternative in consultation with the EPA, DOE is required to issue this proposed plan to fulfill the public participation requirements under Section 117 (a) of the ***Comprehensive Environmental Response, Compensation, and Liability Act of 1980*** **(CERCLA)** (commonly referred to as "Superfund") and 40 **Code of Federal Regulations (CFR)** 300.430(f) (2) and (3) of the **"National Oil and Hazardous Substances Pollution Contingency Plan" (NCP)**. CERCLA establishes the broad federal authority for conduct of cleanup at Superfund sites, and the NCP defines the requirements and expectations for the cleanup.

- EPA**.** As the lead regulatory agency for these OUs, EPA provides regulatory oversight of the Hanford Site cleanup. EPA, in consultation with DOE, will prepare the ROD identifying the cleanup alternative selected for implementation.

- Ecology. Washington State Department of Ecology**.** As the non-lead regulatory agency for these OUs, Ecology will determine whether the State of Washington concurs with the selected alternative.

The 300 Area work has been completed following the CERCLA remedial action decision process (Figure 3). Completion of the RI field work is the first major step in the CERCLA decision-making process (Figure 3). The RI fieldwork for this project was completed in 2011 and the RI/FS Report, which documents the fieldwork, was prepared in support of this proposed plan. The RI/FS Report is available in the Tri-Party Agreement **Administrative Record**.

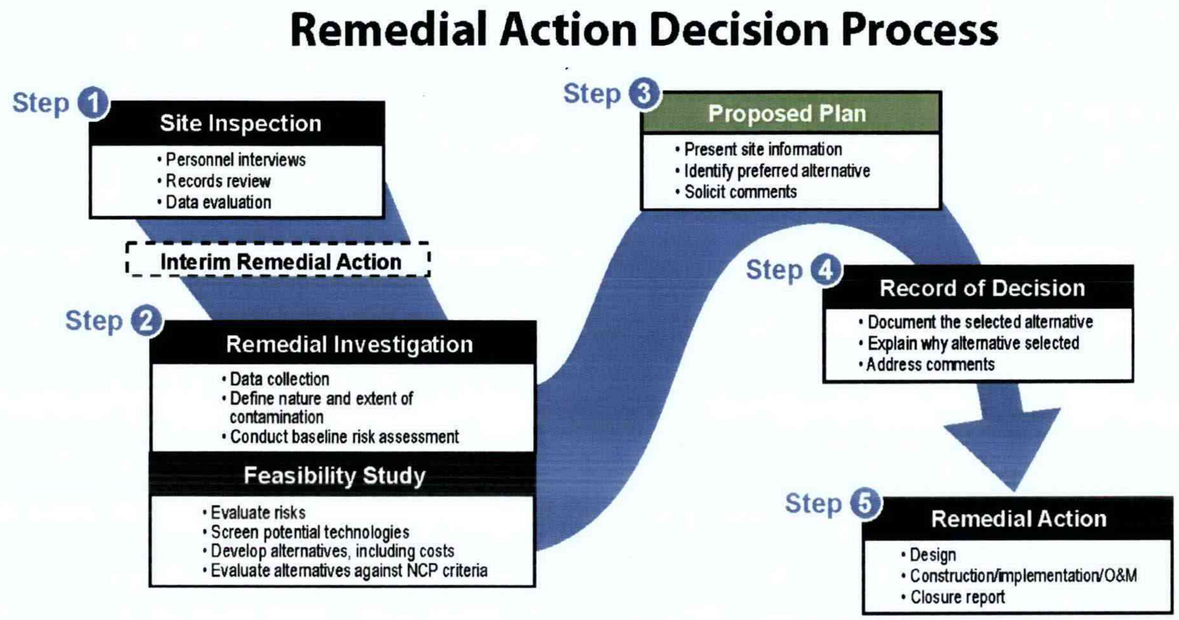
This proposed plan presents cleanup recommendations for the 300 Area and is one of six proposed plans that DOE will issue for the River Corridor. The content and recommendations contained in this proposed plan are based on the recently completed 300 Area RI/FS Report (DOE/RL-2010-99). The RI/FS Report summarizes the results of previous investigations, remedial actions conducted, and remedial alternatives being considered for these OUs.

After the Tri-Party agencies consider the comments received on this proposed plan, they will issue a final remedy decision identifying the selected remedy for implementation. The final remedy decision will establish cleanup levels (or remediation goals) for all waste sites and groundwater in the 300 Area. The remedy decisions for each OU will be documented in a ROD (and depending on the remedy decision for the 300-FF-1 OU, a ROD amendment, since a ROD already exists for this OU). The ROD and the ROD Amendment, if necessary, also will contain a responsiveness summary presenting Tri-Party agency responses to comments received during the public comment period.

Previous Investigations

After issuing the Tri-Party Agreement in 1989, the Tri-Party agencies prioritized the need for CERCLA investigations to address waste site and groundwater contamination in the 300 Area. As a result, RIs and **Limited Field Investigations** were initiated in the early 1990s for the 300-FF-1, 300-FF-2, and 300-FF-5 OUs to characterize the **nature and extent of contamination** in the **vadose zone** and groundwater. The primary investigations included the following:

- WHC-SD-EN-TI-052, 1992, *Phase I Hydrogeologic Summary of the 300-FF-5 Operable Unit*
- DOE/RL-92-43, 1993, *Phase I Remedial Investigation Report for the 300-FF-1 Operable Unit*
- DOE/RL-93-21, 1994, *Phase I Remedial Investigation Report for the 300-FF-5 Operable Unit*
- WHC-SD-EN-TI-279, 1994, *Summary of Remedial Investigations at the 307 Retention Basins and 307 Trenches (316-3) at the 300-FF-2 Operable Unit*



Step 1. Site Inspection—Includes interviewing site personnel regarding the history of the site, reviewing waste disposal records, and evaluating existing data.

Step 2. Remedial Investigation/Feasibility Study—Topics of the combined segments are:

- **Remedial Investigation**—Consists of an environmental study to identify the nature and extent of contamination and a preliminary evaluation of the risk posed to human health and the environment.
- **Feasibility Study**—Includes the details of a remedial alternative evaluation and identifies PRGs.

Step 3. Proposed Plan—Based on previous field investigations and reports that are completed in the first two steps of the process, the Proposed Plan summarizes the remedial alternative evaluations and presents the preferred alternative for comments.

Step 4. Record of Decision—Formally documents the cleanup alternative that was selected after review and response to comments on the Proposed Plan.

Step 5. Remedial Action—Consists of the actual cleanup activities being performed. When cleanup is completed, a final report is written that describes the remedial actions implemented, the result of the actions, and the conclusion of the process.

CHPUBS_RC_0002

Figure 3. CERCLA Process

- DOE/RL-94-85, 1995, *Remedial Investigation/Feasibility Study Report for the 300-FF-5 Operable Unit*
- DOE/RL-96-42, 1996, *Limited Field Investigation Report for the 300-FF-2 Operable Unit*
- DOE/RL-99-40, 2000, *Focused Feasibility Study for the 300-FF-2 Operable Unit*
- PNNL-16435, 2007, *Limited Field Investigation Report for Uranium Contamination in the 300-FF-5 Operable Unit at the 300 Area, Hanford Site, Washington*
- PNNL-16454, 2007, *Current Conditions Risk Assessment for the 300-FF-5 Groundwater Operable Unit*

A summary of 300 Area previous investigations and findings is presented in Appendix N (Table N-1) of DOE/RL-2010-99. These investigations provide information on the nature and extent of contaminants in vadose zone soil and groundwater, and the threat the contaminants pose to human health and the environment. The findings from these investigations resulted in decisions to implement remedial actions in the 300-FF-1 and 300-FF-5 OUs (EPA/ROD/R10-96/143, *Record of Decision for the 300-FF-1 and 300-FF-5 Operable Units, Hanford Site, Benton County, Washington*) and in the 300-FF-2 OU (EPA/ROD/R10-01/119, *EPA Superfund Record of Decision: Hanford 300-Area, Benton County Washington*). A timeline of previous investigations and remedial actions for the 300-FF-1, 300-FF-2, and 300-FF-5 OUs is presented on Figure 4.

Previous Remedial Actions, Five-Year Review Reports, and Pilot Testing

Remedial Actions

The Tri-Party agencies conducted two removal actions in 1991 to mitigate the threat to human health and the environment from contaminant migration in the 300 Area: (1) removal of soil from the 300 Area Process Trenches in the 300-FF-1 OU (EPA, 1991, *Action Memorandum: 316-5 Process Trenches, U.S. Department of Energy (DOE) Hanford Site, Richland, Washington*); and (2) removal and disposal of drums containing uranium-contaminated methyl isobutyl ketone (hexone) from the 618-9 Burial Ground in the 300-FF-2 OU (DOE, 1991, *618-9 Burial Ground Expedited Response Action*). As a result of these expedited response actions, the 300 Area Process Trenches were partially remediated, and all waste was removed from the 618-9 Burial Ground.

In 1996, as part of the final action ROD for the 300-FF-1 OU (EPA/ROD/R10-96/143), remedies were selected for 15 waste sites. The 15 waste sites included liquid waste disposal sites (e.g., South Process Pond [316-1], North Process Pond [316-2], and 300 Area Process Trenches [316-5]) and solid waste disposal sites (e.g., 618-4 Burial Ground and 628-4 Landfill). Following these remedial actions, the Tri-Party agencies determined that remediation was complete at these 15 waste sites.

In 1996, the remedy selected in the ROD for interim actions in the 300-FF-5 groundwater OU (EPA/ROD/R10-96/143) was **monitored natural attenuation (MNA)** with **institutional controls (ICs)**. The 300-FF-5 OU ROD required continued groundwater monitoring to verify modeled predictions of contamination attenuation and to evaluate the need for active remedial measures. ICs were required to prevent groundwater use while contaminant plumes were still present with concentrations above drinking water standards (DWSs). The 300-FF-5 OU ROD assumes that the groundwater aquifer is a potential future source of drinking water and will be restored to DWSs in a reasonable timeframe.

The **remedial action objectives (RAOs)** defined in the 300-FF-5 ROD were selected to protect human and ecological receptors from exposure to contaminants in the groundwater and to protect the Columbia River from contaminant levels that could exceed the State of Washington Surface Water Quality Standards. The **operation and maintenance (O&M)** plan for 300-FF-5 OU defined three activities to accomplish these goals: (1) groundwater monitoring, (2) near-shore river monitoring, and (3) posting warning signs.

In 2001, as part of the interim ROD for waste sites in the 300-FF-2 OU (EPA/ROD/R10-01/119), interim remedial actions were identified for the known wastes sites. The interim ROD also provided a regulatory framework for a **plug-in approach** to allow newly discovered sites to be remediated under the 300-FF-2 OU interim ROD, pending approval by the Tri-Party agencies. The waste sites are currently being remediated under the 300-FF-2 OU Interim ROD.

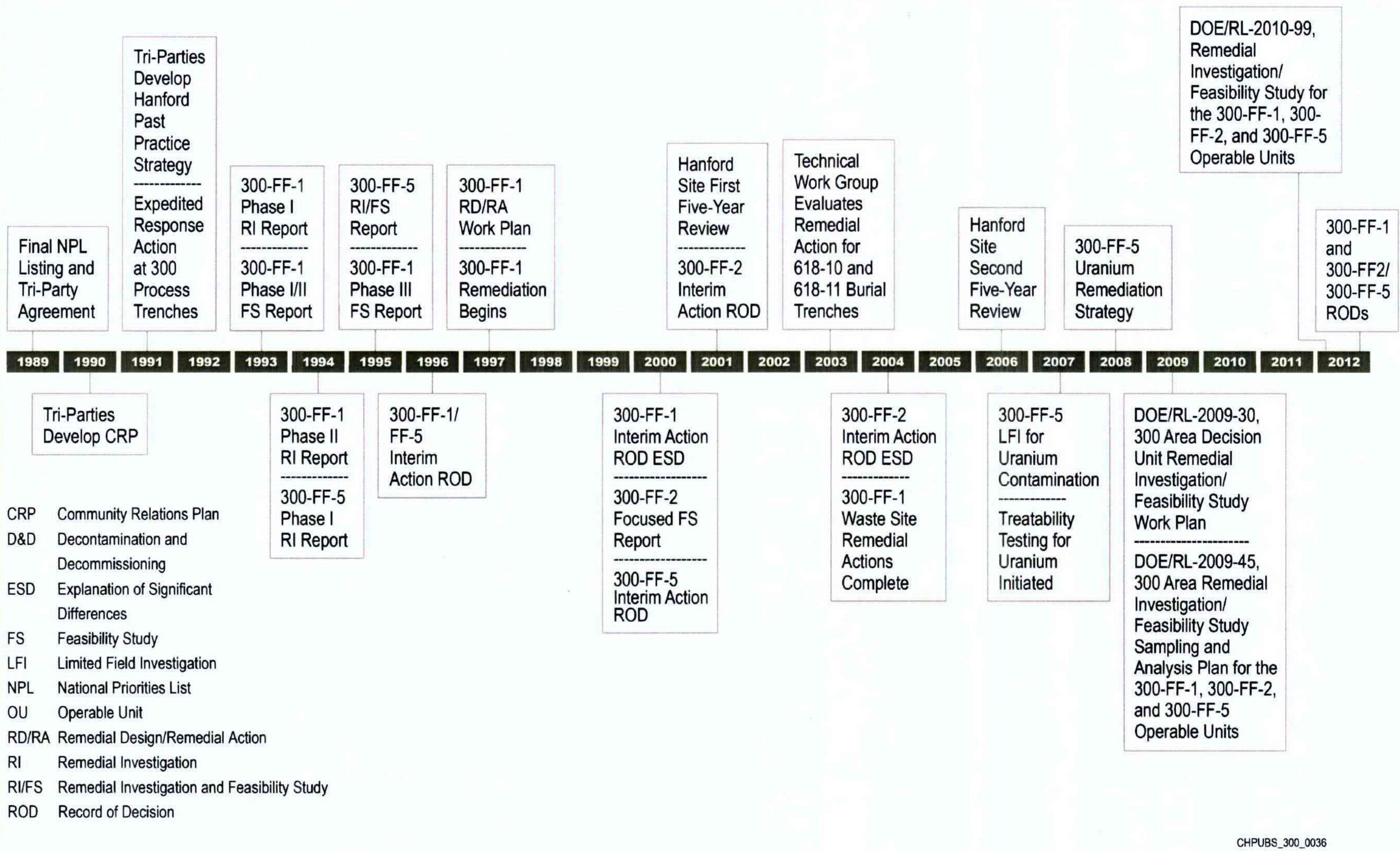


Figure 4. 300 Area Timeline

Five-Year Review Reports

The CERCLA process requires that the status of remedial actions be reviewed at least every 5 years to determine whether the selected remedies at a site remain protective of human health and the environment.

In 2001, the first five-year review of the 1996 ROD for the 300-FF-1 and 300-FF-5 OUs concluded that the remedies selected for the 300 Area were still appropriate. However, the review included an action item to add more requirements for monitoring along the river shoreline and to assess the effectiveness of the MNA remedy. The MNA remedy assessment required by the five-year review was provided in PNNL-15127, *Contaminants of Potential Concern in the 300-FF-5 Operable Unit: Expanded Annual Groundwater Report for Fiscal Year 2004.*

In 2006, the second five-year review (DOE/RL-2006-20) of the 1996 ROD for the 300-FF-1 and 300-FF-5 OUs and the 2001 ROD for the 300-FF-2 OU concluded that the final remediation actions for the 300-FF-1 OU waste sites met all of the RAOs, the interim remedial actions selected for the 300-FF-2 OU waste sites were still appropriate, and remediation of the uranium plume in the 300 Area groundwater through MNA had not achieved the RAOs in the 10-year timeframe envisioned when the ROD for interim action for groundwater was established. The issue identified in the five-year review stated the following:

> *Predicted attenuation of uranium contaminant concentrations in the groundwater under the 300 Area has not occurred. DOE is currently performing additional characterization and treatability testing in the evaluation of more aggressive remedial alternatives.*

To address this issue concerning uranium contamination, the review put forth the following action items: (1) complete the focused FS for the 300-FF-5 OU to provide better **characterization** of the uranium contamination, (2) develop a conceptual model, (3) validate ecological consequences, and (4) evaluate treatment alternatives. The action also required concurrent testing of polyphosphate injection into the aquifer to immobilize the uranium and reduce the concentration of dissolved uranium.

The characterization, evaluation, and testing required by the second five-year review action item were documented in the following reports:

1. Improved characterization of uranium contamination in the subsurface:
   - PNNL-16435, 2007, *Limited Field Investigation Report for Uranium Contamination in the 300-FF-5 Operable Unit at the 300 Area, Hanford Site, Washington.*
   - PNNL-17031, 2007, *A Site-Wide Perspective on Uranium Geochemistry at the Hanford Site*
   - PNNL-17793, 2008, *Uranium Contamination in the 300 Area: Emergent Data and Their Impact on the Source Term Conceptual Model*
2. Updated conceptual model for uranium contamination:
   - PNNL-17034, 2008, *Uranium Contamination in the Subsurface Beneath the 300 Area, Hanford Site, Washington*
   - Yabusaki et al., 2008, "Building Conceptual Models of Field-Scale Uranium Reactive Transport in a Dynamic Vadose Zone-Aquifer-River System"
3. Validated ecological consequences:
   - PNNL-16454, 2007, *Current Conditions Risk Assessment for the 300-FF-5 Groundwater Operable Unit*
   - PNNL-16805, 2007, *Investigation of the Hyporheic Zone at the 300 Area, Hanford Site*

- DOE/RL-2007-21, 2008, *River Corridor **Baseline Risk Assessment**, Volume II: Human Health Risk Assessment*
- DOE/RL-2008-11, 2008, *Remedial Investigation Work Plan for Hanford Site Releases to the Columbia River*

4. Evaluated treatment alternatives for uranium:
   - PNNL-16761, 2007, *Evaluation and Screening of Remedial Technologies for Uranium at the 300-FF-5 Operable Unit, Hanford Site, Washington*
   - DOE/RL-2008-36, 2008, *Remediation Strategy for Uranium in Groundwater at the Hanford Site 300 Area, 300-FF-5 Operable Unit*
5. Tested polyphosphate injection into the aquifer to immobilize uranium:
   - PNNL-16571, 2007, *Treatability Test Plan for 300 Area Uranium Stabilization Through Polyphosphate Injection*
   - PNNL-17480, 2008, *Challenges Associated with Apatite Remediation of Uranium in the 300 Area Aquifer*
   - PNNL-18529, 2009, *300 Area Uranium Stabilization Through Polyphosphate Injection: Final Report*
   - DOE/RL-2009-16, 2009, *300-FF-5 Groundwater Operable Unit Infiltration Test Sampling and Analysis Plan*

Uranium Sequestration Pilot Testing

Because remediation of uranium in deep subsurface soils using uranium sequestration is a relatively new remedial process at Hanford, DOE has undertaken laboratory-scale and field-scale pilot testing to evaluate the technology. The findings from this work are presented in this section.

The evaluation and screening of potential uranium treatment alternatives found that methods to immobilize uranium in the vadose zone and/or aquifer offer the potential for reducing the continued input of mobile uranium to the groundwater (PNNL-16761; DOE/RL-2008-36). The concept is to change the dissolved uranium to a form that is more permanently stored with sediment, with a resulting drop in concentrations of dissolved uranium. For the 300 FF-5 OU uranium plume, one approach is sequestration of uranium as insoluble phosphate phases in the unconfined aquifer. Therefore, a project to study the ability of phosphate phases to precipitate and adsorb dissolved uranium was performed. The project tested the direct formation of the uranium mineral autunite ($Ca(UO_2)_2(PO_4)_2 \cdot nH_2O$) by the introduction of a polyphosphate mixture and the formation of the mineral apatite (various forms of calcium phosphate) in the aquifer as a continuing source of phosphate for long-term treatment of uranium.

After a series of successful bench-scale tests, a field treatability test was conducted in June 2007 in a well at the 300 Area (PNNL-16008, *Site Characterization Plan: Uranium Stabilization through Polyphosphate Injection*). The objective of the treatability test was to evaluate the efficacy of using polyphosphate injections to treat uranium-contaminated groundwater in situ. A test site consisting of an injection well and 15 monitoring wells was installed in the 300 Area at the southern end of the former 300 Area Process Trenches, which had previously received uranium-bearing effluents. The results indicated that while the direct formation of the uranium mineral autunite was successful, the outcome of the apatite formation part of the test was limited. A complete description of the aquifer injection test and its results is presented in PNNL-18529.

Two separate overarching issues limited the effectiveness of apatite remediation for uranium sequestration within the 300 Area: (1) the formation and emplacement of apatite via polyphosphate technology, and (2) the efficacy of apatite for sequestering uranium under the present geochemical and hydrodynamic conditions (PNNL-17480). The first challenge, dealing with the emplacement, was largely to the result of very high groundwater velocities in this part of the 300-FF-5 OU, which could reach 18 m/d (59 ft/d). This problem could very likely be overcome by modifying the timing and application procedure. The second issue is more fundamental. The role of apatite was to adsorb dissolved uranium from groundwater. The uranium was expected to subsequently react with the phosphate in the apatite to form insoluble mineral phases, such as autunite. However, because of the elevated alkalinity of the groundwater, apatite did not adsorb the uranium to a sufficient degree to make it an effective treatment for reducing concentrations in groundwater.

Because it appears that apatite will not work as a continuing supply of phosphate in the aquifer, the remaining alternative is to treat the uranium source in the vadose zone and in the **periodically rewetted zone** (PRZ) (the lowermost portion of the vadose zone that becomes saturated when the river stage rises and locally elevates the water table). The most straightforward approach is to infiltrate solutions containing phosphate from the ground surface. As these solutions contact the uranium in the vadose zone and the PRZ, they should react to form insoluble autunite minerals, thus limiting further leaching of the uranium to the aquifer. As of September 2011, preliminary infiltration tests at the 300 Area have not indicated high infiltration rates, although only a very small area has been tested. Given the results of the preliminary tests, treating the lower portion of the vadose zone and PRZ using injection wells could be deployed to address the uncertainties associated with surface infiltration. Alternate chemical delivery methods that target the contamination in the vadose zone and PRZ have been evaluated for use in the 300 Area (see PNNL-19461, *Evaluation of Reagent Emplacement Techniques for Phosphate-based Treatment of the Uranium Contamination Source in the 300 Area: White Paper*).

Previous Public Involvement

The Tribal Nations, the public, and the **Hanford Advisory Board (HAB)** are routinely informed on the progress of 300 Area activities through regular updates and placement of documents in the **Administrative Record**. This has included briefings and/or formal review of the CERCLA documents (e.g., DOE/RL-2009-30, *300 Area Decision Unit Remedial Investigation/Feasibility Study Work Plan for the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units*; DOE/RL-2010-99) and the annual groundwater monitoring reports.

Public participation was conducted in conjunction with issuance of the final action ROD for the 300-FF-1 OU and the interim ROD for the 300-FF-5 OU (EPA/ROD/R10-96/143), and the interim ROD for the 300-FF-2 OU (EPA/ROD/R10-01/119). Amendments to these RODs also involved public participation or notices consistent with the Tri-Party Agreement **Community Relations Plan** (Ecology et al., 2002, *Hanford Site Tri-Party Agreement Public Involvement Community Relations Plan*).

The Community Relations Plan (Ecology et al., 2002) outlines stakeholder and public involvement processes and opportunities. As part of the Community Relations Plan (Ecology et al., 2002), the HAB advises the Tri-Party agencies on cleanup issues. Previous HAB input on other remedial decisions has been considered in this proposed plan.

Communication and consultation with the Tribal Nations is a priority for DOE and is coordinated through the DOE Richland Operations Office (DOE-RL). Briefings to Tribal Nations occur through forums, such as the monthly Tribal Nations, State of Oregon, and DOE groundwater and vadose zone meetings. DOE-RL works with the Tribal Nations to ensure ongoing communication and involvement in the River Corridor decision-making process.

Background and Site Characteristics

Information and knowledge about the Hanford Site, specifically the 300 Area, that is important to support final remedy selection is summarized below. More detailed information is provided in the RI/FS Report (DOE/RL-2010-99).

Hanford Site

The Hanford Site encompasses approximately 1,517 km^2 (586 mi^2) in the Columbia Basin in south-central Washington State. The Hanford Site is culturally rich. Historically, Native Americans inhabited the lands both within and around the Hanford Site. Settlers' presence in the mid-Columbia region began in 1805 shortly after the arrival of the Lewis and Clark Expedition along the Columbia and Snake Rivers. In the late 19th and early 20th centuries, intensive settlement and farming began on the Hanford Site. Farmstead communities existed from 1880 to 1943, primarily in the upland areas adjacent to the Columbia River. The farming landscape was abruptly halted in 1943 when the federal government took possession of the land to produce weapons-grade plutonium as part of the **Manhattan Project**. The Hanford Site was chosen because of its remoteness, the availability of water from the Columbia River, and access to electricity from hydropower plants at the Bonneville and Grand Coulee Dams. The Hanford Site's plutonium production mission continued throughout the Cold War period. In July 1989, EPA placed the Hanford Site 100, 200, 300, and 1100 Areas on the "National Oil and Hazardous Substances Pollution Contingency Plan," Appendix B, "National Priorities List" (40 CFR 300) or **National Priorities List (NPL)**. Since being placed on the NPL, the Hanford Site's mission has been refocused to environmental cleanup. The NPL contains the nation's highest-ranked hazardous waste sites prioritized based on their known or potential threat to release hazardous substances, pollutants, or contaminants to the environment.

300 Area Description

The 300 Area encompasses approximately 146 km^2 (56 mi^2), as shown in Figure 5. For the purposes of the RI/FS and the proposed plan, the 300 Area includes the following: the 300 Area Industrial Complex (major liquid waste disposal sites, burial grounds, and facilities); the 400 Area; and waste sites within the 600 Area (including the 618-11 and the 618-10/316-4 Burial Grounds). The 600 Area (the area within the 300 Area boundary that does not include 300-FF-1 OU or 300-FF-2 OU waste sites) is also referred to as the non-operational areas and is described in Appendix L of the RI/FS Report (DOE/RL-2010-99).

A brief description of each of these areas follows:

- The 300 Area Industrial Complex facilities which operations began in 1943 and include fuel fabrication buildings, raw material storage, waste storage, finished product storage, technical support, service support, and research and development (R&D) related to fuel fabrication and other Hanford Site processes. The complex includes the buildings, facilities, and process units where the majority of uranium fuel production and R&D activities took place.
- The 400 Area contains the Fast Flux Test Facility (FFTF) Reactor and its support facilities. It is located approximately 8 km (5 mi) northwest of the 300 Area Industrial Complex and about 6 km (4 mi) west of the Columbia River.
- The 618-10 and 618-11 Burial Grounds received solid waste from operations in the 300 Area Industrial Complex.

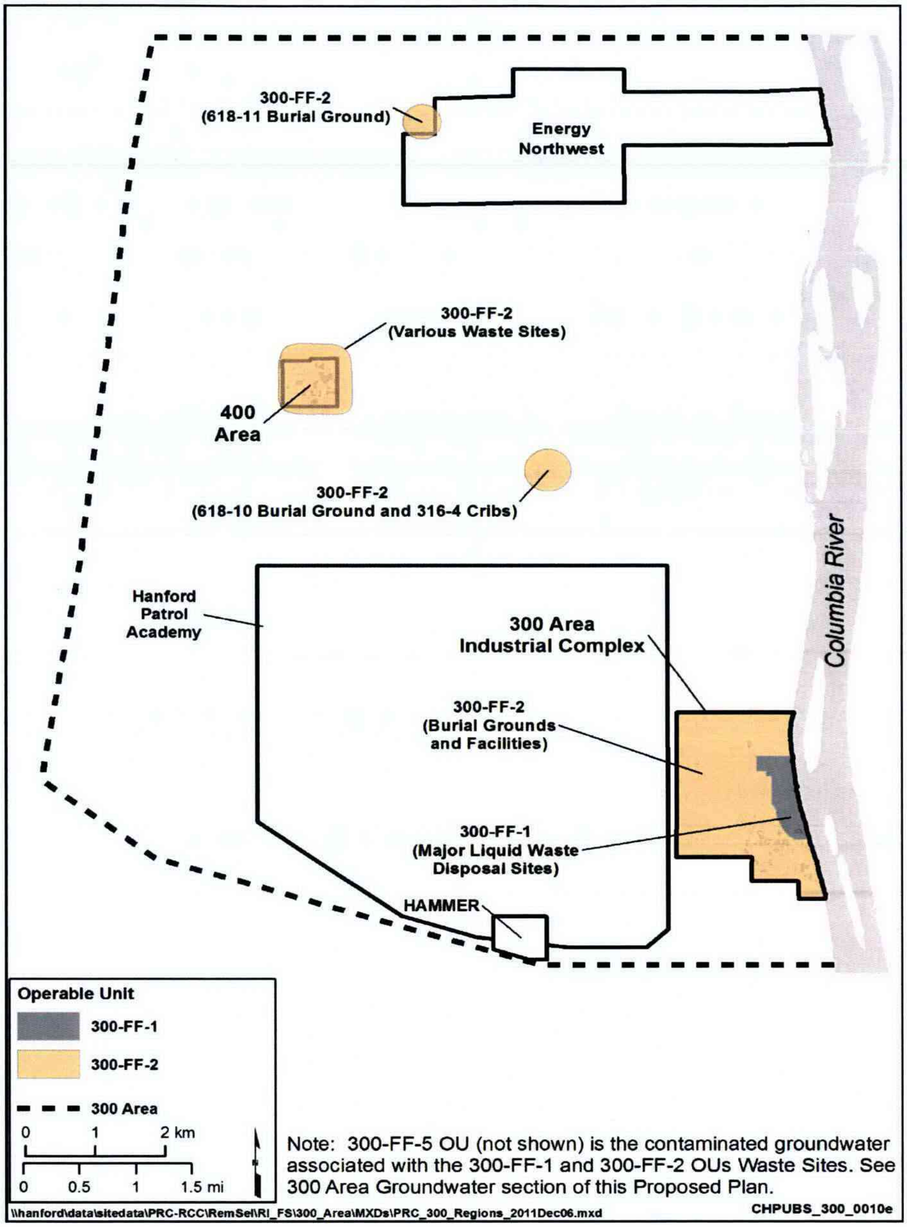


Figure 5. 300 Area OU Boundaries

As the Hanford Site production reactors were being shut down, fuel fabrication activities in the 300 Area decreased and, at the same time, R&D activities increased. The newer buildings in the 300 Area primarily housed laboratory operations and large-scale test facilities. R&D activities focused on peaceful uses of plutonium, reactor fuels development, liquid metal technology, FFTF support, gas-cooled reactor development, and life science research. Industrial activities continue in the 300 Area that are associated with Energy Northwest, training facilities (HAMMER), Hanford Patrol Academy, and R&D.

Many communities downstream of the 300 Area and overall Hanford site draw water from the Columbia River for all or part of their domestic water supply. The City of Richland's water uptake is the closest to the Hanford site. The City of Richland provides an annual drinking water report to comply with the *Safe Drinking Water Act of 1974*. No alternate water sources have been required because of contamination resulting from Hanford operations.

Contaminant Sources

For investigation and cleanup purposes, the 300 Area was divided into the 300-FF-1 and 300-FF-2 source OUs and the 300-FF-5 groundwater OU (Figure 5). The 300-FF-1 OU contains contaminant sources associated with facilities and waste sites of the former North Process Pond (316-1), South Process Pond (316-2), and 300 Area Process Trenches (316-5), where large volumes of liquid waste containing uranium were discharged (Figure 6). The 300-FF-2 OU contains contaminant source areas associated with facilities and waste sites within the 300 Area Industrial Complex, the 400 Area, and the 618-10 and 618-11 Burial Grounds. Contaminant releases identified at waste sites resulted in several groundwater contaminant plumes that lie within the 300-FF-5 groundwater OU.

Figure 6. 300 Area Industrial Complex (June 1976)

Liquid wastes consisting of sanitary wastes and various radiochemical and radio-metallurgical process wastes were discharged via the Process Sewer System (300-15) to open ponds and trenches during most of the 300 Area's operational history. The process sewer system consists of an extensive network of 50 km (31 mi) of underground piping. Liquid wastes were conveyed by the process sewer system to the North and South Process Ponds (316-1 and 316-2) between 1943 and 1975. Both ponds received upwards of 1.5 to 11.4 million L/day (400,000 to 3 million gal/day) from the fuel fabrication facilities until they were phased out of service in 1974 and 1975. The 300 Area Process Trenches (316-5) replaced the ponds in 1975 and were used for disposal until 1994.

A complex series of waste streams were disposed to these facilities, including process waste from nuclear fuel fabrication (the primary waste stream), radioactive liquid waste, sewage, lab waste, and coal power plant waste. The waste from nuclear fuel fabrication included basic sodium aluminate solutions and acidic copper/uranyl nitrate solutions. Primary chemical contaminants disposed to North Process Pond and South Process Pond included uranium (33,565 to 58,967 kg), copper (241,311 kg), fluoride (117,026 kg), aluminum (113,398 kg), nitrate (2,060,670 kg), and large volumes of nitric acid and base (NaOH). Additional information on the remaining liquid waste handling facilities such as the Sanitary Sewer System (300-276), the 340 Complex, 300 Area Retention Process Sewer (300-214), 300 Area Radioactive Liquid Waste System (300 RLWS), 307 Process Trenches (316-3), the 307 Retention Basins, and the 311 Tank Farm (311-TF), WATS (300-224), and the 316-4 **Crib** is provided in DOE/RL-2010-99.

Solid wastes were initially disposed of in burial grounds and shallow landfills from 1943 through the 1950s. In later years, highly radioactive wastes, including wastes with **transuranic** constituents were disposed of in 600 Area burial grounds. The primary burial grounds are 300-7, 300-9, 300-10, 618-1, 618-2, 618-3, 618-4, 618-5, 618-7, 618-8, 618-9, 618-10, 618-11, 618-12, and 618-13. Detailed descriptions of these burial grounds are provided in DOE/RL-2010-99.

The FFTF located in the 400 Area is a sodium-cooled research reactor. Because the design, construction, and operation of the FFTF differed from that of the Hanford Site production reactors, the type and extent of contamination associated with FFTF also differed. Because the FFTF reactor is cooled by liquid sodium, all interfacing equipment and systems are sealed in an inert atmosphere to prevent adverse reactions with the liquid sodium. As a result, the FFTF is radiologically clean. The FFTF reactor is not within the scope of this proposed plan and is addressed under a separate regulatory process.

Efforts have been conducted to ensure that all waste sites posing a threat to human health and the environment are addressed through the Non-operational Area Evaluation process, including the Orphan Site Evaluation (OSE) and Discovery Site processes. These processes help ensure that no waste sites will be missed. The OSE process is a systematic approach for reviewing land parcels and identifying potential waste sites within the River Corridor that are not currently listed in existing CERCLA decision documents, such as RODs. The OSE for the 300-FF-1 OU started in fiscal year 2004 and was completed in April 2005. The OSE for the 300-FF-2 OU started in fiscal year 2009 and was completed in November 2010 for the 300 Area Industrial Complex and 400 Area. The OSE for the remainder of the 300 Area is scheduled to be completed in fiscal year 2012 (DOE/RL-2010-99, Chapter 2).

Site Characteristics

The surface topography of the 300 Area is relatively flat inland from the Columbia River. The principal surface water feature near the area is the Columbia River. Topographic changes are greatest near the Columbia River where the riverbank slopes steeply. Surface elevations range from 135 to 137 m (443 and 449 ft) above mean sea level at the 618-11 Burial Ground and Energy Northwest Complex to the north to between 115 and 118 m (377 and 387 ft) above mean sea level at the 300 Area to the south.

The unconfined aquifer, which includes the water table, occurs in the highly permeable gravel-dominated Hanford formation (Figure 7) and the underlying, less permeable sands and gravels of Ringold formation (unit E/C). The Ringold formation lower mud unit is the aquitard at the base of the unconfined aquifer and is characterized by very low permeability fine-grained sediment. This hydrologic unit prevents further downward movement of groundwater and contamination to deeper aquifers. The thickness of the unconfined aquifer along the Columbia River shoreline varies between 25 and 30 m (80 and 100 ft).

Groundwater in the unconfined aquifer discharges to the Columbia River via upwelling through the riverbed and, to a lesser degree, via riverbank springs and seepage. The rate of discharge from the Hanford Site aquifer is very low, compared to the flow of the river. For the entire Hanford Site shoreline, groundwater discharges at a rate less than 3 m^3/s (100 ft^3/s), while typical river flow ranges seasonally from 1,100 m^3/s (40,000 ft^3/s) to 7,100 m^3/s (250,000 ft^3/s). For the 300 Area shoreline, computer simulation of groundwater flow suggests a net discharge rate of approximately 0.01 m^3/s (0.4 ft^3/s) for the length of shoreline affected by the uranium plume. Because the river stage regularly fluctuates up and down, flow beneath the shoreline is back and forth, with river water intruding into the unconfined aquifer and mixing with groundwater, prior to subsequent flow back to the river. If the river stage drops quickly and to a relatively low elevation, riverbank springs appear.

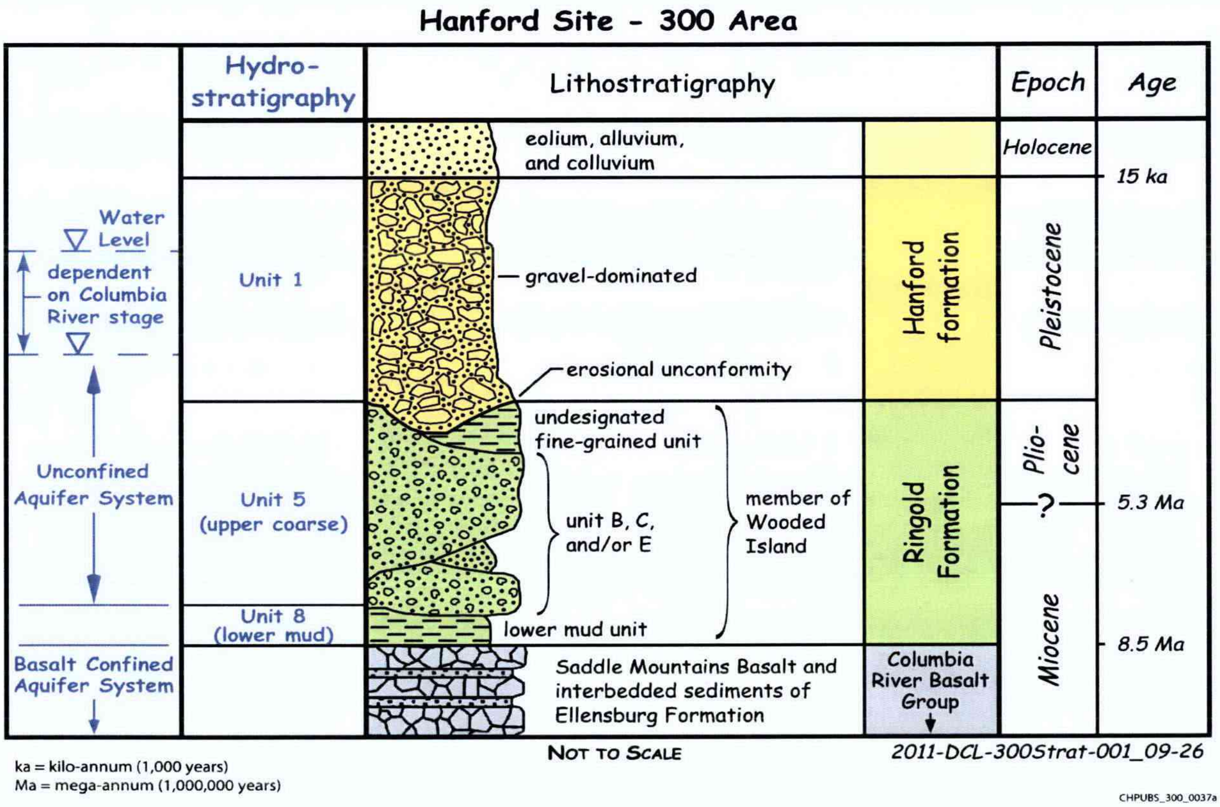


Figure 7. Stratigraphy of the 300 Area

Groundwater flow velocities beneath the 300 Area are relatively rapid in the saturated Hanford gravels portion of the unconfined aquifer, with rates up to 18 m/d (59 ft/d) having been observed during planned and opportunistic tracer tests. However, the hydraulic gradients that drive groundwater flow change direction in response to river stage, which fluctuates on daily, seasonal, and multiyear cycles. Consequently, groundwater flow, while rapid, is not always directed toward the river, and the net rate of discharge is smaller than it would be if the groundwater flow was always in the same direction.

In general, regional groundwater flow converges from the northwest, west, and southwest, inducing an east-southeast flow direction. During periods of extended high river stage (March through June), the hydraulic gradient reverses along a several hundred meter wide section of the shoreline. The rise and fall of the river stage creates a dynamic zone of interaction between groundwater and river water (Figure 8), affecting groundwater flow patterns, contaminant transport rates (e.g., uranium in groundwater), contaminant concentrations, and attenuation rates.

Nature and Extent of Contamination

300 Area Industrial Complex Vadose Zone. Following remediation, sampling of vadose zone soil, beneath the former South Process Pond (316-1), North Process Pond (316-2), and the 300 Area Process

Trenches (316-5) showed that in most instances, uranium concentrations were not indicative of a substantive residual contaminant mass. However, sampling in the southwestern quadrant of the North Process Pond (316-2), near the former effluent inlet, and in the southern portion of the 300 Area Process Trenches (316-5) identified residual uranium concentrations in the **deep vadose zone** and PRZ sediments. Uranium concentrations increase in groundwater at these locations when the water table rises during high river stage, suggesting that these locations constitute ongoing groundwater contamination sources. Soil sampling prior to remediation at the 307 Process Trenches (316-3) and the 307 Retention Basins identified uranium concentrations in the deep vadose zone under the central and eastern portions of the 307 Process Trenches and on the eastern side of the 307 Retention Basin.

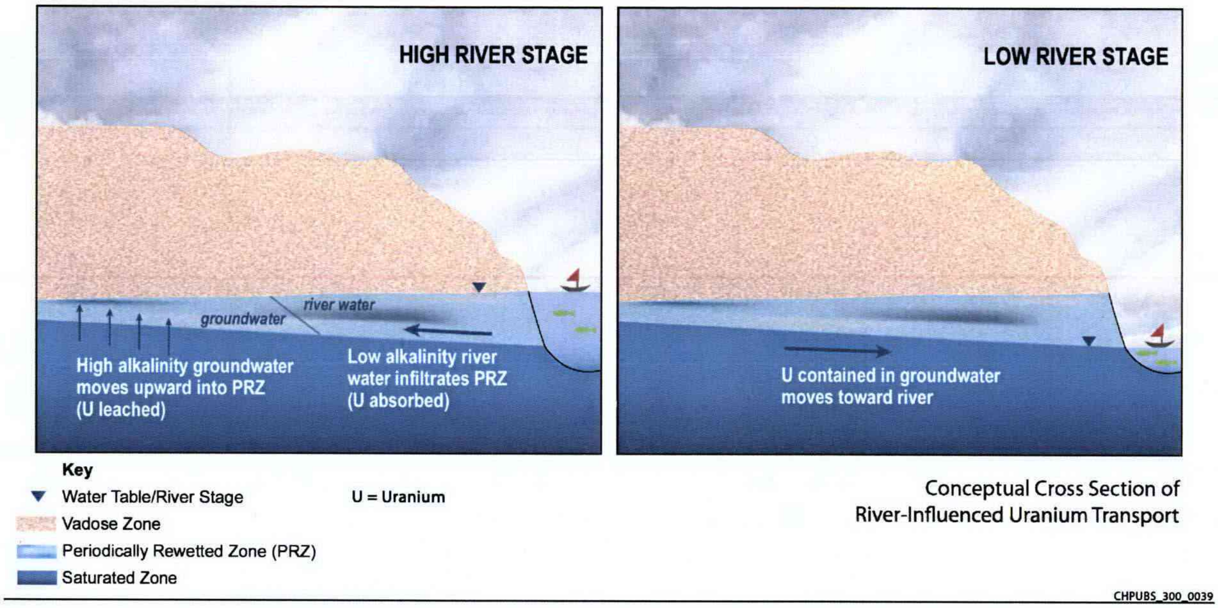


Figure 8. High and Low River Stage Effects on Groundwater in the 300 Area

Investigation of the soils beneath the 324 Building indicates that cesium-137 and strontium-90 contamination extends at least 1.5 m (5 ft) below the building floor. The contamination was discovered during decontamination and demolition activities at the building in 2009 but likely resulted from a 1986 **unplanned release** of liquid within the B-Cell. A portion of the spill is believed to have left the cell through a breach in the floor (Waste Information Data System [WIDS] UPR 300-296). Because of this recent discovery, the frequency of groundwater monitoring in wells downgradient from the 324 Building was increased in 2010, and a new well was placed downgradient of the building. No conclusive evidence has been found that the past releases have affected groundwater.

Three burial ground sites in the 300 Area Industrial Complex may be associated with potential sources of uranium contamination to groundwater. At the 618-1 and 618-2 Burial Grounds, residual uranium contamination, at very low concentrations, remains in the deep vadose zone, potentially above the recent vertical extent of the PRZ. The data suggest that groundwater mounding associated with the South Process Pond (316-1) liquid waste disposal site has stranded low levels of uranium in the deep vadose zone at locations some distance away from the point of discharge, where it may be accessible to a fluctuating water table. Alternatively, the contamination may be the result of unplanned releases from 300 Area Industrial Complex process sewer lines. The 618-3 Burial Ground, which is adjacent to the 618-2 Burial Ground, is associated with relatively shallow uranium contamination that may have the potential to contaminate groundwater.

300 Area Groundwater. In groundwater beneath the 300 Area, tritium, uranium, trichloroethene (TCE), nitrate, hexavalent chromium and cis-1,2-dichloroethene are waste effluent indicators that still persist in the unconfined aquifer. Tritium in groundwater at the location of the 618-11 Burial Ground reflects release of tritium as a gas from buried radiological solid wastes. Uranium and organic compounds at the location of the 618-10 Burial Ground are monitored as indicators of waste disposed to the burial ground and adjacent 316-4 Cribs, which received liquid waste. Other constituents that affect groundwater quality, such as nitrate, hexavalent chromium, and radiological indicators gross alpha and gross beta, continue to exceed their respective drinking water standards at some locations. Groundwater beneath the 300 Area also contains waste effluent indicators whose origin is disposal or unplanned releases in the 200 East Area. This widespread plume contains tritium, nitrate, technetium-99, and iodine-129. These contaminants are being evaluated as part of the 200-PO-1 OU.

The uranium plume, defined where concentrations exceed the 30 µg/L DWS, covers an area approximately 0.5 km^2 (0.2 mi^2) in the 300 Area Industrial Complex. The volume of the uranium plume is approximately 700,000 m^3 (2.5 million ft^3), and the mass of uranium dissolved in the plume is estimated to be approximately 50 kg (110 lbs). The extent of Columbia River shoreline affected by the plume is approximately 1,200 m (3,390 ft). For recent monitoring events, uranium concentrations in the vicinity of the 300 Area range between the natural background concentration of 8 µg/L up to approximately 200 µg/L. Exceptions occur during periods of unusually high water table conditions, as during May and June of 2011, when values as high as 440 µg/L were observed at several monitoring wells. The highest concentrations during any particular year often occur in the late fall/early winter months near the river adjacent to the former South Process Pond (316-1). Riverbank springs, when flowing, typically have revealed concentrations near 150 µg/L. Figure 9 presents groundwater uranium plumes for winter and summer seasons from 2008 through 2011.

Because of seasonal changes in the unconfined aquifer, which are related to seasonal conditions in the Columbia River flow, the shape, position, and concentration pattern for the uranium plume varies significantly during the year. Input of uranium from the lower portion of the vadose zone is suspected to continue at several locations, as revealed by relatively higher concentrations during high water table conditions in June. Also, relatively low concentrations in the plume are observed during June at wells near the river, when river water infiltrates the aquifer causing dilution of contamination. Later in the summer and fall, concentrations near the river increase as a consequence of the higher concentrations from new inland input migrating to the river and the absence of diluting river water.

The rate at which contaminated groundwater enters the Columbia River from the site via discharge at the riverbed is exceedingly small compared to the flow of the river, so the site groundwater impact on river water quality is negligible. This lack of impact is confirmed by regular monitoring of Columbia River water under the DOE Public Resource Protection Program, and also by analyses done by the City of Richland at the first point of withdrawal for public use (the Richland Pumphouse).

Long-term monitoring records for the free-flowing stream of the river, including nearshore regions where groundwater impacts are most likely to be observed, do not reveal evidence for degradation of river water quality that would be of concern to downstream users.

Measurements made during past investigations were used to estimate the uranium inventories remaining in various subsurface regions at the 300 Area Industrial Complex (PNNL-17034). The 10 subsurface regions, and the estimate for the inventory in each region, are shown on Figure 10. The largest inventory is in the vadose zone beneath former liquid waste disposal sites, and the second largest inventory is in the zone beneath waste sites through which the water table rises and falls (the current PRZ). The distribution of the estimated uranium inventory suggests the primary pathways for exchange of uranium between various media (for example, between sediment and pore water) and between various subsurface regions

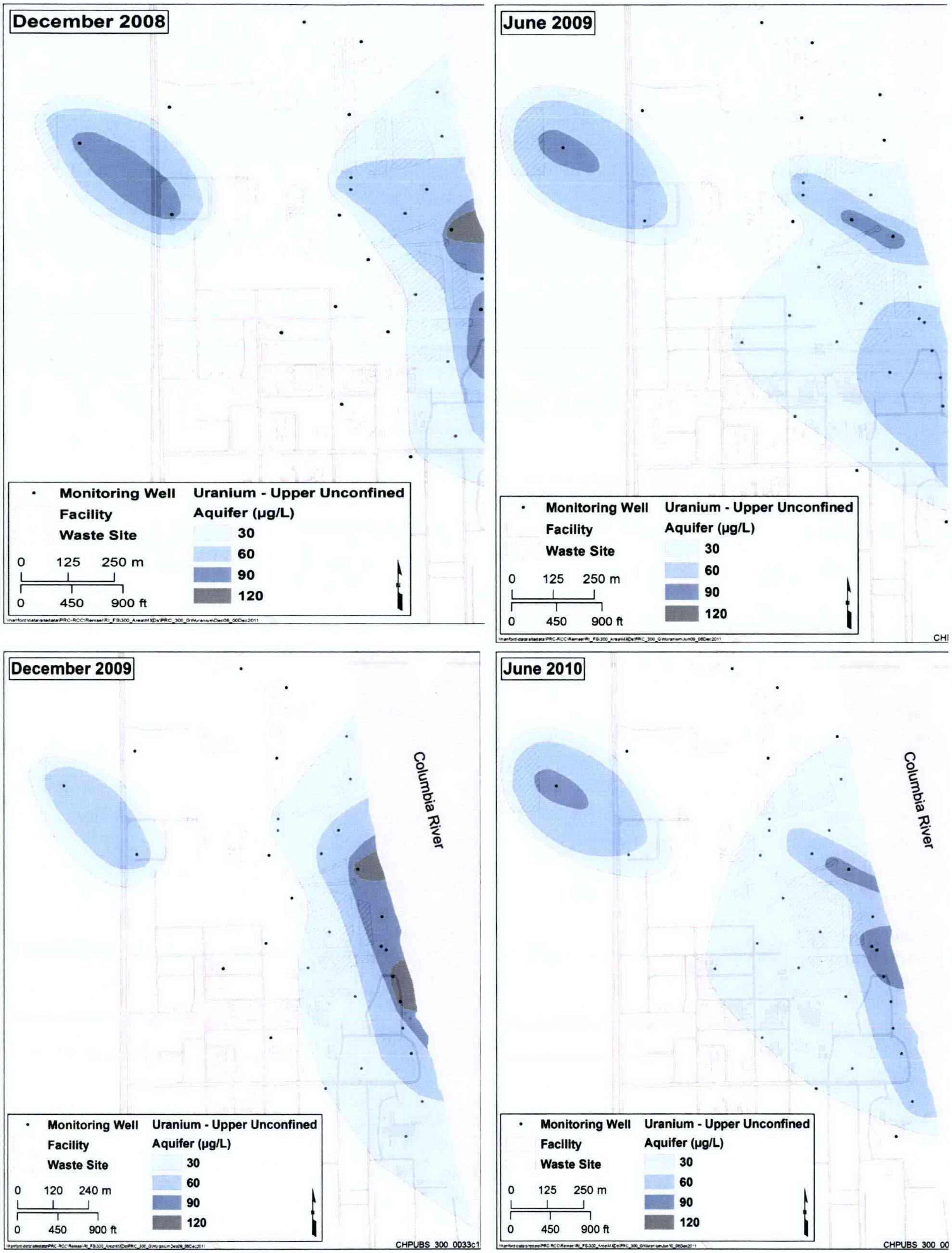


Figure 9. Uranium Plume in Groundwater Beneath the 300 Area, 2008 through 2011

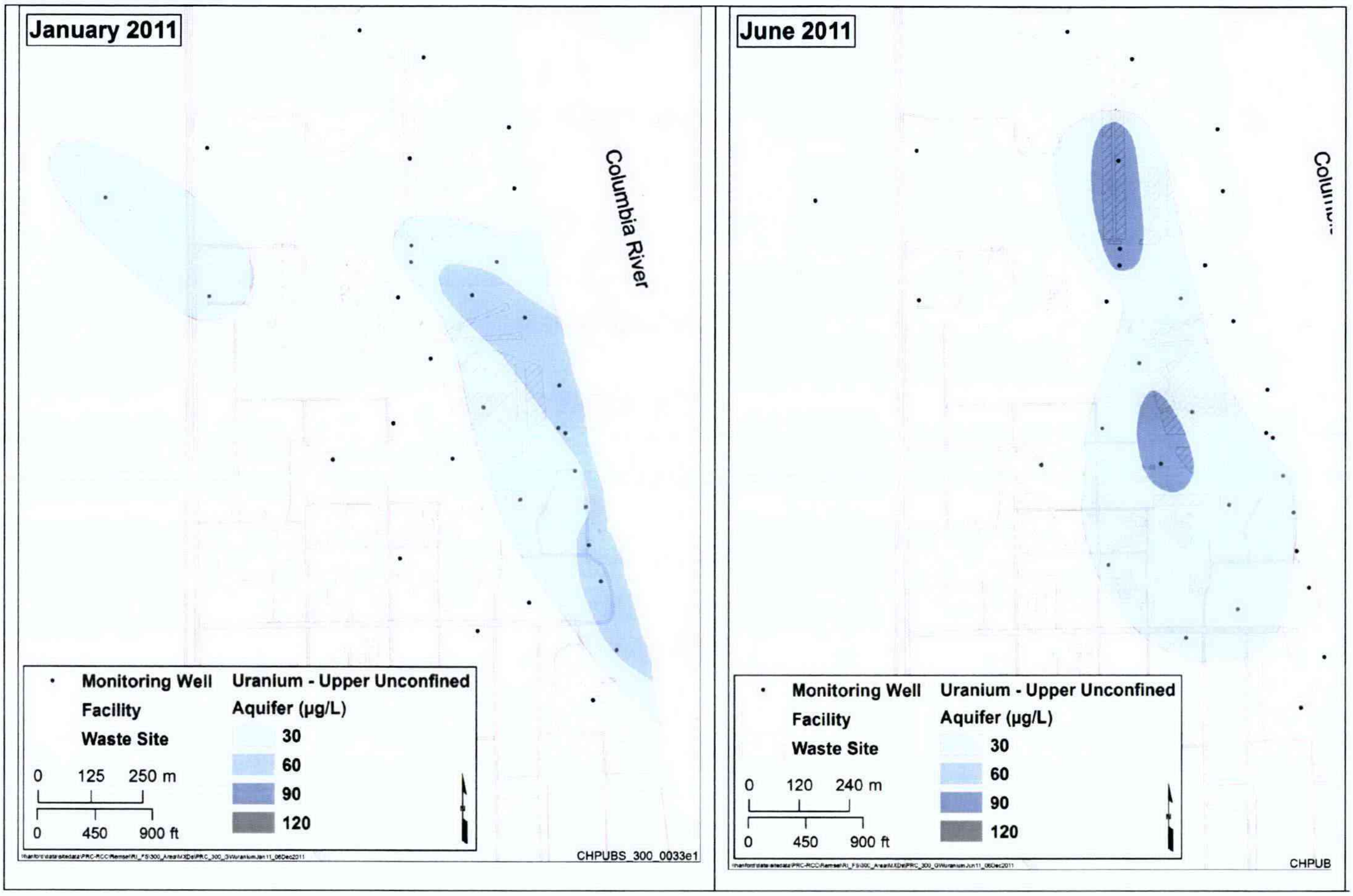


Figure 9 (continued). Uranium Plume in Groundwater Beneath the 300 Area, 2008 through 2011

(for example, between the current PRZ and the unconfined aquifer). For example, the vadose zone region is less likely to be currently contributing uranium to groundwater because of the relatively low moisture flux in that region. The current PRZ is more likely to be currently contributing uranium to groundwater because of periodic saturation of that zone by groundwater. Key assumptions underlying the uranium inventory estimates are that uranium concentrations from previous studies are representative of the various 300 Area Industrial Complex subsurface regions and that the vadose zone regions beneath former liquid waste disposal facilities are most likely to have the largest inventories.

Other 300 Area Industrial Complex waste indicator contaminants that persist in the unconfined aquifer include several volatile organic compounds (VOCs). Cis-1,2-dichloroethene, a degradation product of TCE and tetrachloroethene, is present in the lower portion of the unconfined aquifer at a single monitoring well. The exact origin for this contamination is not fully explained, but it is related to the use of TCE and tetrachloroethene as degreasing solvents during the manufacture of nuclear fuel. The occurrence poses little threat of exposure, in that the sediment is not conducive to development as a water supply, nor is the hydrologic unit incised by the Columbia River channel.

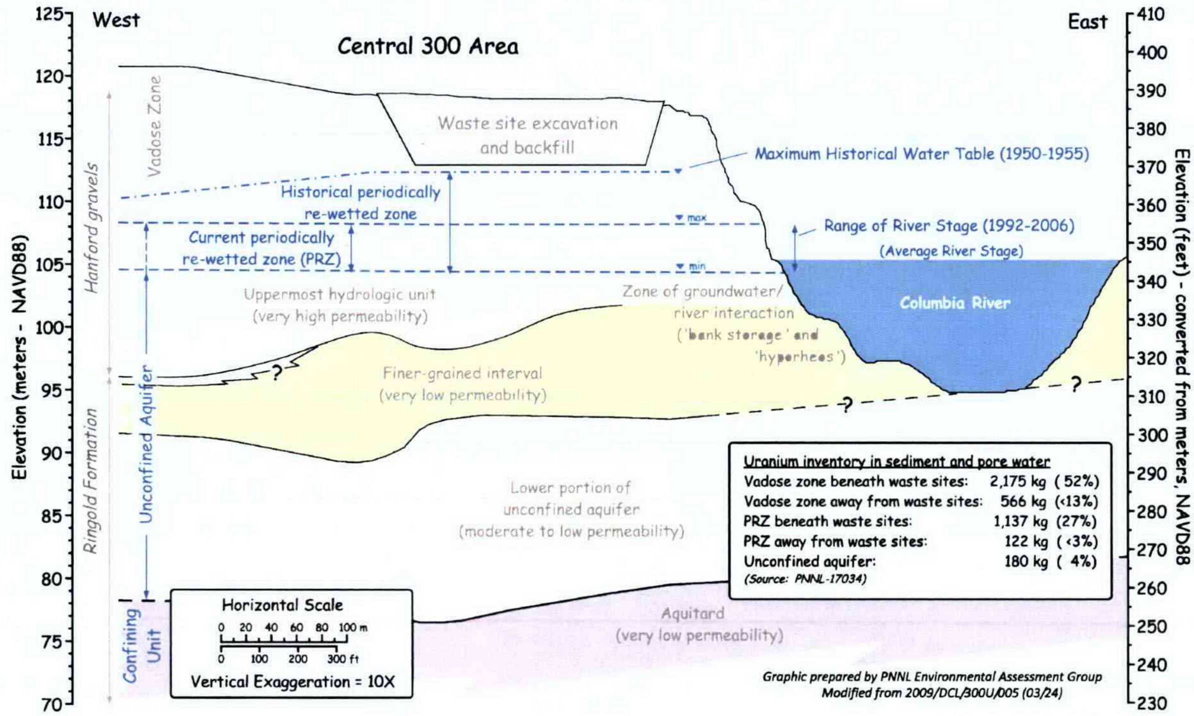


Figure 10. Ten Subsurface Regions and Uranium Inventory Estimate in Each Region

A second VOC occurrence involves TCE in a fine-grained interval of Ringold Formation sediment in the unconfined aquifer. Concentrations exceed the DWS; however, the sediment has very low permeability, so low that extracting enough water during drilling for analysis was difficult. Given the low permeability of this unit, no additional monitoring wells have been installed in these sediments. The likelihood of future consideration as a water supply for this area of the aquifer is very low due to the low water yield. The sediment interval is incised by the Columbia River channel, but given the low permeability, release to the river would be exceedingly slow. Riverbed sediment pore water sampling in this area did not reveal the presence of VOCs. The TCE appears to be localized in an area near the former South Process Pond (316-1).

Nitrate concentrations in groundwater beneath the 300 Area are lower than the 45 mg/L DWS (i.e., 10 mg/L measured as nitrogen in nitrate), except for a small area around the 618-11 Burial Grounds and the southern portion of the 300 Area, including the Columbia River shoreline region. Based on groundwater analyses and groundwater flow direction information, some nitrate has migrated into the 300 Area from non-Hanford Site sources to the southwest and also migrates into the 300 Area from the northwest as part of the site-wide plume that originates in the 200 East Area, with concentrations typically ranging from 25 to 30 mg/L upon arrival in the 300 Area.

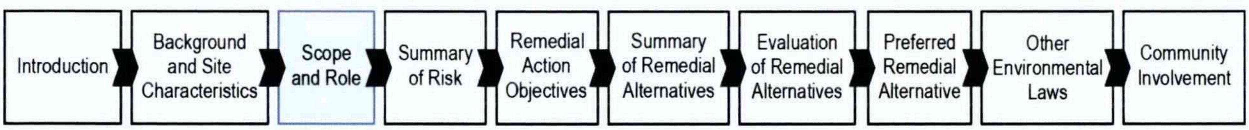
618-10/316-4 Burial Ground Groundwater. Uranium has been detected in groundwater beneath this location, with the primary source being the uranium-contaminated organic solvents that were disposed to the former 316-4 Cribs between 1948 and 1956. The organic solvents included methyl isobutyl ketone (hexone) and tributyl phosphate. Concentrations in groundwater have remained below the 30 µg/L DWS since 2007. Detections do not indicate a plume of contamination coming from either waste site. However, tritium and nitrate contamination from 200 East Area sources reaches this area at concentrations below their respective DWSs.

618-11 Burial Ground Groundwater. The tritium plume that extends to the east of the 618-11 Burial Ground has remained relatively constant in shape since its discovery in 1999. The primary source for the contamination was tritium gas released from buried materials, which interacted with vadose zone moisture and eventually made its way to groundwater. Concentrations have remained above the 20,000 **pCi**/L DWS with concentrations between 800,000 and 1,000,000 pCi/L observed in 2011. Concentrations have remained at this approximate level since 2007, following a peak value of 8,380,000 pCi/L in 2000. Nitrate also exceeds its DWS near this burial ground, which is also impacted by upgradient sources.

400 Area Groundwater. Groundwater beneath the 400 Area is monitored to provide information on the potential impact on the active water supply well in the 400 Area. The principal contaminants in the plumes in this area (from the 200 East Area sources) are iodine-129, nitrate, and tritium. During 2010, all contaminants of interest were measured at concentrations below their respective DWSs. Waste sites in the 300-FF-2 OU are not contributing to groundwater contamination in the 400 Area.

Geographical and Topographical Factors Influencing Remedy Selection

The Hanford Reach was set aside by Presidential Proclamation as a national monument in 2000 (65 FR 37253, "Establishment of the Hanford Reach National Monument." The Hanford Reach National Monument (HRNM) includes lands along the western shore of the Columbia River, reaching approximately .4 km (.25 mile) inland adjacent to a portion of the 300 Area (Figure 2). The HRNM does not extend into the 300 Area Industrial Complex. The near-shore lands include sensitive ecological and cultural areas. Protection of the Columbia River is one of the key factors influencing DOE's interim and final remedial action decisions.



Scope and Role

DOE established a Hanford Site Cleanup Completion Framework (DOE/RL-2009-10) to support cleanup decisions for the Hanford Site. The River Corridor and Central Plateau (Figure 2) are the two main geographic areas of cleanup work on the Hanford site. The River Corridor includes the former fuel fabrication and reactor operations areas adjacent to the Columbia River, and cleanup must deal with the threats to that valuable resource. The Central Plateau includes the former fuel processing facilities and numerous waste disposal facilities. The purpose of the completion framework is to ensure that cleanup actions address all threats to human health and the environment.

The River Corridor has been divided into six geographic areas to achieve source and groundwater remedy decisions for OUs. These decisions will provide comprehensive coverage for all areas within the River Corridor. The 300 Area is the southernmost location of the six geographic areas.

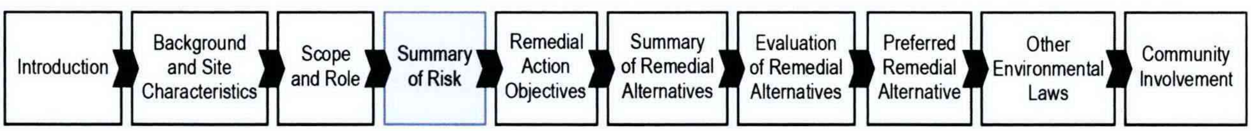
Three OUs (two soil and one groundwater) are addressed in this proposed plan. An integrated decision is needed for soil and groundwater to implement the final remedial actions. Depending on the alternative selected, the integrated decision may consist of an amendment to the 300-FF-1 OU ROD and final actions for the 300-FF-2 and 300-FF-5 OUs. Through the defined treatment technologies identified in this proposed plan, the preferred alternative will permanently reduce the toxicity, mobility, and volume of contaminated media present in the 300 Area, thereby providing long-term protection of human health and the environment, while meeting the statutory requirements for remedy selection and compliance with ARARs.

Principal Threat Wastes

The NCP (40 CFR 300.430[a][l][iii][A]) establishes an expectation that treatment will be used to address the principal threats posed by a site wherever practicable. Principal threat wastes are those source materials considered highly toxic or highly mobile that generally cannot be reliably contained, or would present a significant risk to public health or the environment should exposure occur. Where the toxicity and mobility of source material combine to pose a potential human health **excess lifetime cancer risk** greater than one in a thousand (1×10^{-3}), treatment alternatives should be identified (EPA, 1991, *A Guide to Principal Threat and Low Level Wastes* [OSWER Publication 9380.3-06FS]).

Historically, activities in the 300 Area Industrial Complex generated contaminants and wastes that are considered highly toxic and/or mobile that could pose a significant risk to public health and the environment and that could be defined as principal threat wastes. In general these contaminants and wastes have been more carefully managed when encountered at the site, and special measures have been taken to prevent releases to the environment. For example, waste containing long-lived transuranic constituents were placed in burial grounds specifically developed for that purpose. Those burial grounds include the 618-10 and 618-11 Burial Grounds. Retrieval and disposal of waste from those burial grounds is an element of the 300 Area remedial action. Waste determined to be transuranic will be transported offsite for deep geologic disposal. Deep geologic disposal at the Waste Isolation Pilot Plant in New Mexico, while not treatment, will be effective in permanently isolating this waste from the environment. With the exception of the 618-10 and 618-11 Burial Grounds, most of the sites containing potential principal threat waste have been addressed by interim actions.

During the course of remedial actions, there are likely to be instances where highly radioactive material will be identified. Such identification recently occurred adjacent to the 324 Building. The materials posing the threat are being isolated until they are removed for final disposal at an appropriate disposal facility. Radioactive contamination will be removed to the extent necessary to ensure protection of human health and the environment (groundwater protection). The remaining 300 Area waste sites and groundwater are not considered to be principal threat wastes.



Summary of Site Risks

This section of the proposed plan provides information on the 300 Area land and groundwater use, and describes the risks posed to human health and the environment by the contamination in the 300 Area.

Current and Projected Land and Groundwater Use

Several Hanford special purpose industrial areas or facilities in the 300 Area are not included in this CERCLA decision document and the related CERCLA remedial action ROD, such as the following:

- Hanford Patrol Training Academy, including the firing range
- FFTF reactor and associated facilities
- Energy Northwest including Bonneville Power Administration facilities and related waste sites (600-58, 600-59, 600-60, and 600-62)
- HAMMER Training Facility
- HRNM

In addition, R&D activities within the 300 Area Industrial Complex are ongoing and projected to continue within defined facilities through at least 2027. Given the large amount of current and planned future industrial land use in this area, the reasonably anticipated future land use for the 300 Area is industrial. The industrial future land use is also supported by previous decisions.

Under 50 USC 2582, "Requirement to Develop Future Use Plans for Environmental Management Programs," DOE holds express statutory authority to establish future land use for the Hanford Site. DOE involved Tribal Nations and stakeholders during the Environmental Impact Statement (EIS) process, under the ***National Environmental Policy Act of 1969*** and the *State Environmental Policy Act of 1971* (RCW 43.21C), to evaluate future land use alternatives. This process was conducted in coordination with nine cooperating government agencies and resulted in the *Final Hanford Comprehensive Land Use Plan Environmental Impact Statement* (DOE/EIS-0222-F) and Record of Decision (ROD) (64 FR 61615, "Record of Decision for Hanford Comprehensive Land-Use Plan Environmental Impact Statement").

The 1999 **Hanford Comprehensive Land Use Plan** EIS ROD (DOE/EIS-0222-F) and ROD Amendment (73 FR 55824, "Amended Record of Decision for the Hanford Comprehensive Land-Use Plan Environmental Impact Statement") designated future land use as predominantly industrial, with several isolated areas designated as conservation (mining) for the nonprocessing areas. Figure 11 presents the land use for the 300 Area.

Although the future land use in the 300 Area is designated as industrial, DOE has elected to clean up a large portion of the 300 Area to a more protective land use standard (unrestricted which is the same a residential used in the exposure scenario below). Therefore, the RAOs identified in this proposed plan for cleanup of the areas outside the 300 Area Industrial Complex and 618-11 Burial Grounds (adjacent to Energy Northwest) are for the unrestricted land use criteria.

Preservation of cultural and historic properties under the *National Historic Preservation Act of 1966* and other laws, and land use considerations, such as consistency with the Hanford Comprehensive Land Use Plan, are considered in remedial action decisions under the Tri-Party Agreement.

Tribal treaty reserved fishing rights are also recognized on rivers within the ceded lands, including the Columbia River, which flows through the Hanford site. The Tribal Nations have been participants in DOE's land use planning process, and DOE considered the Tribal Nation concerns in that process.

A Presidential Proclamation in 2000 (65 FR 37253, "Establishment of the Hanford Reach National Monument," established the HRNM within the boundaries of the Hanford Site (Figure 2). The Proclamation generally mandated more restrictive land uses within the HRNM boundaries than those DOE adopted in the Hanford Comprehensive Land Use Plan. The HRNM mandate is to preserve the natural and cultural resources for which the HRNM was established. The U.S. Fish and Wildlife Service has developed a comprehensive conservation plan for management of the HRNM.

Regarding groundwater, the NCP established an expectation to "return useable ground waters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site" (40 CFR 300.430[a][1][iii][F]). EPA generally defers to state definitions of groundwater classification provided under EPA-endorsed Comprehensive State Groundwater Protection

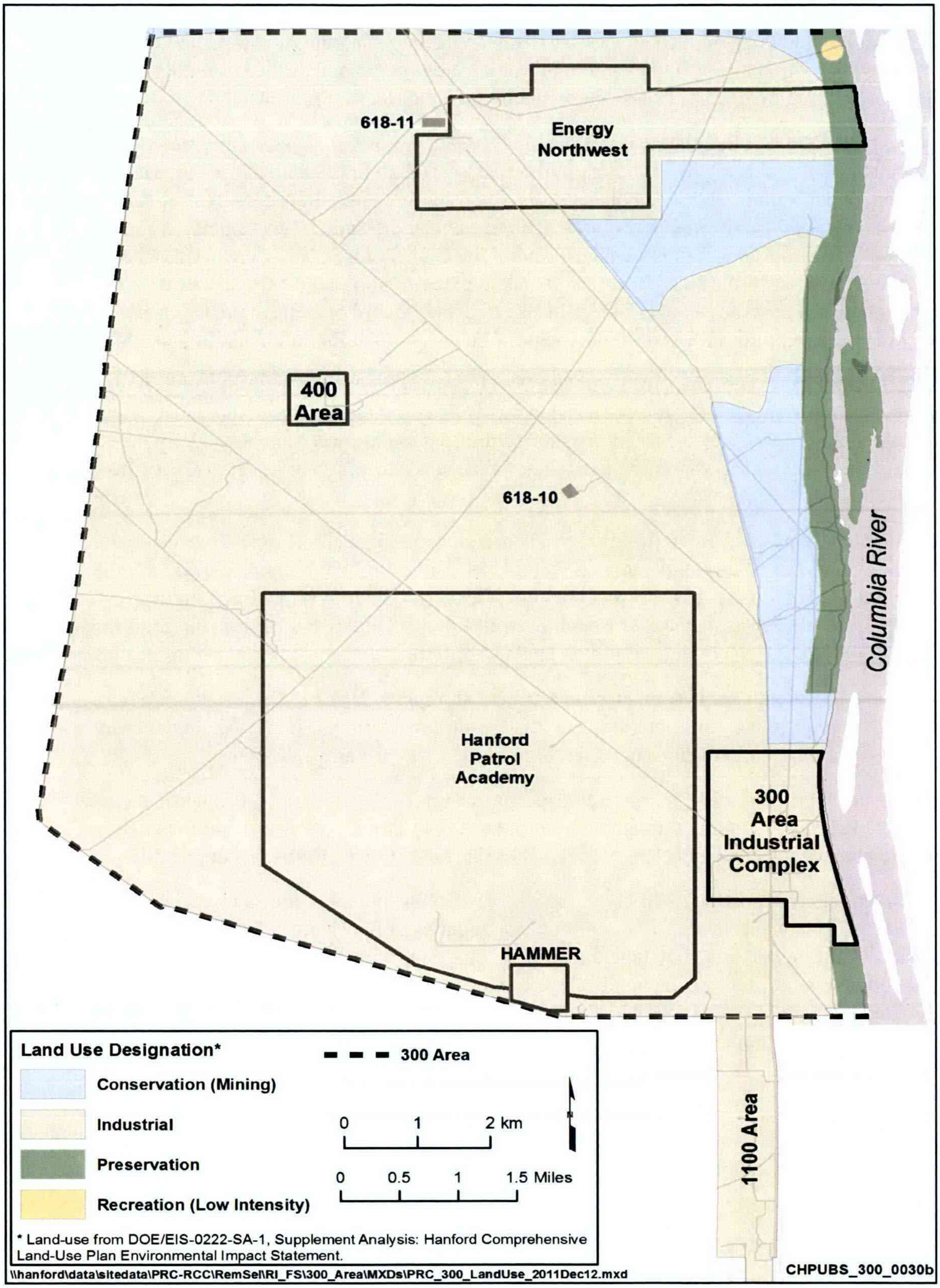


Figure 11. Land Use in the 300 Area

Programs (EPA/540/G-88/003, *Guidance on Remedial Actions for Contaminated Ground Water at Superfund Sites*). Under EPA's groundwater classification program, 300 Area groundwater would be designated Class IIA/B, groundwater that is a current and future source of drinking water.

What did the River Corridor Baseline Risk Assessment determine?

The *River Corridor Baseline Risk Assessment* (RCBRA) (DOE/RL-2007-21) assessed human health risks associated with exposure to residual contamination at the 17 waste sites in the 300 Area where interim remedial actions have been completed. The RCBRA evaluated a rural residential exposure scenario where a hypothetical resident could be exposed to radionuclides through direct contact, as well as, ingestion of food from a locally-grown source, and to chemicals through direct contact. The RCBRA determined that for hypothetical receptors, the residual cumulative excess lifetime cancer risk factors from contaminants at remediated waste sites were less than 1×10^{-5}. Residual cumulative cancer risk factors for radionuclides were less than 5×10^{-4} at three remediated waste sites and less than $1 \text{ x } 10^{-4}$ for the remaining remediated waste sites.

Noncancer hazard indices (HI) for chemicals did not exceed the threshold of 1 except at two sites. Waste sites reporting residual risks greater than 1×10^{-4} or an HI greater than 1 are associated with the 300-FF-1 and 300-FF-2 source OUs where the land use designation is industrial. The residual cumulative cancer risks for radionuclides are less than 1×10^{-4} with an HI less than 1 when evaluated for an industrial scenario.

The risk evaluation presented in the RI/FS Report verified a basis for action at waste sites identified in the interim ROD, where cleanup has not yet occurred. The risk evaluation also addressed waste sites where interim actions have been completed and included that information in the process used to develop the **Preliminary Remediation Goals (PRGs)** in the RCBRA.

What are the contaminants of concern in each medium?

During the development of the RI/FS Work Plan, an initial list of contaminants of potential concern (COPC) is identified to guide data collection as well as the evaluation and analysis in the RI/FS document. In the RI/FS process, the results of the risk assessment and fate and transport evaluations are used to identify final vadose zone and groundwater COPCs. Table 1 lists the initial COPCs and highlights the final COPCs that have been identified in the human health and ecological risk assessment evaluations as well as the fate and transport evaluations for the vadose zone and groundwater.

Who are the potentially exposed populations and exposure pathways for current and future risk scenarios?

Based on the formally designated land use and existing ICs, there are currently no complete exposure pathways for risk to human populations. Nevertheless, for purposes of assessing potential risks in the absence of remediation and controls, hypothetical land use and human exposure scenarios were evaluated in the RI/FS Report's risk assessment evaluation. The residential, industrial, resident monument worker, and casual recreational user exposure scenarios reflect exposure assumptions and exposure pathways that are consistent with reasonably anticipated future land use. The residential exposure scenario is a conservative case used for comparison against the other scenarios while also providing the basis for remedial action decision making.

Table 1. Vadose Zone and Groundwater COPCs

Radionuclides	Metals	Volatile Organics
Americium-241	Aluminum**	1,1,1-Trichloroethane
	Antimony**	
Carbon-14	Arsenic	1,2-Dichloroethene
Cesium-137	Barium	2-Butanone
Cobalt-60	Beryllium	4-Methyl-2-pentanone
Europium-152	Bismuth	Benzene
Europium-154	Boron	Carbon tetrachloride**
Europium-155	Cadmium	Chloroform**
Iodine-129	Chromium, total	**Cis-1,2-Dichloroethene***
Nickel-63	**Chromium Hexavalent***	Ethyl acetate
Plutonium-238	Cobalt**	Ethylene glycol
Plutonium-239/240	Copper**	Hexachlorobutadiene
Plutonium-241	Iron**	Hexachloroethane
	Lead**	
Technetium-99	Lithium	Nitrobenzene
Strontium-90	Manganese	Tetrachloroethene
Tritium*	Mercury	Toluene
Uranium-233/234	Nickel**	**Trichloroethene***
Uranium-235	Selenium	Vinyl chloride
Uranium-238	Silver**	**Semivolatile Organics**
Inorganic Anions	Strontium	Bis(2-ethylhexyl)phthalate
Cyanide	Thallium	Benzo(a)anthracene
Fluoride	Tin	Butylbenzylphthalate
Nitrate*	**Uranium***	Chrysene
Nitrite	Vanadium	Phenanthrene
Sulfate**	Zinc**	Tributyl phosphate
PCB Aroclors	**Organics**	
Aroclor 1016	Total Petroleum Hydrocarbons (diesel range, motor oil)	
Aroclor 1221	Normal paraffin hydrocarbons	
Aroclor 1232		
Aroclor 1242		
Aroclor 1248		
Aroclor 1254		
Aroclor 1260		

Source: From Table 8-3 in DOE/RL-2010-99.
* Indicates a groundwater COC
** Contaminants detected in groundwater that will be included in the Site-wide groundwater monitoring program.
Bold indicates the contaminants that exceed proposed cleanup levels.

OC = contaminant of concern
COPC = contaminant of potential concern
PCB = polychlorinated biphenyl

Residential Scenario. The residential scenario, also known as the unrestricted scenario, is represented by a resident in a subsistence farming setting. This scenario assumes that a receptor lives in an onsite residence with a basement, vegetable and fruit crops are grown in a backyard garden, and a pasture is used to raise livestock sufficient for meat and milk production. A downgradient well is installed where exposure could occur from contaminants leaching from the vadose zone to the groundwater beneath the residence (the leaching pathway). The resident could potentially come into direct contact with soil from the remediated waste site, potentially inhale dust in the ambient air, and consume groundwater. The resident could also consume crops raised in a backyard garden and consume meat (beef and poultry) and milk raised on the pasture. Exposure pathways for chemicals in soil also include direct contact from incidental soil ingestion and inhalation of vapors and dust in ambient air.

Industrial Scenario. The industrial worker scenario, also known as the industrial scenario, is represented by an adult who works in a building located on a remediated waste site but resides offsite. This scenario assumes that the receptor potentially comes in contact with soil from the remediated waste site and inhales dust in the ambient air. Drinking water is assumed to come from an offsite source. Exposure pathways for chemicals in soil include direct contact from incidental soil ingestion and inhalation of vapors and dust in ambient air.

Resident Monument Worker Scenario. The resident monument worker scenario is a site-specific scenario that envisions a resident employee of the HRNM. These receptors are assumed to be exposed primarily in an outdoor environment as they lead tours, conduct ecological education, or perform similar activities. When not working, these receptors are envisioned to live in an onsite residence associated with the HRNM. This scenario assumes that the receptor potentially comes in contact with soil from the remediated waste site and inhales dust in the ambient air. By use of a domestic well at their residence, these receptors may also be exposed to groundwater contaminants through domestic water use.

Casual Recreational User Scenario. The casual recreational user scenario is the receptor of potential exposures from recreational use along the River Corridor. Casual recreational users would participate in activities such as walking and picnicking in areas along the Columbia River where paths and benches are likely to exist. This scenario assumes that the receptor potentially comes in contact with soil from the remediated waste site and inhales dust in the ambient air. These receptors are assumed to be exposed in an outdoor environment where drinking water is obtained from an offsite source.

Groundwater. Groundwater is currently contaminated in some areas, and withdrawal is restricted because of ICs placed on it by DOE. Under current site use conditions, no complete human exposure pathways to groundwater exist. Regardless of land use designations, groundwater will not become a future source of drinking water until cleanup criteria are met and groundwater is restored to beneficial use. Groundwater in the risk evaluation was evaluated assuming potential use for drinking water; therefore, COPC concentrations were compared to DWSs. Groundwater COPC concentrations were also compared to aquatic criteria because groundwater would discharge to the Columbia River via riverbank seeps and upwelling through the river bottom. Comparison of groundwater COPC concentrations to DWSs and aquatic criteria supports a remedial action determination.

What is contaminant fate and transport modeling?

Contaminant fate and transport modeling was performed to evaluate desorption of uranium from the vadose zone sediments and transport through the PRZ and the saturated zone. Transport modeling was conducted using equilibrium and kinetic sorption models along a two-dimensional transect, where the dissolved uranium concentrations have remained historically high (over the past decade). The predictions based on the calibrated models indicate a long-term declining trend in the dissolved uranium concentrations with episodic rises and falls in concentrations seasonally as the water table rises and falls with river stage fluctuations. The mean annual dissolved uranium concentration for the monitoring wells along the flow path is predicted to take less than 30 years (starting in 2014) to drop below the groundwater action level of 30 µg/L (or by 2044), while the 95 percent upper confidence limit (UCL) on the mean annual dissolved concentration is predicted to take approximately 35 years and the 90th percentile concentration is predicted to take approximately 38 years.

These estimates of cleanup time are based on the assumption of current hydrologic and chemical conditions and assume that they will remain unchanged. The cleanup timeframe is based on both the 90th percentile and 95 percent UCL concentration (whichever is longest) for the well with the highest uranium concentration to achieve the DWS.

For chemical contaminants, the *Model Toxics Control Act* requires that the 95 percent UCL on the true mean groundwater concentration be used to determine whether the cleanup goals are met. For radionuclide contaminants, CERCLA has not specified requirements on how to determine when cleanup levels are met. Historically, the 90th percentile concentration has been used during CERCLA groundwater evaluations. The methods to determine when groundwater cleanup levels for chemical and radionuclide contaminants are met will be documented in the ROD.

Results from transport modeling are summarized for other groundwater contaminants that are locally present in the aquifer, such as tritium, TCE, and cis-1,2-dichloroethene. A fate and transport model was constructed for the tritium in the groundwater that exceeds the DWS beneath the 618-11 Burial Ground. This analysis determined that the tritium concentrations would decline to below the DWS by 2031. Analysis and modeling of the tetrachloroethene disposed of in the 300 Area Trench concluded that it is feasible for the TCE to migration and partially degradation in the sediments to form the observed TCE and cis-1,2-dichloroethene concemtrations in groundwater.

What is the summary of the human health soil and groundwater risk evaluation?

The RI/FS risk evaluation included the human health risks for the residential, industrial, residential monument worker, and casual recreational user exposure scenarios. Additionally, several of the residential exposure assumptions used in the RCBRA were updated for the RI/FS risk evaluation to reflect the latest EPA risk assessment guidance as identified in the RI/FS Chapter 6 (DOE/RL-2010-99).

The risk evaluation included cleanup verification data from the 70 interim remedial action waste sites. Residential cumulative risk associated with exposure to radionuclides within shallow soil (top 4.6 m [15 ft]) exceeded the upper end of the CERCLA target risk range (1×10^{-4} to 1×10^{-6}) at four remediated waste sites (316-1, 316-2, 316-5, and 618-3). Cancer risks associated with the resident monument worker scenario are similar to those for the residential scenario. Cancer risks for the casual recreational user scenario fell within the CERCLA target risk range. The 316-1, 316-2, and 316-5 waste sites were remediated under the 300-FF-1 OU ROD using cleanup goals for industrial land use. The 618-3 waste site was remediated under the 300-FF-2 OU interim ROD based on cleanup levels for industrial land use. The land use is designated industrial for these waste sites and based on that, the associated risks are less than 1×10^{-4} for the industrial scenario. The industrial exposure scenario represents the reasonably anticipated future land use, and no further action is warranted.

While individuals are unlikely to be regularly exposed to contaminants in deep soil below 4.6 m (15 ft), cancer risk was assessed to identify the need for ICs on deep excavation. The cancer risk associated with residential exposure to radionuclides in deep vadose zone material exceeded the upper end of the CERCLA target risk range at two waste sites (618-1 and 618-2). Radionuclides associated with historic waste disposal contribute to a majority of the risk and are expected to decay to concentrations less than the residential screening levels within 15 to 60 years. These results indicate the need for controls to limit the potential for future exposure by restricting deep soil excavation and drilling activities within defined areas.

Contaminant transport modeling was also performed to determine the PRGs for several COPCs, including uranium for waste sites. A calculation was performed by maximizing the extent of contamination in the vadose zone and considering several recharge scenarios, with the most conservative value being chosen as the PRG. The groundwater PRG for uranium is calculated to be 117 µg/g and is applicable to waste sites where groundwater contamination does not exist currently. Comparing this value to the exposure point concentrations (EPCs) for various waste sites calculated based on sampled data, five waste sites are found to exceed the groundwater PRG. The waste sites are 316-2, 316-5, 618-1, 618-2, and 618-3.

For the waste sites without analytical data, an evaluation of the risk drivers was made based on knowledge of the process performed at the sites and remediation results at similar sites in the River Corridor. The remedial approaches for the COCs (major risk drivers) are developed for each alternative and presented in the Remedial Alternatives section of this proposed plan.

Groundwater was evaluated as a potential drinking water source using through a comparison of the EPC for each contaminant against the lowest applicable standard, including drinking water standards and ambient water quality criteria. This evaluation identified two primary plumes within the 300-FF-5 groundwater OU. The first plume is located in the 300 Area Industrial Complex where the uranium concentrations are greater than the federal and state DWSs. Concentrations of all nonradiological carcinogenic groundwater contaminants are less than the "Human Health Risk Assessment Procedures" (WAC 173-340-708) risk threshold of 1×10^{-5} for multiple hazardous substances and within the CERCLA target risk range. The HI for groundwater noncancer COPCs is 2.4, which is greater than the EPA and WAC 173-340 target HI of 1.

The primary contributor to the noncancer HI is uranium. Based on the results of the groundwater risk evaluation, concentrations of uranium, cis-1,2-dichloroethene, TCE, chromium/hexavalent chromium, and nitrate in the 300 Area Industrial Complex are present at levels that warrant an evaluation of remedial action.

The second plume is located in the 600 Area subregion, which received releases from the 618-10 and 618-11 Burial Grounds and the 316-4 Crib. Tritium concentrations in the 600 Area subregion are greater than the federal DWS. In addition, nitrate concentrations in localized areas are greater than the federal and state DWSs. Concentrations of all nonradiological carcinogenic groundwater contaminants are less than the "Human Health Risk Assessment Procedures" (WAC 173-340-708) risk threshold of 1×10^{-5} for multiple hazardous substances; also, they are within the CERCLA target risk range. The HI for groundwater noncancer COPCs is less than 1, which is less than the EPA and WAC 173-340 target HI of 1. Based on the results of the groundwater risk evaluation, concentrations of tritium and nitrate in the 600 Area subregion are present at levels that warrant an evaluation of remedial action.

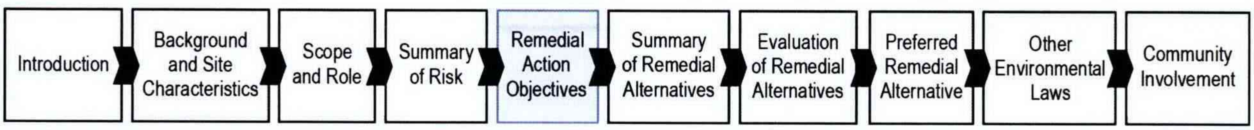
Contaminant concentrations in groundwater were also compared to surface water standards for protection of human health and aquatic organisms because of groundwater discharges to the Columbia River. This comparison indicates that the 90th percentile EPCs for all contaminants were less than ambient water quality standards.

What is the summary of the ecological risk evaluation?

Seventy interim remediated waste sites with cleanup verification sampling and analysis data were evaluated for potential ecological risks. The results of the evaluation determined that there were no unacceptable risks to wildlife, plants, or invertebrates.

The ecological risk assessment presented in the RI/FS Report also summarized ecological risks in riparian and near-shore areas, based on the analysis presented in the RCBRA. The RCBRA evaluated risks against assessment endpoints using measures of exposure, effect, and ecosystem/receptor characteristics at representative near-shore study sites. The study sites were selected to represent locations that may be adjacent to or directly affected by known contaminated media (groundwater seeps and springs, soil, and sediment). The assessment conducted in the RCBRA has been supplemented with a conceptual model depicting the relationships between sources and riparian or near-shore media (soil, sediment, pore water, and surface water). The conceptual model is presented in Chapter 4 of the RI/FS Report. Based on the information developed for the conceptual model, no contaminants were present at levels that warrant remedial action.

The ecological risk assessment presented in the RI/FS Report also evaluates potential impacts to aquatic life from exposure to uranium and TCE originating in groundwater. Uranium and TCE can be transported from groundwater to the Columbia River via upwelling through the riverbed, and to a lesser extent, via riverbank springs that appear during periods of low river stage. Pore water samples (also known as groundwater upwelling samples) were collected and analyzed to determine whether uranium and TCE are present at concentrations that could affect aquatic life. There are no Washington State ambient water quality criterion for uranium or TCE; therefore, concentrations of uranium and TCE were compared to published benchmarks developed for protection of aquatic plants and aquatic invertebrates for comparison purposes. Concentrations of uranium in some pore water samples are greater than available aquatic plant- and invertebrate-based water benchmarks; however, uranium was not detected in the Columbia River. TCE was not detected in pore water samples, and it was not detected in the Columbia River. Based on the results of this evaluation, the amount of uranium and TCE in groundwater is small, and impacts to aquatic life in the Columbia River are not measureable.



Remedial Action Objectives

RAOs describe what a proposed remedial action is expected to accomplish. Typically, RAOs include information on the media, receptors, and COPCs, taking into account the anticipated future land use. For the 300 Area, the anticipated future land use has been identified as industrial. However, both the unrestricted land use criteria based upon the future residential scenario and the industrial land use criteria were used for the preparation of the following RAOs:

- RAO 1. Prevent unacceptable risk to human health from ingestion of and exposure to groundwater containing contaminant concentrations above federal and state standards and risk-based thresholds.
- RAO 2. Prevent unacceptable risk to human health and ecological exposure to surface water containing contaminant concentrations above federal and state standards and risk-based thresholds.
- RAO 3. Prevent unacceptable risk from contaminants migrating and/or leaching through soil that will result in groundwater concentrations that exceed federal and state standards and risk-based thresholds for protection of surface water and groundwater.
- RAO 4. Prevent unacceptable risk to human health from exposure to the upper 4.6 m (15 ft) of soil and to structures and **debris** contaminated with nonradiological constituents at concentrations above

the unrestricted land use exposure scenario for areas outside the 300 Area Industrial Complex and waste site 618-11 (adjacent to Energy Northwest).

- RAO 5. Prevent unacceptable risk to human health from exposure to the upper 4.6 m (15 ft) of soil and to structures and debris contaminated with radiological constituents at concentrations above a dose rate limit that causes an excess lifetime cancer risk threshold of 10^{-6} to 10^{-4} above background for the unrestricted land use exposure scenario for areas outside the 300 Area Industrial Complex and waste site 618-11 (adjacent to Energy Northwest).
- RAO 6. Prevent unacceptable risk to human health from exposure to the upper 4.6 m (15 ft) of soil and to structures and debris contaminated with nonradiological constituents at concentrations above the industrial land use exposure scenario for the 300 Area Industrial Complex and waste site 618-11 (adjacent to Energy Northwest).
- RAO 7. Prevent unacceptable risk to human health from exposure to the upper 4.6 m (15 ft) of soil and to structures and debris contaminated with radiological constituents at concentrations above a dose rate limit that causes an excess lifetime cancer risk threshold of 10^{-6} to 10^{-4} above background for the industrial land use exposure scenario for the 300 Area Industrial Complex and waste site 618-11 (adjacent to Energy Northwest).
- RAO 8. Prevent unacceptable risk to ecological receptors from exposure to the upper 4.6 m (15 ft) of soil and to structures and debris contaminated with nonradiological constituents above the soil contaminant levels and radiological constituents above a dose rate limit of 0.1 rad/day for terrestrial wildlife populations.

Preliminary Remediation Goals

PRGs were used to assess the effectiveness of the selected remedial alternatives to meet the RAOs during the FS process. PRGs provide the basis for identifying cleanup levels in the ROD. PRGs for unrestricted land use and industrial land use for waste site soils are presented in Table 2, and PRGs for 300-FF-5 OU groundwater are presented in Table 3.

The following sections provide a summary of the waste sites and groundwater with respect to the PRGs.

Waste Sites Summary

A risk management approach was applied in developing the remedial alternatives for the waste sites COCs that have been identified for the 300-FF-1 and 300-FF-2 OUs. A total of 552 potential waste sites were identified in the 300 Area. Of these potential waste sites, 275 sites were not accepted as waste sites during the waste site evaluation process because they do not have contamination that exceed risk-based levels. As a result, this proposed plan addresses the 277 waste sites in the 300-FF-1 and 300-FF-2 OUs. Of these waste sites, 122 sites have been identified for no further action and 155 waste sites are being evaluated for remedial actions (Table 4) as follows:

1. One hundred twenty two waste sites are identified for no further action.
2. Six waste sites have been previously remediated and warrant additional remedial actions because they exceed groundwater protection PRGs for total uranium isotopes (Figure 12). These waste sites are located in an area of uranium groundwater contamination and will be addressed as part of the groundwater remedy.

Table 2. Summary of Proposed Cleanup Levels for Vadose Zone

COC	Hanford Site Background Concentration	Unrestricted Land Uses: Proposed Shallow Cleanup Levels (< = 15 ft bgs)		Industrial Land Uses: Proposed Shallow Cleanup Levels (< = 15 ft bgs)		Unrestricted and Industrial Land Uses: Proposed Vadose Zone Cleanup Levels for Groundwater and Surface Water Protection	
		PRG	Exposure Driver	PRG	Exposure Driver	PRG	Exposure Driver
Radionuclides pCi/g							
Americium-241	--	32	DOE/RL-96-17 Residential RAG	210	DOE/RL-2001-47 Industrial RAG	>1,000,000	GWP[e]
Carbon-14	--	8.7	DOE/RL-96-17 Residential RAG	31.6	Ecological[g]	902	GWP[e]
Cesium-137	1.1	4.4	Direct Human Health	18	Direct Human Health	>1,000,000	GWP[e]
Cobalt-60	0.0084	1.4	DOE/RL-96-17 Residential RAG	5.2	DOE/RL-2001-47 Industrial RAG	>1,000,000	GWP[e]
Europium-152	--	3.3	DOE/RL-96-17 Residential RAG	12	Direct Human Health	>1,000,000	GWP[e]
Europium-154	0.033	3.0	DOE/RL-96-17 Residential RAG	11	DOE/RL-2001-47 Industrial RAG	>1,000,000	GWP[e]
Europium-155	0.054	125	DOE/RL-96-17 Residential RAG	518	DOE/RL-2001-47 Industrial RAG	>1,000,000	GWP[e]
Iodine-129	--	0.076	Direct Human Health	1,940	Direct Human Health	169	GWP[e]
Nickel-63	--	608	Direct Human Health	>1,000,000	Direct Human Health	>1,000,000	GWP[e]
Plutonium-238	0.0038	39	DOE/RL-96-17 Residential RAG	155	DOE/RL-2001-47 Industrial RAG	>1,000,000	GWP[e]
Plutonium-239/240	0.025	35	DOE/RL-96-17 Residential RAG	245	DOE/RL-2001-47 Industrial RAG	>1,000,000	GWP[e]
Plutonium-241	--	854	DOE/RL-2001-47 Residential RAG	12,900	DOE/RL-2001-47 Industrial RAG	>1,000,000	GWP[e]
Technetium-99	--	1.5	Direct Human Health	5,360	Ecological[i]	405	GWP[e]
Total beta radiostrontium (Strontium-90)	0.18	2.3	Direct Human Health	91	Ecological[g]	>1,000,000	GWP[e]
Tritium	--	420	Ecological[g]	420	Ecological[g]	11,700	GWP[e]
Uranium-233/234	1.1	27.2	DOE/RL-2001-47 Residential RAG	167	DOE/RL-2001-47 Industrial RAG	--	--
Uranium-235	0.11	2.7	DOE/RL-2001-47 Residential RAG	16	DOE/RL-2001-47 Industrial RAG	--	--
Uranium-238	1.1	26.2	DOE/RL-2001-47 Residential RAG	167	DOE/RL-2001-47 Industrial RAG	--	--
Total Uranium	--	56.1	DOE/RL-2001-47 Residential RAG	350	DOE/RL-2001-47 Industrial RAG	--	--

Table 2. Summary of Proposed Cleanup Levels for Vadose Zone

COC	Hanford Site Background Concentration	Unrestricted Land Uses: Proposed Shallow Cleanup Levels (< = 15 ft bgs)		Industrial Land Uses: Proposed Shallow Cleanup Levels (< = 15 ft bgs)		Unrestricted and Industrial Land Uses: Proposed Vadose Zone Cleanup Levels for Groundwater and Surface Water Protection	
		PRG	Exposure Driver	PRG	Exposure Driver	PRG	Exposure Driver
Chemicals mg/kg							
Antimony	0.13	32	Direct Human Health	146	Ecological[g]	4,790	SWP[f]
Arsenic	6.5	20[b]	WAC 173-340-900, Table 740-1, Method A	20[c]	WAC 173-340-900, Table 745-1, Method A	20[b]	WAC 173-340-900, Table 740-1, Method A
Barium	132	358	Ecological[j]	358	Ecological[j]	388,000	SWP[f]
Beryllium	1.5	10	Ecological[h]	10	Ecological[h]	388,000	GWP[e]
Bismuth	--	--	--	--	--	--	--
Boron	3.9	29.6	Ecological[h]	29.6	Ecological[h]	388,000	GWP[e]
Cadmium	0.56	9.84	Ecological[h]	9.84	Ecological[h]	1,700	SWP[f]
Cobalt	15.7	15.7	Ecological[h,j]	15.7	Ecological[h,j]	29,300	SWP[f]
Copper	22	58	Ecological[j]	58	Ecological[j]	44,700	SWP[f]
Chromium	18.5	109	Ecological[i]	109	Ecological[i]	388,000	SWP[f]
Chromium (VI)	--	2.0[d]	DOE/RL 96-17 SWP RAG	21	DOE/RL-2001-47 Industrial RAG	2.0[d]	SWP[f]
Lead	10.2	156	Ecological[i]	156	Ecological[i]	14,300	SWP[f]
Lithium	13.3	13.3	Background	13.3	Background	361,000	GWP[e]
Manganese	512	1,260	Ecological[h,j]	1,260	Ecological[h,j]	388,000	GWP[e]
Mercury	0.013	0.30	Ecological[h]	0.30	Ecological[h]	81.4	SWP[f]
Nickel	19.1	38	Ecological[h]	38	Ecological[h]	388,000	SWP[f]
Selenium	0.78	1.43	Ecological[g]	1.43	Ecological[g]	5,670	SWP[f]
Silver	0.17	2.99	Ecological[j]	2.99	Ecological[j]	53,000	SWP[f]
Strontium	--	1,210	Ecological[g]	1,210	Ecological[g]	388,000	GWP[e]
Thallium	0.19	0.459	Ecological[j]	0.459	Ecological[j]	3,850	SWP[f]
Tin	--	204	Ecological[i]	204	Ecological[i]	388,000	SWP[f]
Total Uranium Isotopes	3.2	40	Ecological[g]	40	Ecological[g]	117	STOMP 2D Uranium Model GWP
Uranium	3.2	40	Ecological[g]	40	Ecological[g]	117	STOMP 2D Uranium Model GWP
Vanadium	85.1	85.1	Background	85.1	Background	388,000	GWP[e]
Zinc	68	621	Ecological[h]	621	Ecological[h]	388,000	SWP[f]
Cyanide	--	1,600	Direct Human Health	20,700	Ecological[g]	11,700	SWP[f]
Fluoride	2.8	2,280	Ecological[i]	2,280	Ecological[i]	388,000	GWP[e]
Nitrate	52	567,000	DOE/RL-96-17 Residential RAG	340,000	Ecological[g]	4,500	GWP[e]
Nitrite	--	24,000	Direct Human Health	340,000	Ecological[g]	451	GWP[e]
Sulfate	237	--	--	--	--	113,000	GWP[e]
Aroclor 1016	--	0.50	DOE/RL-96-17 Residential RAG	1.82	Ecological[i]	1.55	SWP[f]
Aroclor 1221	--	0.50	Direct Human Health	1.47	Ecological[g]	0.15	SWP[f]

Table 2. Summary of Proposed Cleanup Levels for Vadose Zone

COC	Hanford Site Background Concentration	Unrestricted Land Uses		Industrial Land Uses		Unrestricted and Industrial Land Uses	
		Proposed Shallow Cleanup Levels (< = 15 ft bgs)		Proposed Shallow Cleanup Levels (< = 15 ft bgs)		Proposed Vadose Zone Cleanup Levels for Groundwater and Surface Water Protection	
		PRG	Exposure Driver	PRG	Exposure Driver	PRG	Exposure Driver
Aroclor 1232	--	0.50	Direct Human Health	1.44	Ecological[g]	0.15	SWP[f]
Aroclor 1242	--	0.50	Direct Human Health	1.49	Ecological[g]	0.65	SWP[f]
Aroclor 1248	--	0.325	Ecological[g]	0.325	Ecological[g]	0.63	SWP[f]
Aroclor 1254	--	0.50	Direct Human Health	1.47	Ecological[g]	1.09	SWP[f]
Aroclor 1260	--	0.50	Direct Human Health	1.47	Ecological[g]	11.9	SWP[f]
Benzo(a)pyrene	--	0.14	Direct Human Health	2.41	Ecological[i]	3,480	SWP[f]
Bis(2-ethylhexyl) phthalate	--	0.14	Ecological[i]	0.14	Ecological[i]	29,800	SWP[f]
Butylbenzyl phthalate	--	526	Direct Human Health	69,100	Direct Human Health	25,700	SWP[f]
Chrysene	--	1.4	Ecological[i]	1.4	Ecological[i]	126	SWP[f]
Phenanthrene	--	29	Ecological[j]	29	Ecological[j]	--	--
1,1,1-Trichloroethane	--	165	Ecological[i]	165	Ecological[i]	778	GWP[e]
1,2-Dichloroethene (total)	--	720	Direct Human Health	31,500	Direct Human Health	86.7	GWP[e]
2-Butanone	--	3,120	Ecological[i]	3,120	Ecological[i]	2,500	GWP[e]
4-Methyl-2-pentanone	--	1,930	Ecological[i]	1,930	Ecological[i]	430	GWP[e]
Benzene	--	0.57	Inhalation Human Health	5.7	Inhalation Human Health	1.34	GWP[e]
Carbon tetrachloride	--	0.24	Inhalation Human Health	2.4	Inhalation Human Health	0.97	SWP[f]
Chloroform	--	0.24	Inhalation Human Health	2.4	Inhalation Human Health	2.07	GWP[e]
Cis-1,2-Dichloroethylene	--	165	Ecological[i]	165	Ecological[i]	77.6	GWP[e]
Ethyl acetate	--	--	--	>1,000,000	Direct Human Health	--	--
Ethylene glycol	--	160,000	Direct Human Health	>1,000,000	Direct Human Health	5,030	GWP[e]
Hexachloro-butadiene	--	13	Direct Human Health	700	DOE/RL-2001-47 Industrial RAG	5,340	SWP[f]
Hexachloro-ethane	--	71	Direct Human Health	3,500	Direct Human Health	542	SWP[f]
Nitrobenzene	--	2.0	Inhalation Human Health	20	Inhalation Human Health	50.6	GWP[e]
Tetrachloroethene	--	0.88	Inhalation Human Health	8.8	Inhalation Human Health	0.82	GWP[e]
Toluene	--	195	Ecological[i]	195	Ecological[i]	2,490	GWP[e]
Trichloroethene	--	0.17	Inhalation Human Health	1.7	Inhalation Human Health	1.21	GWP[e]
Vinyl chloride	--	0.52	Inhalation	5.2	Inhalation Human	0.020	SWP[f]

Table 2. Summary of Proposed Cleanup Levels for Vadose Zone

COC	Hanford Site Background Concentration	Unrestricted Land Uses		Industrial Land Uses		Unrestricted and Industrial Land Uses	
		Proposed Shallow Cleanup Levels (< = 15 ft bgs)		Proposed Shallow Cleanup Levels (< = 15 ft bgs)		Proposed Vadose Zone Cleanup Levels for Groundwater and Surface Water Protection	
		PRG	Exposure Driver	PRG	Exposure Driver	PRG	Exposure Driver
			Human Health		Health		
Xylenes (total)	--	103	Inhalation Human Health	149	Ecological[i]	12,500	GWP[a]
Normal paraffin hydrocarbon	--	57,900	Ecological[i]	57,900	Ecological[i]	--	--
Total Petroleum Hydrocarbons-diesel	--	200	DOE/RL-96-17 Residential RAG	200	Ecological[j]	200	DOE/RL-96-17 GWP RAG
Tributyl phosphate	--	109	Direct Human Health	14,300	Direct Human Health	217	GWP[e]

a. Hanford Site background values for nonradionuclides: DOE/RL-92-24, Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes; ECF-HANFORD-11-0038, Soil Background Data for Interim Use at the Hanford Site; Hanford Site background values for radionuclides: DOE/RL 96-12, Hanford Site Background: Part 2, Soil Background for Radionuclides.
b. Arsenic PRG is compared to the WAC 173-340-900, "Model Toxics Control Act—Cleanup," "Tables," Table 740-1, Method A, soil cleanup level for unrestricted Land Use.
c. Arsenic PRG is compared to the WAC 173-340-900, "Model Toxics Control Act—Cleanup," "Tables," Table 745-1, Method A, soil cleanup level for unrestricted Land Use.
d. Cr(VI) PRG is set to the interim action RAG of 2.0 mg/kg (DOE/RL-96-17, Remedial Design Report/Remedial Action Work Plan for the 100 Area).
e. 100:0 Contaminant Source Model groundwater protection
f. 100:0 Contaminant Source Model surface water protection
g. Ecological Mammal
h. Ecological Plant
i. Ecological Avian
j. Ecological Invertebrate
bgs = below ground surface
GWP = groundwater protection
SWP = surface water protection

Table 3. Summary of Proposed Cleanup Levels for Groundwater

COPC	Units	Drinking Water Standard	Aquatic Standard	Proposed Cleanup Level
Uranium	µg/L	30		30
Tritium	pCi/L	20,000		20,000
Nitrate[b]	µg/L	45,000	-	45,000
Trichloroethene	µg/L	5	-	4.9
Cis-1,2-DCE	µg/L	70	-	70
Hexavalent Chromium	µg/L	48*	10	10
Gross Alpha	pCi/L	15	-	15

* The chromium federal DWS is 100 ug/l and the state DWS is 48 ug/l
EPC = exposure point concentration
COPC = contaminant of potential concern

Table 4. Waste Sites Evaluated During Feasibility Study

Rationale for Inclusion In Feasibility Study	Waste Sites
No Action Waste Sites (***122 waste sites***)	300 Ash Pits[c], 300 RFBP, 300-44, 300-49, 300-50, 332 SF, 618-12, UPR-300-15, UPR-300-19, UPR-300-20, UPR-300-21, UPR-300-22, UPR-300-23, UPR-300-24, UPR-300-25, UPR-300-26, UPR-300-27, UPR-300-28, UPR-300-29, UPR-300-30, UPR-300-32, UPR-300-33, UPR-300-34, UPR-300-35, UPR-300-36, UPR-300-37, UPR-300-47, UPR-300-8, UPR-300-9, UPR-300-FF-1, 300 FBP:1, 301 FBP:2, 300-3, 300-51, 300-52, UPR-600-15, 437 MASF, 300 SE, 300-10, 300-19, 300-223, 300-23, 300-231, 300-262, 300-272, 300-35, 300-37, 300-45, 300-53, 300-57, 303-K CWS, 304 CF, 304 SA, 305-B SF, 311 MT1, 311 MT2, 311-TK-40, 311-TK-50, 313 CENTRIFUGE, 313 FP, 313 MT, 313 URO, 313-TK-2, 333-TK-11, 333-TK-7, 334 TFWAST, 334-A-TK-B, 334-A-TK-C, 3718-F BS, 3718-F SF, 3718-F TT1, 3718-F TT2, Biological Treatment Test Facilities, Physical and Chemical Treatment Test Facilities, Thermal Treatment Test Facilities, UPR-300-41, UPR-300-7, 300-278, 300 VTS, 300-109, 300-110, 300-18, 300-256, 300-259, 300-275, 300-33, 300-41, 300-8, 303-M SA, 303-M UOF, 333 ESHWSA, UPR-300-17, UPR-300-46, 300-1, 300-253, 300-260, 300-29, 331 LSLDF, 4843, 400-31, 400-5, 427 HWSA, 4831 LHWSA, 400-36, 618-4, 628-4, 600-278, 600-46, 618-9, 600-243[c], 600-259, 600-259:1, 600-259:2, 600-290:1, 600-47, 618-1:1, 618-1:2, 618-13, 618-5, 618-7, 618-8, 600-22
Waste Sites Previously Remediated that Exceed Groundwater Protection PRGs ***(6 waste sites)***	**300-FF-1 OU:** 316-1[a], 316-2, 316-5 **300-FF-2 OU:** 618-1, 618-2, 618-3
Waste Sites to be remediated prior to ROD Signing. (***43 waste sites***)	**300-FF-2 OU:** 300-121, 300-123, 300-16, 300-16:1, 300-16:3, 300-219, 300-224, 300-24, 300-249, 300-25, 300-264, 300-268, 300-270, 300-273, 300-274, 300-276, 300-28, 300-40, 300-43, 300-46, 300-48, 300-6, 307 RB, 313 ESSP, 333 White Sands Test Facility, 600-117, 618-10, UPR-300-1, UPR-300-11, UPR-300-38, UPR-300-39, UPR-300-4, UPR-300-40, UPR-300-42, UPR-300-45, UPR-600-22, 300-16:2, 300-218, 300-251, 300-258, 300-80, 3712 USSA, 316-4
Waste Site Requiring Remediation after ROD Signing (***66 waste sites***)	**300-FF-2 OU:** 300 RLWS, 300 RRLWS, 300-11, 300-15, 300-175, 300-2, 300-214, 300-22, 300-255, 300-257, 300-263, 300-265, 300-269, 300-277, 300-279, 300-280, 300-281, 300-282, 300-283, 300-284, 300-286, 300-287, 300-288, 300-289, 300-290, 300-291, 300-292, 300-293, 300-294, 300-295, 300-296, 300-32, 300-34, 300-39, 300-4, 300-5, 300-7, 300-9, 309-TW-1, 309-TW-2, 309-TW-3, 309-WS-1, 309-WS-2, 309-WS-3, 316-3, 323 TANK 1, 323 TANK 2, 323 TANK 3, 323 TANK 4, 325 WTF, 331 LSLT1, 331 LSLT2, 340 Complex, 400 Process Pond and Sewer System, 400-37, 400-38, 600-290, 600-290:2, 600-367, 600-63, 618-11, UPR-300-10, UPR-300-12, UPR-300-2, UPR-300-48, UPR-300-5
Consolidated Sites (***40 waste sites***)[b]	**300-FF-2 OU:** 300-131, 300-132, 300-133, 300-134, 300-135, 300-136, 300-137, 300-138, 300-139, 300-140, 300-141, 300-142, 300-143, 300-144, 300-145, 300-146, 300-147, 300-148, 300-149, 300-150, 300-81, 300-82, 300-83, 300-84, 300-92, 333 ESHTSSA, UPR-300-44, UPR-600-1, UPR-600-10, UPR-600-2, UPR-600-3, UPR-600-4, UPR-600-5, UPR-600-6, UPR-600-7, UPR-600-8, UPR-600-9, 333 LHWSA, UPR-300-13, UPR-300-14
Total Waste Sites 159	

a. Waste site 316-1 did not exceed PRGs for protection of groundwater but is being considered a potential uranium source of groundwater contamination based on process knowledge.

b. Consolidated Sites: A reclassification status indicating a WIDS site is a duplicate of, physically located within, or adjacent to another WIDS site and will be dispositioned as part of that other WIDS site. NOTE: A consolidated WIDS site requires no future updates in WIDS after reclassification. All updates may be limited to the WIDS site with which it was consolidated.

c. Coal ash sites that have undergone past remediation and have no actions proposed for this Proposed Plan.

3. One hundred twenty two waste sites are identified for no further action.
4. Six waste sites have been previously remediated and warrant additional remedial actions because they exceed groundwater protection PRGs for total uranium isotopes (Figure 12). These waste sites are located in an area of uranium groundwater contamination and will be addressed as part of the groundwater remedy.
5. Forty-three waste sites (Figure 13) are currently being remediated under the 300-FF-2 interim ROD (EPA/ROD/R10 01/119) or are anticipated to be remediated by the time the final action ROD is signed. These waste sites are included in this proposed plan and will achieve the PRGs. DOE assumes that the ongoing interim actions will meet the PRGs so that no further action (or costs) will be required under this proposed plan.
6. Sixty six waste sites (Figure 14) will not have interim remedial actions completed before this final action ROD is signed. These wastes sites are evaluated for remedial alternatives in this proposed plan.
7. Forty waste sites, identified as Consolidated Sites, lie within the remediation footprint of other sites. The costs for remediation of these waste sites are already included in the costs for remediation of the other waste sites.

If a newly discovered site does not meet the final cleanup levels, the site will be evaluated depending on the risk drivers that are present, and an RTD remedy will be evaluated. The selected remedial actions will be considered minor modifications to the ROD and made through an administrative process (NPL fact sheets).

Groundwater Summary

A risk management approach was applied in developing remedial alternatives for the groundwater COC plumes identified for the 300-FF-5 OU. The final COCs for groundwater include uranium and tritium.

Uranium. Uranium that exceeds the DWS in groundwater occurs in the 300 Area Industrial Complex and covers an area of about 0.5 km^2. Cleanup of the groundwater plume and protection of the Columbia River will be accomplished through remediation of the source of uranium contamination that resides in the vadose zone and PRZ. Groundwater monitoring will be used to assess progress toward achieving cleanup goals. The waste sites that exceed the groundwater protection PRGs (Table 4) are located within the uranium groundwater plume. These waste sites have undergone previous remediation, but based on confirmation sampling, the residual uranium concentrations remain above the proposed PRGs for groundwater protection. Based on process knowledge of historical waste disposal, soil concentration data, and uranium concentrations in the groundwater, it appears that the majority of the vadose zone contamination is associated with waste sites 316-1, 316-2 and 316-5.

Tritium. Tritium in groundwater that exceeds DWSs occurs beneath the 618-11 Burial Ground. A groundwater transport model was constructed using monitoring well chemical and hydraulic data, along with dispersion estimates and tritium decay rates used to predict future tritium concentrations in the area (PNNL-15293, *Evaluation of the Fate and Transport of Tritium Contaminated Groundwater from the 618-11 Burial Ground*). Several scenarios were run with this model, and it was concluded that the maximum tritium concentration will decline to below the DWS by 2031. Thus, the model predicts that a combination of natural radiological decay and dispersion during transport will achieve the PRG within a reasonable timeframe.

Waste site 316-1 did not exceed the proposed soil PRGs for groundwater protection following remediation under the interim ROD, but is included for remediation because of the waste disposal history and nearby contaminated groundwater.

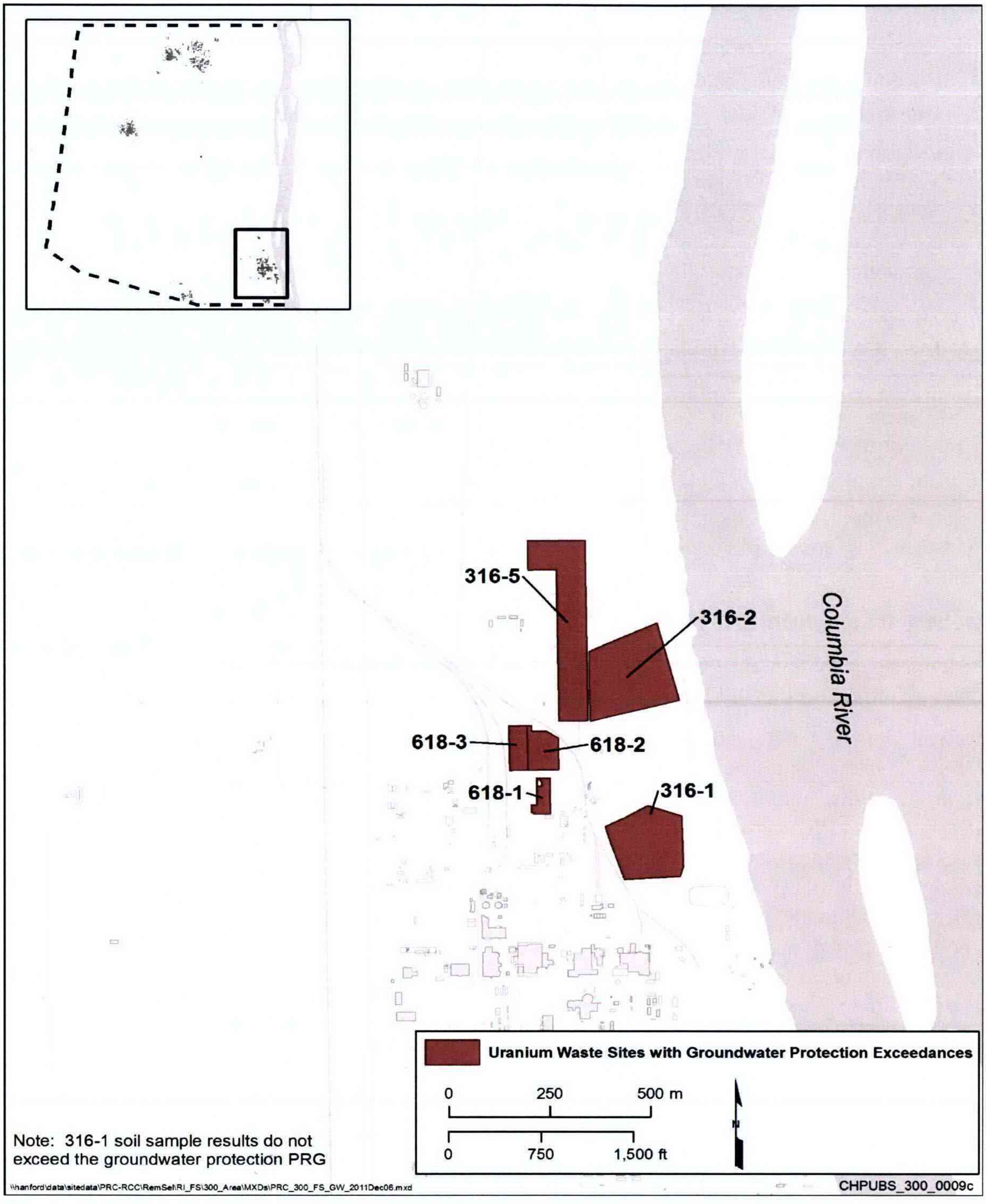


Figure 12. Previously Remediated Waste Sites with Groundwater Protection Exceedences

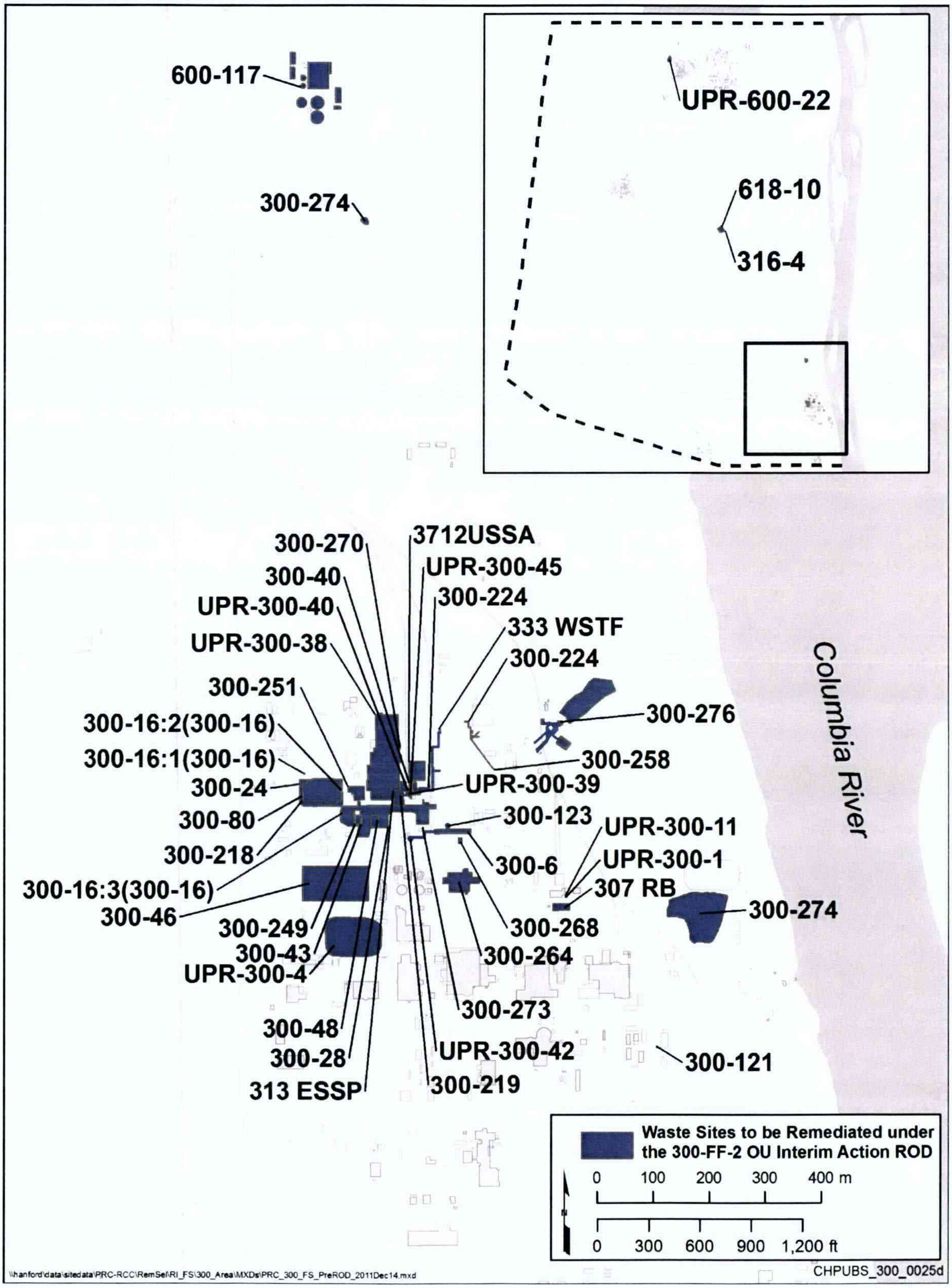


Figure 13. Waste Sites to be Remediated under the 300-FF-2 OU Interim ROD

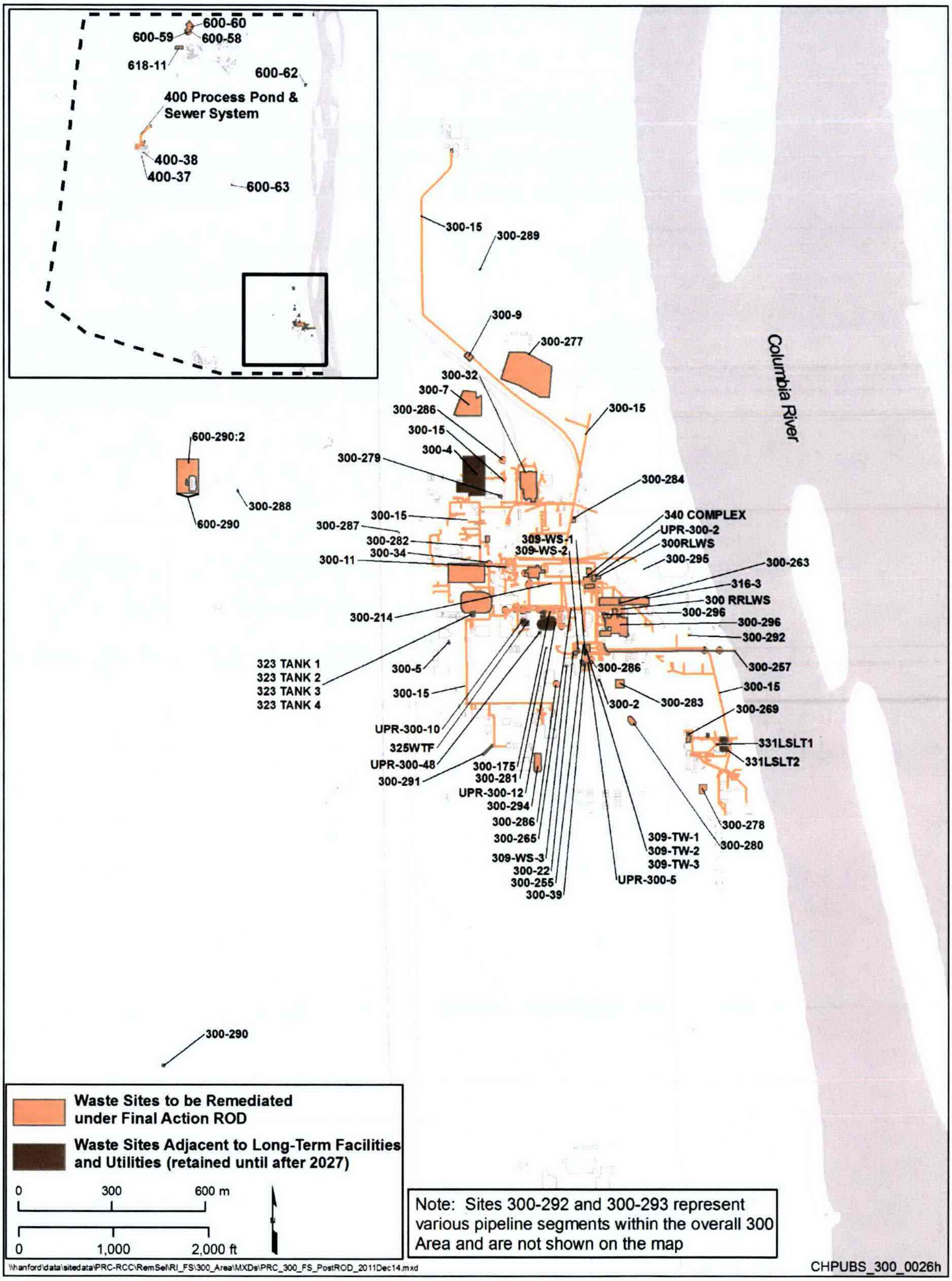


Figure 14. Waste Sites Not Previously Remediated

Remediation of the contaminated groundwater using typical pump-and-treat technology was screened out during the FS because only about 1 percent of the total uranium residues in the groundwater would be affected by this remediation technique. Implementation of pump-and-treat technology will not reduce the time to achieve cleanup. Because most of the uranium contamination resides in the vadose zone and PRZ, an effective remediation approach will target those zones to reduce the amount of mobile uranium that can enter the groundwater. In situ mining of uranium (flush the uranium from the vadose zone and PRZ) with pump-and-treat capture in the groundwater was not carried into the proposed plan. Industry experience demonstrates it is problematic to restore the aquifer after extraction, and it may be difficult to capture the released uranium. Sequestration of uranium (through biological manipulation of the vadose zone, PRZ, and aquifer) was not carried forward into the proposed plan because it is not possible to maintain long-term anoxic conditions required to keep uranium sequestered with this technology.

In addition to the groundwater COCs identified above for the 300 Area, several contaminants have been identified that exceed federal and state standards in localized areas . These contaminants which are referred to as COPCs are listed below with a brief explanation of their original and concentration trends, where applicable:

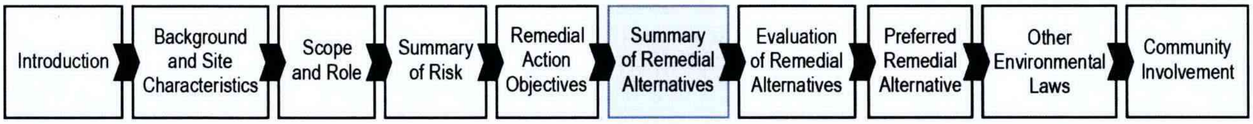
Gross alpha. Most gross alpha is associated with the uranium contamination and this parameter will not be carried forward as a groundwater COPC. Achieving the uranium standards will also result in the gross alpha standard being achieved. However, continued monitoring for gross alpha will be performed.

Nitrate. Nitrate in the 300 Area Industrial Complex exceed the 45 mg/L DWS in areas where groundwater has been impacted by off-site agricultural activities. The relatively higher concentrations in the southern portion currently reflect the migration of nitrate-contaminated groundwater into the 300 Area from sources to the southwest. Gradually increasing concentrations are also observed in wells and at shoreline sites as the nitrate-laden groundwater migrates into the 300 Area Industrial Complex. Although nitrate is considered a COPC near the 618-10 and 618-11 Burial Grounds, the origin for nitrate observed in this area is uncertain. One explanation suggests that waste disposal at the 200 East Area sites may be implicated and the contamination is part of the sitewide groundwater plume assigned to the 200-PO-1 OU. Due to the association with the sitewide nitrate plume, nitrate near the burial grounds and in the overall 300 Area will not be addressed in the remedial alternatives, but continued monitoring for nitrate will be performed.

TCE. Recent analytical results for TCE at several wells in the southern portion of the 300 Area show increases in concentrations over time, some of which now exceed the DWS of 5 μg/L (wells 399-3-21 and 399-4-14). Other VOCs do not show similar increases, and the TCE increases do not appear correlated with trends for other contaminants. Offsite groundwater from the southwest migrates into the southern portion of the 300 Area, and TCE is potentially associated with offsite sources (e.g., the AREVA facility and the DOE's former Horn Rapids Landfill) is present in that groundwater. TCE will not be addressed in the remedial alternatives, but continued monitoring for TCE will be performed.

Cis-1,2-DCE. The Cis-1,2-DCE concentrations continue to exceed the DWS at one well (399-1-16B) located near the North Process Pond. Well 399-1-16B is screened in Ringold Formation gravelly sediments in the lower portion of the aquifer. The origin for cis-1,2-DCE attributed to degradation of TCE disposed to the Process Trenches and/or North Process Pond (see PNNL-17666). Since the areas of exceedance are very localized, cis-1,2-DCE will not be addressed in the remedial alternatives, but will be a component in the groundwater monitoring program.

Hexavalent Chromium. The Hexavalent chromium concentrations appeared as part of the plume associated with recent remedial actions at the 618-7 Burial Ground, which was completed in 2008. At well 399-8-5A, which is adjacent to the eastern fence line of the former burial ground, concentrations measured as total chromium in filtered and unfiltered samples had a high value of 105 μg/L. Chromium from the eastern fence line then migrated downgradient to well 399-8-1. Since then, concentrations have declined to near the aquatic standard of 10 µg/L. The source for the chromium is attributed to remedial actions at the burial grounds, dust control water application which reached groundwater, and corrosion of the stainless-steel well screen in well 399-8-5A. Since the areas of chromium exceedance are localized and attributable to completed remediation activities, chromium will not be addressed in the remedial alternatives, but will be a component in the groundwater monitoring program.



Summary of Remedial Alternatives

According to the approach summarized below, remedial alternatives were developed in DOE/RL-2010-99 based on the results of a detailed technology screening. The following alternatives include a range of technology groupings that address vadose zone soil and groundwater collectively:

- **Alternative 1-**No Action
- **Alternative 2-**RTD and Groundwater Monitoring
- **Alternative 3-**RTD, Uranium Sequestration, and Groundwater Monitoring
- **Alternative 4-**RTD, Uranium Sequestration, Focused Deep RTD, and Groundwater Monitoring
- **Alternative 5-**Expanded RTD and Groundwater Monitoring

Alternative 1—No Action

The NCP (40 CFR 300.430(e)(6)) requires consideration of a No Action Alternative. The No Action Alternative, which serves as a baseline for evaluating other remediation action alternatives, is retained throughout the FS process. Under this alternative, all ongoing interim actions and groundwater monitoring activities would be discontinued once this ROD is signed, which is anticipated to occur in December 2012. In addition, any remedial actions for the remaining waste sites, groundwater restoration, and implementation of ICs would not be performed under this alternative.

The No Action alternative would not remediate the waste sites and as a result, these waste sites would have residual contamination that is not protective of human health and the environment. Groundwater restoration for the uranium contamination in the 300 Area Industrial Complex would only occur through natural processes.

Based upon a two-dimensional model of the uranium concentration, with the highest residual uranium mass in the vadose zone and PRZ, it is estimated to take approximately 38 years[1] (by year 2052) for the uranium concentrations in the groundwater to decrease below the DWS without additional source control measures. This analysis was performed using the three wells that have the highest uranium concentrations and are located downgradient from the waste sites with the highest uranium source mass.

Alternative 2—RTD and Groundwater Monitoring

Alternative 2 completes DOE's commitments in the 300-FF-2 interim ROD (EPA/ROD/R10 01/119) for RTD of the waste sites to protect human health and ecological receptors from direct exposure at depths of less than 4.6 m (15 ft) below ground surface (bgs), MNA for tritium, and groundwater monitoring. For these waste sites, the actions will vary depending on the nature and extent of contamination at the waste site.

---

[1] The timeframe is based on the 90th percentile or the 95th percentile UCL concentration (whichever is longest) for the well with the highest uranium concentration to achieve the DWS.

Remedial technologies (Figure 15) include the following:

- RTD of the contaminated soil and debris with concentrations above cleanup levels would be removed from the waste sites, treated as necessary to meet disposal facility requirements, and sent to **Environmental Restoration Disposal Facility (ERDF)** or another facility approved by EPA. The RTD alternative assumes an excavation depth sufficient to meet all RAOs, including protection of groundwater, protection of the Columbia River (except for residual uranium in the deep vadose zone/PRZ, which is addressed as a separate component of the groundwater remedy), and the prevention of direct exposure. The RAOs for protection of groundwater and the Columbia River must be met through the entire soil column from the surface to groundwater. The RAO for direct exposure applies only to the upper part of the soil column, which is defined as the top 4.6 m (15 ft) of soil below the surrounding grade or the bottom of an engineered structure (burial ground trench, caisson, or pipe unit), whichever is deeper. It is anticipated that all of the RAOs would be achieved at depths of less than 4.6 m (15 ft) at many of the 300-FF-2 waste sites because records indicate that the contamination is shallow, and available characterization data suggest that migration of contaminants through the soil column has not occurred.

  If residual contamination exceeding cleanup standards in the soil column is found below 4.6 m (15 ft), the extent of remediation may require reevaluation by the Tri-Parties. Any decision to leave contaminants that exceed cleanup standards in place below 4.6 m (15 ft) will be made by the Tri-Parties and will require public comment depending on the nature of the waste.

- RTD of the pipelines that are shallower than or at 4.6 m (15 ft) bgs for the protection of human health and ecological receptors from direct exposure.
- RTD of the contaminated pipelines (300-15) that transported the majority of the uranium waste to the disposal sites (316-1, 316-2, 316-5 and 618-1, 618-2 and 618-3).
- MNA for tritium in groundwater.
- Groundwater monitoring for uranium, TCE, cis-1,2-DCE, chromium, and nitrate.
- ICs will be implemented for the protection of human health and ecological receptors during the timeframe of this remedial alternative.

Temporary surface caps will be installed over the waste sites that are adjacent to the 300 Area facilities and utilities that will remain in operation through at least 2027 (long-term facilities). In addition, pipelines associated with long-term facilities will be interim void filled, as necessary, for groundwater protection. When the long-term facilities are no longer in use and removed, the waste sites and pipelines will be remediated as described above.

Under Alternative 2, the timeframe for the uranium concentration in the groundwater to decrease below the DWS is the same as that of the No Action alternative in that limited source control measures are being implemented to mitigate the flux of uranium from the vadose zone and PRZ. Therefore, it is estimated that it will take approximately 38 years (by year 2052) for the uranium concentrations in the groundwater to decrease below the DWS. This timeframe is based on the two-dimensional model using the groundwater data from the monitoring wells with the highest uranium concentrations that are downgradient from the waste sites with the highest uranium source mass.

This alternative includes MNA for the tritium contamination in the groundwater beneath the 618-11 Burial Ground. Through a combination of natural radiological decay and dispersion during transport, the computer model predicted that the tritium concentrations will decrease to below the DWS by 2031.

Alternative 2: RTD and Groundwater Monitoring

Overview

Waste Sites

Alternative 2 completes DOE's commitments in the 300-FF-2 interim ROD (EPA/ROD/R10-01/119) for RTD of the waste sites for protection of human health direct exposure and ecological receptors (less than 4.6 m [15 ft] bgs). The actions will vary depending on the nature and extent of contamination at each waste site, and may include one or more of the following:

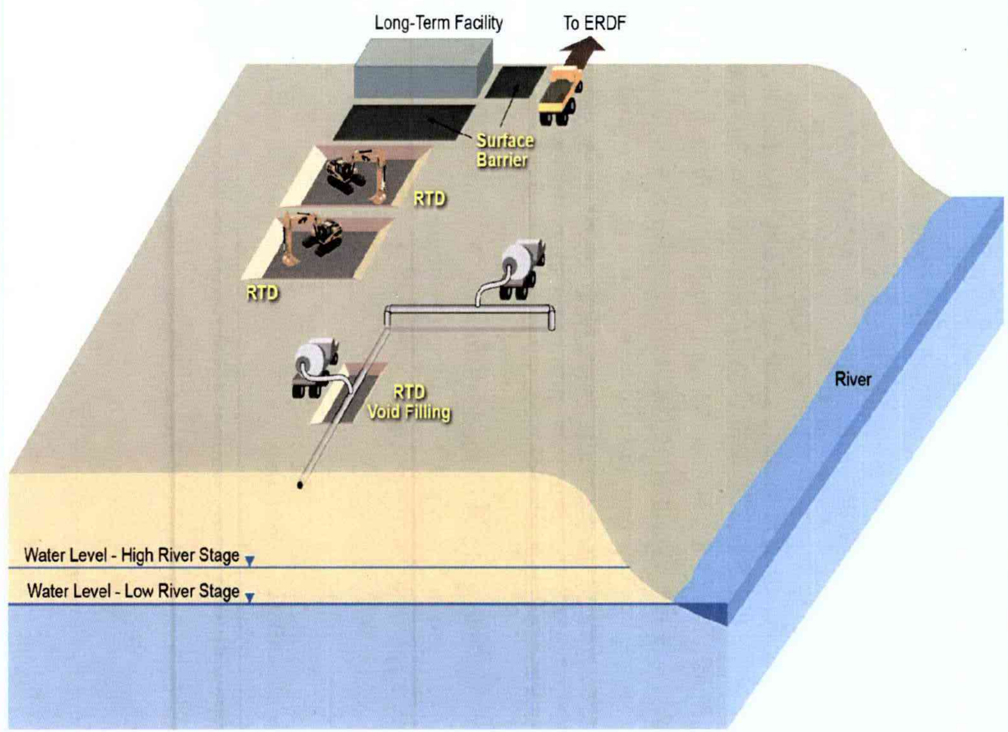
- RTD the waste sites to less than 4.6 m (15 ft) bgs for the protection of human health direct exposure and ecological receptors.
- RTD the waste sites to the depth of contamination that exceeds groundwater protection criteria for non-uranium COCs.
- RTD the pipelines that are shallower than or at 4.6 m (15 ft) bgs for the protection of human health direct exposure and ecological receptors.
- RTD the pipelines that transported the majority of the uranium waste to the disposal sites (i.e., waste sites 316-1, 316-2, 316-5, 618-1, 618-2, and 618-3).
- Temporary surface barriers for waste sites adjacent to long-term facilities.
- Interim void filling of pipelines adjacent to long-term facilities
- Institutional Controls.

Groundwater

- Monitored natural attenuation for tritium.
- Groundwater monitoring
- Institutional controls.

Note: Backfill materials (to fill the excavated waste site) will be determined in the Remedial Design/Remedial Action Work Plan. Excess materials from ERDF construction will be considered for use as waste site backfill material to minimize natural near-site damages.

Conceptual Schematic



Cost

	Waste Site Treatment	Groundwater Treatment	TOTAL
Total Present Value of Alternative (Discounted)	$ 295,857,000	$ 5,136,000	$ 300,993,000

Note: Waste site treatment costs include the costs for institutional controls and construction of an additional ERDF supercell

CHPUBS_300_0016i

Figure 15. Alternative 2—RTD and Groundwater Monitoring

Alternative 3—RTD, Uranium Sequestration and Groundwater Monitoring

Alternative 3 uses a combination of RTD (at depths of less than 4.6 m [15 ft] bgs) for waste sites, uranium sequestration using phosphate for the waste sites with deep uranium contamination, MNA for tritium in groundwater, and groundwater monitoring. This alternative reduces the time required to restore the uranium-contaminated groundwater in the 300 Area Industrial Complex to the DWS. Remedial technologies (Figure 16) include the following:

- RTD. Same as Alternative 2.
- Phased implementation of uranium sequestration using a combination of surface and deep application techniques for the waste sites with uranium contamination deeper than 4.6 m (15 ft) bgs. and groundwater monitoring for uranium.
- MNA for tritium in groundwater.
- Groundwater monitoring for TCE, cis-1,2-DCE, chromium, and nitrate
- ICs will be implemented for the protection of human health and ecological receptors during the timeframe of this remedial alternative.

Temporary surface caps will be installed over the waste sites that are adjacent to the 300 Area facilities and utilities that will remain in operation through at least 2027 (long-term facilities). In addition, pipelines associated with long-term facilities will be interim void filled, as necessary, for groundwater protection. When the long-term facilities are no longer in use and removed, the waste sites and pipelines will be remediated as described above.

The application of phosphate to sequester residual uranium in the vadose zone and PRZ will target the waste sites having the largest mass of residual contamination based on waste disposal history, sample data, and groundwater monitoring data (Figure 17). Because of the uncertainty of applying phosphate to the contaminated areas, a phased approach will be implemented to determine whether the delivery of phosphate to the contamination is viable for uranium sequestration in the vadose zone. Previous tests performed in the vadose zone and PRZ were promising but did not positively demonstrate the viability of this technology for large area application. Phase I of this test will determine this technology's ability to reduce the amount of mobile uranium in the vadose zone sediments that could enter the groundwater. If Phase I is not successful in demonstrating the effectiveness of uranium sequestration by evaluating the pre-and post-remediation soil core samples collected in the Phase I test area, then the approach to restore the groundwater under Alternative 2 will be implemented instead. Alternative 2 is appropriate because the groundwater cleanup levels will be achieved in 38 years (a reasonable timeframe), there will be minimal impacts to the Columbia River, and the area will be maintained under ICs that restrict groundwater use.

Under Alternative 3, the timeframe for the uranium concentration in the groundwater to decrease below the DWS is estimated to take approximately 18 years (by year 2032). This timeframe is based on the two-dimensional model using the groundwater data from the monitoring wells with the highest uranium concentrations that are downgradient from the waste sites with the highest uranium source mass. This shortened timeframe to achieve the DWS for uranium in the groundwater assumes a 50 percent reduction in the amount of mobile uranium in the vadose zone as a result of sequestration.

Alternative 3: RTD, Uranium Sequestration, and Groundwater Monitoring

Overview

Waste Sites

Alternative 3 completes DOE's commitments in the 300-FF-2 interim ROD (EPA/ROD/R10-01/119) for RTD of the waste sites for protection of human health direct exposure and ecological receptors (less than 4.6 m [15 ft] bgs), uranium sequestration using phosphate for the waste sites with deep uranium contamination, MNA for tritium in groundwater, and groundwater monitoring. The actions will vary depending on the nature and extent of contamination at each waste site, and may include one or more of the following:

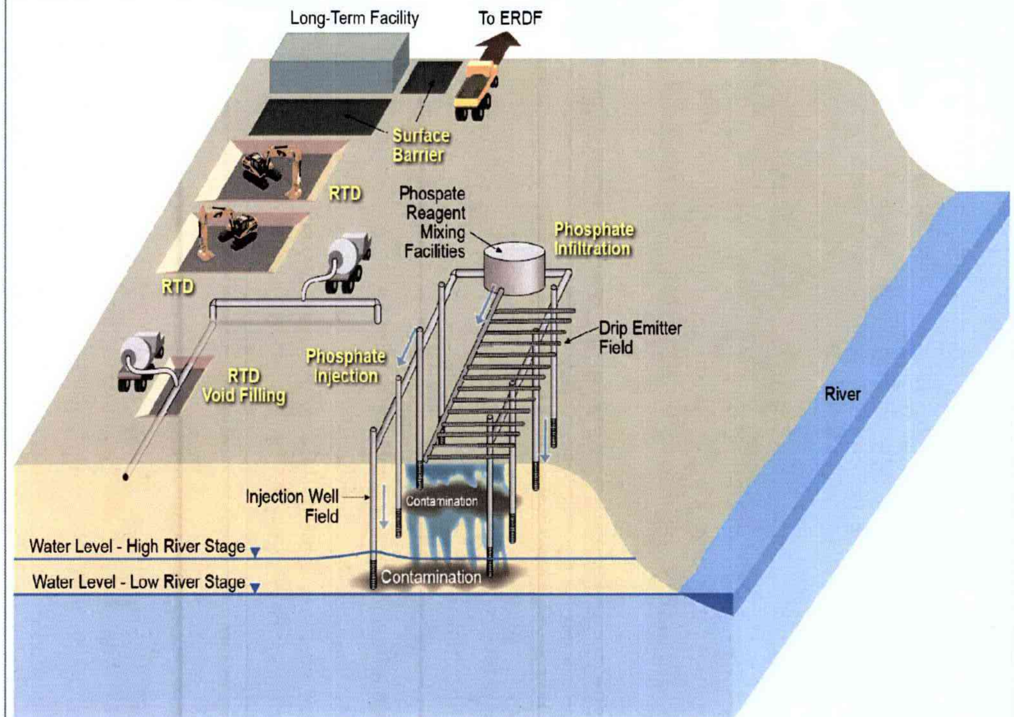
- RTD the waste sites to less than 4.6 m (15 ft) bgs for the protection of human health direct exposure and ecological receptors
- RTD the waste sites to the depth of contamination that exceeds groundwater protection criteria for non-uranium COCs.
- RTD the pipelines that are shallower than or at 4.6 m (15 ft) bgs for the protection of human health direct exposure and ecological receptors.
- RTD the pipelines that transported the majority of the uranium waste to the disposal sites (i.e., waste sites 316-1, 316-2, 316-5, 618-1, 618-2, and 618-3).
- Phased implementation of uranium sequestration using a combination of both surface and deep application techniques for the waste sites with deeper (greater than 4.6 m [15 ft] bgs) uranium contamination.
- Temporary surface barriers for waste sites adjacent to long-term facilities.
- Interim void filling of pipelines adjacent to long-term facilities.
- Institutional Controls.

Groundwater

- Monitored natural attenuation for tritium
- Groundwater monitoring
- Institutional Controls.

Note: Backfill materials (to fill the excavated waste site) will be determined in the Remedial Design/Remedial Action Work Plan. Excess materials from ERDF construction will be considered for use as waste site backfill material to minimize natural near-site damages.

Conceptual Schematic



Cost

	Waste Site Treatment	Groundwater Treatment	TOTAL
Total Present Value of Alternative (Discounted)	$ 399,666,000	$ 13,459,000	$ 413,125,000

Note: Waste site treatment costs include the costs for institutional controls and construction of an additional ERDF supercell.

CHPUBS_300_0017i

Figure 16. Alternative 3—RTD, Uranium Sequestration, and Groundwater Monitoring

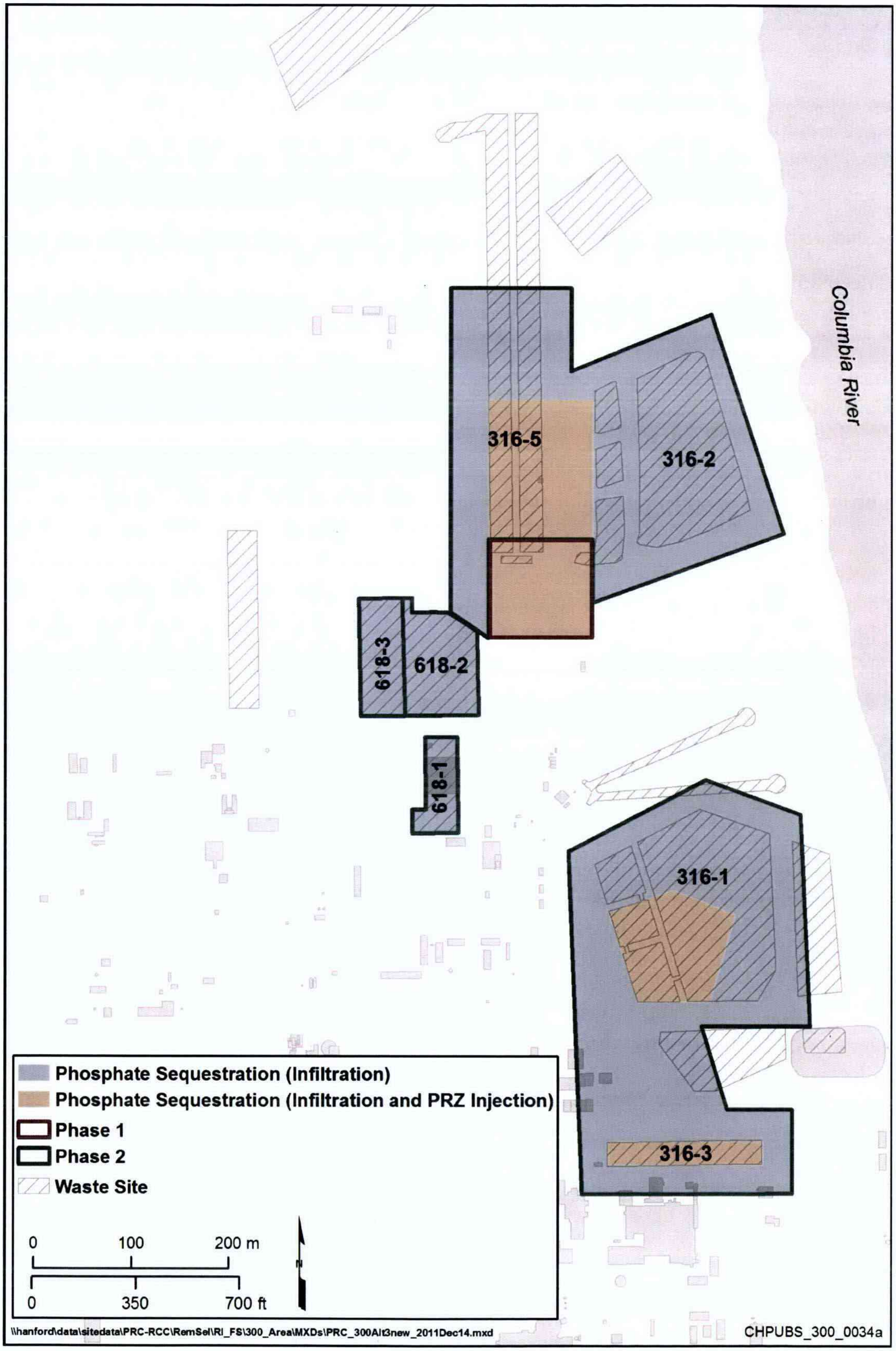


Figure 17. Areas for Uranium Sequestration (Alternative 3)

Alternative 4—RTD, Uranium Sequestration, Focused Deep RTD for Uranium and Groundwater Monitoring

Alternative 4 uses a combination of RTD (at depths of less than 4.6 m [15 ft] bgs) for waste sites, focused deep RTD for areas of higher uranium contamination, sequestration using surface application of phosphate for areas of lower uranium contamination, MNA for tritium in groundwater, and groundwater monitoring. Remedial technologies (Figure 18) include the following:

- RTD. Same as Alternative 2.
- Focused deep RTD in areas of higher uranium mass in the vadose zone.
- Uranium sequestration using surface infiltration of phosphate in areas of lower uranium mass and groundwater monitoring for uranium.
- MNA for tritium in groundwater.
- Groundwater monitoring for TCE, cis-1,2-DCE, chromium, and nitrate.
- ICs will be implemented for the protection of human health and ecological receptors during the timeframe of this remedial alternative.

Temporary surface caps will be installed over the waste sites that are adjacent to the 300 Area facilities and utilities that will remain in operation through at least 2027 (long-term facilities). In addition, pipelines associated with long-term facilities will be interim void filled, as necessary, for groundwater protection. When the long-term facilities are no longer in use and removed, the waste sites and pipelines will be remediated as described above.

This alternative includes focused deep RTD for the areas that contain the highest mass of uranium contamination in the vadose zone and PRZ (Figure 19). In addition, the application of phosphate will be performed in the areas with elevated residual uranium contamination based on waste disposal history, sample data, and the groundwater monitoring data.

Under Alternative 4, the timeframe for the uranium concentration in the groundwater to decrease below the DWS is estimated to take approximately 12 years (by year 2026). This timeframe is based on the two-dimensional model using the groundwater data from the monitoring wells with the highest uranium concentrations that are downgradient from the waste sites with the highest uranium source mass. This shortened timeframe to achieve the DWS for uranium in the groundwater assumes a 100 percent reduction in the uranium mass from the focused deep RTD areas and a 50 percent reduction in the amount of mobile uranium in the vadose zone as a result of sequestration.

Alternative 4: RTD, Uranium Sequestration, Focused Deep RTD for Uranium, and Groundwater Monitoring

Overview

Waste Sites

Alternative 4 completes DOE's commitments in the 300-FF-2 interim ROD (EPA/ROD/R10-01/119) for RTD of the waste sites for protection of human health direct exposure and ecological receptors (less than 4.6 m [15 ft] bgs), focused deep RTD for areas of higher uranium contamination, sequestration using surface application of phosphate for areas of lower uranium contamination, MNA for tritium in groundwater, and groundwater monitoring. The actions will vary depending on the nature and extent of contamination at each waste site, and may include one or more of the following:

- RTD the waste sites to less than 4.6 m (15 ft) bgs for the protection of human health direct exposure and ecological receptors.
- RTD the waste sites to the depth of contamination that exceeds groundwater protection criteria for non-uranium COCs.
- Focused deep RTD in areas of higher uranium mass in the vadose zone.
- RTD the pipelines that are shallower than or at 4.6 m (15 ft) bgs for the protection of human health direct exposure and ecological receptors.
- RTD the pipelines that transported the majority of the uranium waste to the disposal sites (i.e., waste sites 316-1, 316-2, 316-5, 618-1, 618-2, and 618-3).
- Uranium sequestration using surface infiltration of phosphate in areas of lower uranium mass.
- Temporary surface barriers for waste sites adjacent to long-term facilities.
- Interim void filling of pipelines adjacent to long-term facilities.
- Institutional Controls.

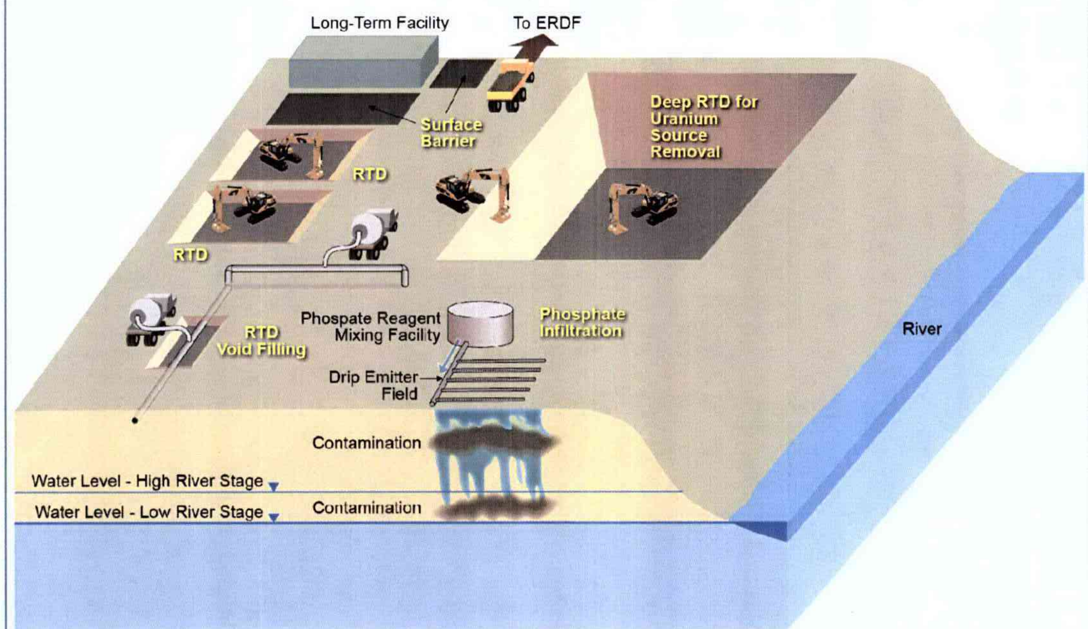
Groundwater

Alternative 4 uses monitoring for groundwater. The scope of the actions include:

- Monitored natural attenuation for tritium.
- Groundwater monitoring.
- Institutional Controls.

Note: Backfill materials (to fill the excavated waste site) will be determined in the Remedial Design/Remedial Action Work Plan. Excess materials from ERDF construction will be considered for use as waste site backfill material to minimize natural near-site damages.

Conceptual Schematic



Cost

	Waste Site Treatment	Groundwater Treatment	TOTAL
Total Present Value of Alternative (Discounted)	$544,801,000	$ 11,295,000	$ 556,096,000

Note: Waste site treatment costs include the costs for institutional controls and construction of an additional ERDF supercell.

CHPUBS_300_0018i

Figure 18. Alternative 4—RTD, Uranium Sequestration, Focused Deep RTD, and Groundwater Monitoring

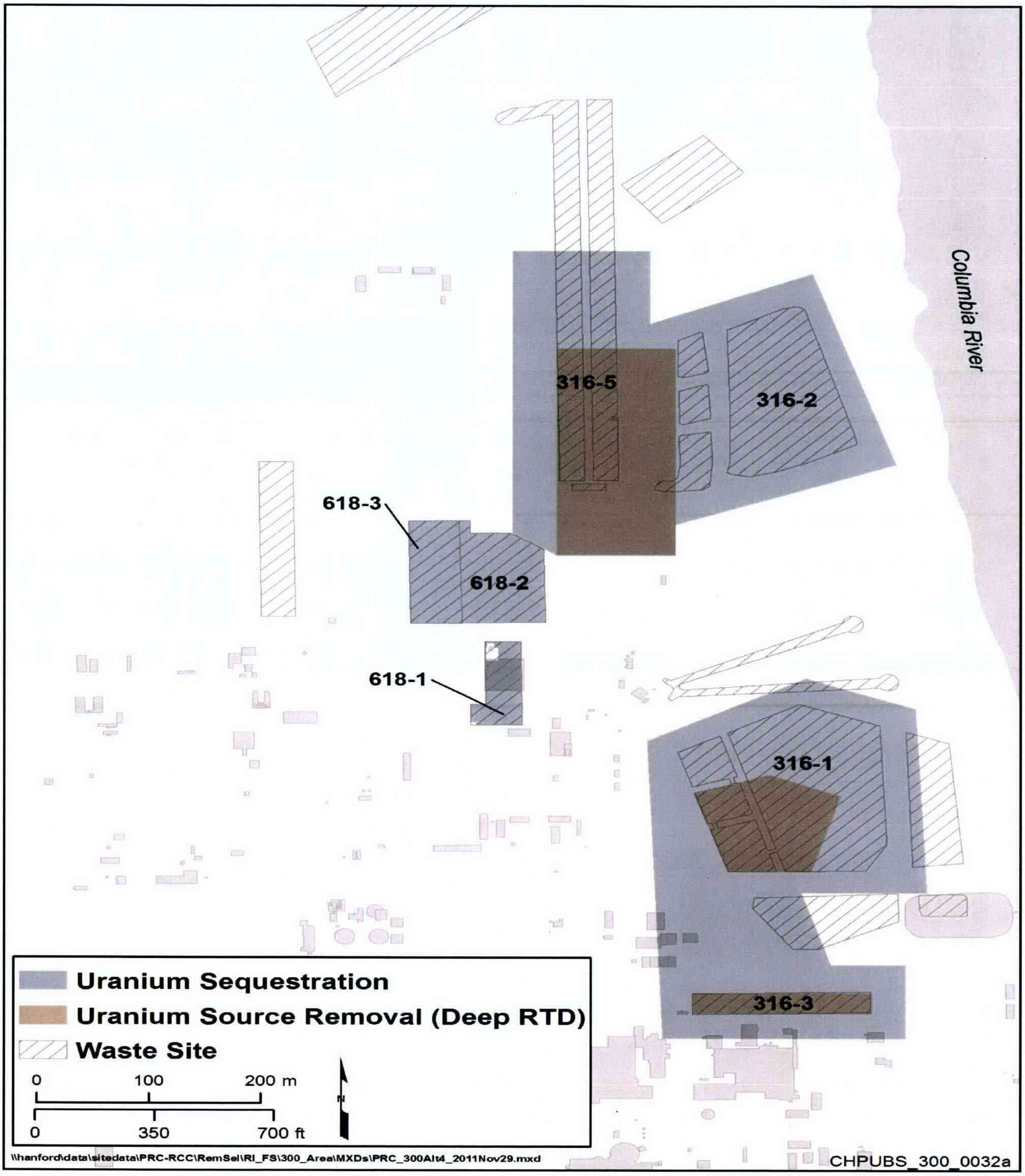


Figure 19. Areas for Uranium Sequestration and Focused Deep Uranium Removal (Alternative 4)

Alternative 5—RTD, Expanded RTD for Uranium and Groundwater Monitoring

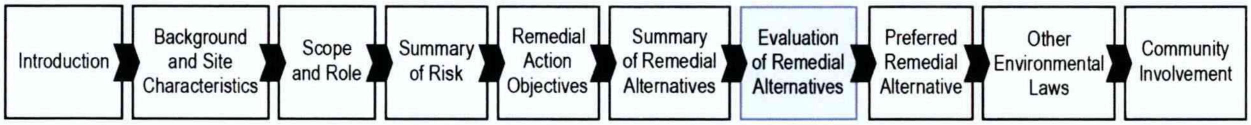
Alternative 5 uses a combination of RTD (at depths of less than 4.6 m [15 ft] bgs) for waste sites, expanded deep RTD for mass removal of uranium contamination, MNA for tritium in groundwater, and groundwater monitoring. Remedial technologies (Figure 20) include the following:

- RTD. Same as Alternative 2.
- Expanded deep RTD of the waste sites with higher uranium mass in the vadose zone (source removal).
- MNA for tritium in groundwater.
- Groundwater monitoring for uranium, TCE, cis-1,2-DCE, chromium, and nitrate
- ICs will be implemented for the protection of human health and ecological receptors during the timeframe of this remedial alternative.

Temporary surface caps will be installed over the waste sites that are adjacent to the 300 Area facilities and utilities that will remain in operation through at least 2027 (long-term facilities). In addition, pipelines associated with long-term facilities will be interim void filled, as necessary, for groundwater protection. When the long-term facilities are no longer in use and removed, the waste sites and pipelines will be remediated as described above.

This alternative includes expanded deep RTD for the waste sites that contain the highest mass of uranium contamination in the vadose zone and PRZ (Figure 21). This expanded deep RTD will not remediate the lateral spreading of uranium contamination in the PRZ.

Under Alternative 5, the timeframe for the uranium concentration in the groundwater to decrease below the DWS is estimated to take approximately 10 years (by year 2024). This timeframe is based on the two-dimensional model using the groundwater data from the monitoring wells with the highest uranium concentrations that are downgradient from the waste sites with the highest uranium source mass. This shortened timeframe to achieve the DWS for uranium assumes a 100 percent reduction in the uranium mass from the expanded deep RTD of the waste sites.



Evaluation of Remedial Alternatives

DOE and EPA evaluated each remedial alternative against CERCLA threshold and balancing criteria to assist in identifying a preferred alternative. Following this evaluation, a comparative analysis was performed to assess the overall performance of each alternative relative to the others.

Figure 22 summarizes the nine CERCLA evaluation criteria. The preferred alternative is the alternative that protects human health and the environment, complies with ARARs, and performs best relative to the balancing criteria. The ability of a preferred alternative to meet the criterion of community acceptance (a modifying criterion) can be completed only after the review and comment period for Tribal Nations and the public, which is initiated with this document.

Alternative 5: Expanded RTD and Groundwater Monitoring

Overview

Waste Sites

Alternative 5 completes DOE's commitments in the 300-FF-2 interim ROD (EPA/ROD/R10-01/119) for RTD of the waste sites for protection of human health direct exposure and ecological receptors (less than 4.6 m [15 ft] bgs), expanded deep RTD for mass removal of uranium contamination, MNA for tritium in groundwater, and groundwater monitoring. The actions will vary depending on the nature and extent of contamination at each waste site, and may include one or more of the following:

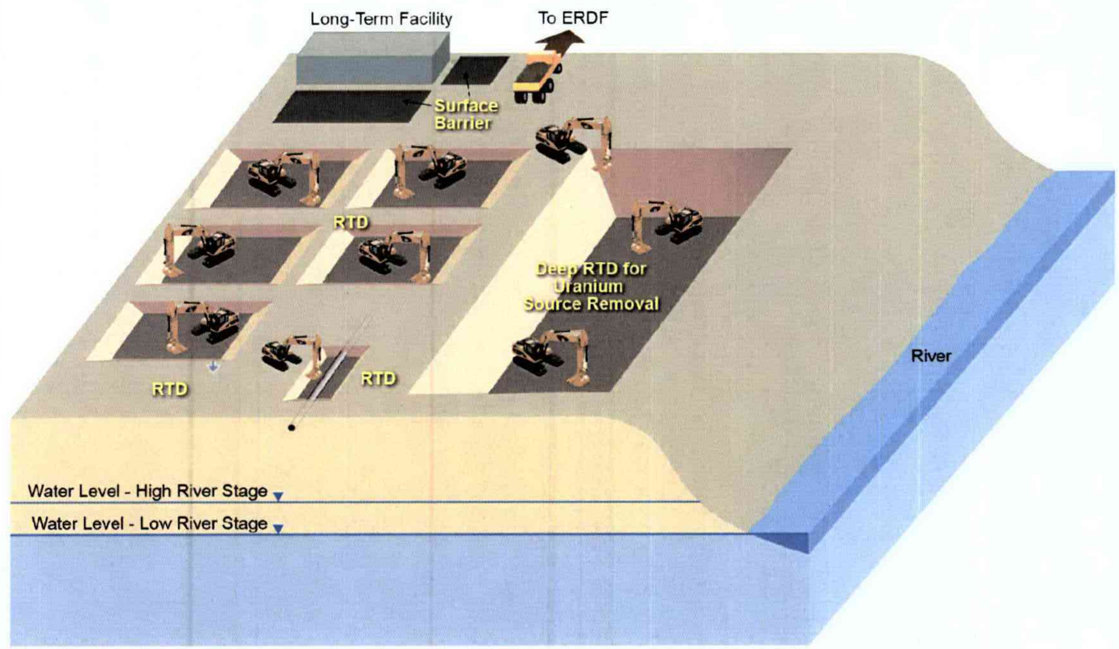
- RTD the waste sites to less than 4.6 m (15 ft) bgs for the protection of human health direct exposure and ecological receptors.
- RTD the waste sites to the depth of contamination that exceeds groundwater protection criteria for non-uranium COCs.
- Expanded deep RTD of the waste sites with higher uranium mass in the vadose zone (source removal).
- RTD the pipelines that are shallower than or at 4.6 m (15 ft) bgs for the protection of human health direct exposure and ecological receptors.
- RTD the pipelines that transported the majority of the uranium waste to the disposal sites (i.e., waste sites 316-1, 316-2, 316-3, and 316-5).
- Temporary surface barriers for waste sites adjacent to long-term facilities.
- Interim void filling of pipelines adjacent to long-term facilities.
- Institutional Controls.

Groundwater

- Monitored natural attenuation for tritium.
- Groundwater monitoring.
- Institutional Controls.

Note: Backfill materials (to fill the excavated waste site) will be determined in the Remedial Design/Remedial Action Work Plan. Excess materials from ERDF construction will be considered for use as waste site backfill material to minimize natural near-site damages.

Conceptual Schematic



Cost

	Waste Site Treatment	Groundwater Treatment	TOTAL
Total Present Value of Alternative (Discounted)	$ 1,155,200,000	$ 3,178,000	$ 1,158,378,000

Note: Waste site treatment costs include the costs for institutional controls and construction of an additional ERDF supercell.

CHPUBS_300_0019i

Figure 20. Alternative 5—Expanded RTD and Groundwater Monitoring

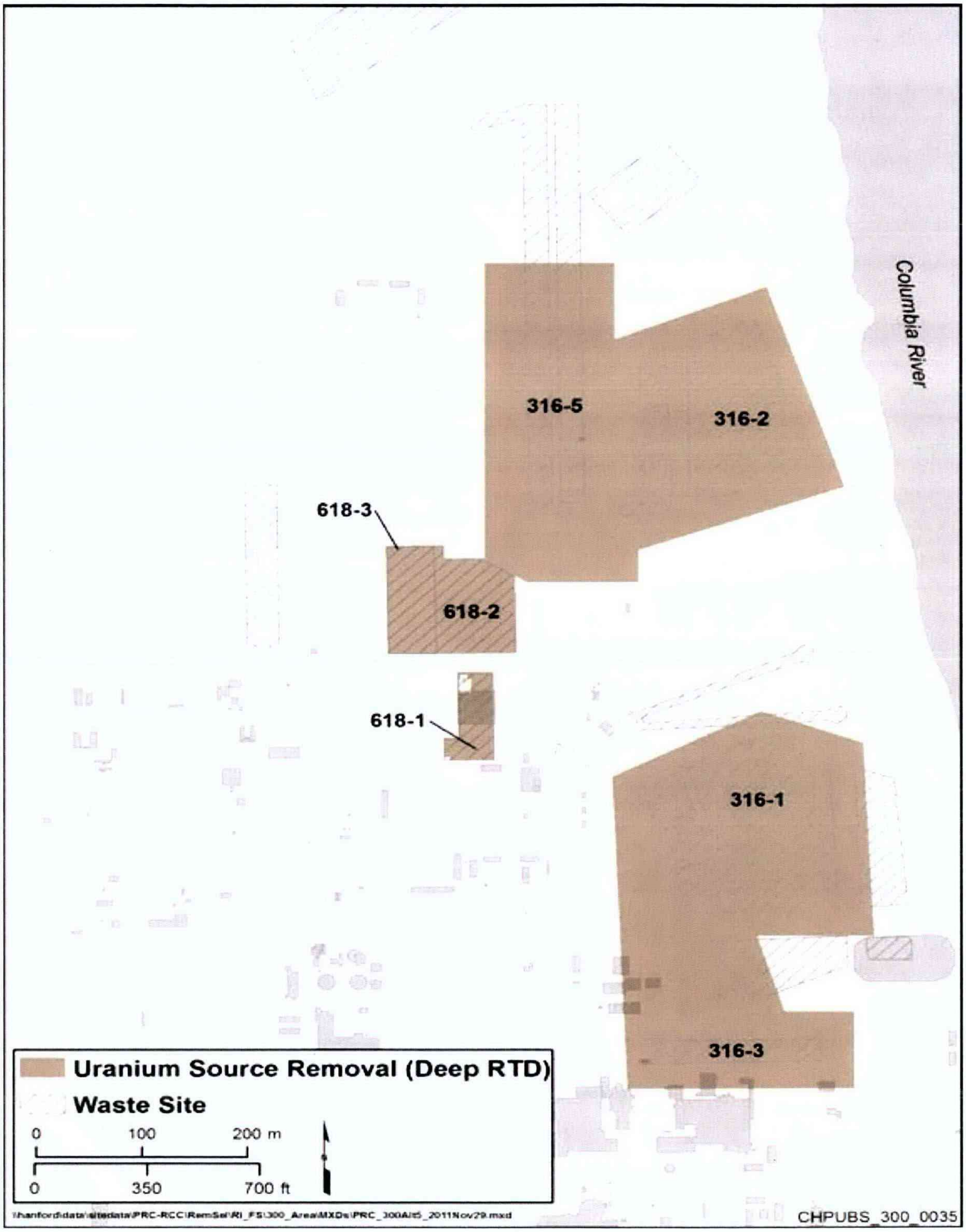


Figure 21. Expanded Deep RTD for Waste Sites Containing High Uranium in Vadose Zone and PRZ

CERCLA Evaluation Criteria

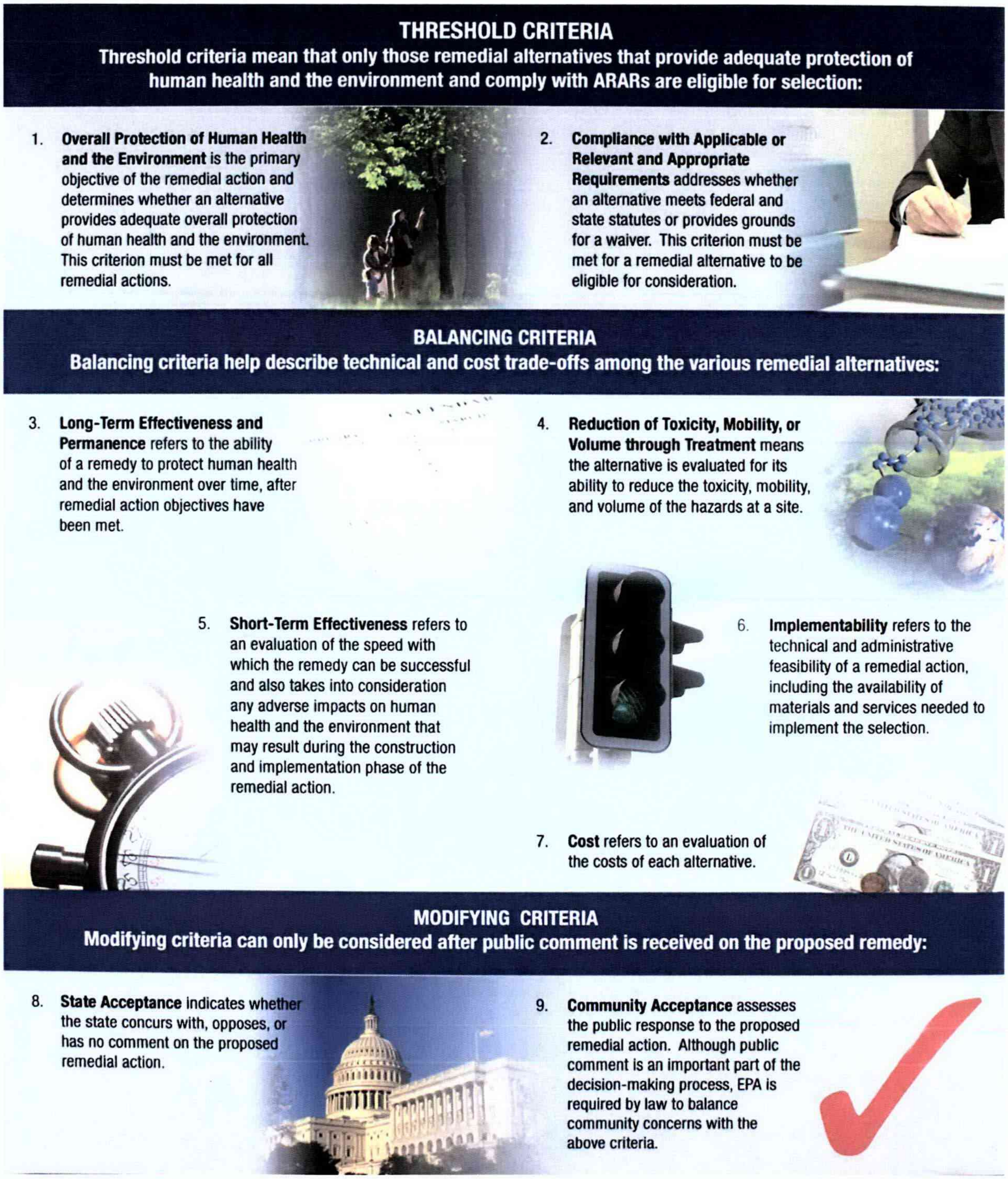


Figure 22. CERCLA Evaluation Criteria

After completion of the formal public comment period, the Tri-Party agency will consider the comments and depending on the remedial alternative selected, will issue the 300-FF-1 ROD amendment and/or 300-FF-2/FF-5 OU ROD. The comments that are received during the public comment period are part of the modifying criteria, as shown in Figure 22, Numbers 8 and 9.

The following describes the comparative evaluation of alternatives that was used to identify the preferred alternative.

Overall Protection of Human Health and the Environment

Alternatives 2 through 5 would comply with all RAOs at the completion of the remedial action and would therefore meet the threshold criterion. The proposed actions under Alternatives 2 through 5 are expected to achieve PRGs for uranium groundwater waste sources and dissolved uranium in groundwater. The certainty for achieving the uranium DWS (in groundwater) across the entire plume area is anticipated to be higher as the alternatives progress upward from Alternative 2 to Alternative 5. However, the use of uranium sequestration could be equally or potentially even more successful than RTD in that the chemical will tend to spread out in the subsurface, over a larger area, thereby contacting more contaminated soil. Alternatives 3 and 4 rely on uranium sequestration and uranium sequestration with focused RTD, respectively, to remediate uranium in the vadose zone and PRZ that is sustaining the current dissolved phase uranium groundwater plume. For non-uranium waste sites, RTD and removal of pipelines and temporary surface barriers will control significant risks to humans and groundwater.

Current unacceptable risks are controlled through implementation of ICs and employee safety procedures, as needed, until RAOs are achieved.

Compliance with ARARs

Following are the 300 Area project ARARs:

Potential Chemical-specific ARARs. The chemical-specific ARARs applicable to this remedial action are the elements of the *Washington Administrative Code* (WAC) regulations that implement the WAC 173-340, "**Model Toxics Control Act** – Cleanup." Within this branch of the WAC, there are detailed regulations with developing standards for remedial actions involving soil cleanup and groundwater cleanup standards. These standards are in the form of risk-based concentrations that help establish soil and groundwater cleanup levels for nonradioactive contaminants.

Additional ARARs from the Washington State and federal regulations include the following:

- WAC 173-340 (WAC 173-340-360 and WAC 173-340-700 through 7493) (2007)
- Nonzero **maximum contaminant level** goals and maximum contaminant levels promulgated under the *Safe Drinking Water Act of 1974* (40 CFR 141) and/or by the State of Washington (WAC 246-290)
- The AWQC developed under the Clean Water Act (Section 304) and/or promulgated by the State of Washington (WAC 173-200 and WAC 173-201)
- The Toxic Substances Control Act (implemented via 40 CFR 761)
- "National Primary and Secondary Ambient Air Quality Standards" (40 CFR 50)
- "National Emissions Standards for Hazardous Air Pollutants" (40 CFR 61)

Potential Location-specific ARARs. Location-specific ARARs that have been identified include those that protect cultural, historic, and Native American sites and artifacts under the *Native American Graves Protection and Repatriation Act of 1990, Archaeological and Historic Preservation Act of 1974, National Historic Preservation Act of 1966* , and those that protect listed endangered and threatened species or their critical habitat under the *Endangered Species Act.*

The *Migratory Bird Treaty Act of 1918* has been identified as a substantive standard for DOE compliance in executive orders and a Memorandum of Understanding between DOE and the U.S. Fish and Wildlife Service, and are a "to-be-considered" for CERCLA response actions when there is a potential to adversely affect protected bird species.

Potential Action-specific ARARs. Action-specific ARARs relate to waste management activities, solid and dangerous waste regulations, and radioactive waste management under the *Atomic Energy Act* regulations. The other major category of action-specific ARARs concerns standards for controlling air emissions to the environment. Alternative 1 does not achieve the chemical-specific ARARs for soil cleanup that are protective of human health and ecological receptors. Since Alternative 1 does not achieve chemical-specific ARARs for human health protection, it was not evaluated further. Alternatives 2 through 5 would comply with ARARs at the completion of the remedial action, and would therefore meet this threshold criterion. Remedial actions proposed under these alternatives would be designed to meet location- and action-specific ARARs. For groundwater and groundwater waste sources, proposed remedies for Alternatives 2 through 5 would achieve DWSs and ambient water quality standard ARARs. The certainty for achieving the uranium DWS across the entire plume is highest for Alternative 5, which relies primarily on expanded source removal instead of sequestration via phosphate infiltration for source control. The comparative evaluation is summarized in Table 5.

Long-Term Effectiveness and Permanence

Alternative 5 has the highest degree of certainty and is expected to perform best with respect to this criterion. However, Alternatives 2, 3, and 4 can be equally as successful in stabilizing uranium over the long term, once the material is excavated (Alternative 2) or the phosphate (Alternatives 3 and 4) reaches the contaminant. There is less certainty in the ability to deliver the chemical to the contaminant in Alternatives 3 and 4 than there is in the ability to excavate the wastes in Alternatives 5. Therefore, there is a higher degree of certainty for achieving RAOs from the expanded use of RTD to address waste site contamination.

RTD with disposal of excavated material at ERDF, as proposed to varying degrees in Alternatives 2 through 5, has been previously demonstrated to be effective and reliable at the Hanford Site through the interim actions. The timeframe for achieving RAOs is considered longest for Alternative 2 because it does not employ treatment for residual uranium present in the deep vadose zone and PRZ that is sustaining the uranium plume. Alternative 2 relies more on monitoring and ICs to manage the uranium groundwater plume.

Alternatives 3 and 4 address deep residual uranium mass more effectively than Alternative 2 by using uranium sequestration in Alternative 3 and uranium sequestration and focused RTD in Alternative 4. Uranium sequestration will require phased implementation to evaluate its long-term effectiveness and its ability to successfully target the chemical to the waste (delivery methods for infiltration and injection). By way of comparison, Alternative 5 actively removes the greatest volumes of residual uranium through expanded RTD, which has been demonstrated to be effective and reliable at the Hanford Site. Alternatives 2 through 5 also each include implementation of groundwater performance monitoring.

Table 5. Comparative Evaluation of Alternatives for 300-FF-1, 300-FF-2 and 300-FF-5

CERCLA Criteria	Remedial Alternatives				
	1	2	3	4	5
Threshold Criteria					
Protection of human health/environment	No	Yes	Yes	Yes	Yes
Compliance with ARARs	No	Yes	Yes	Yes	Yes
Balancing Criteria					
Long-term effectiveness and permanence	Not Evaluated	○	○	○	◉
Reduction of toxicity, mobility, or volume through treatment	Not Evaluated	●	◉	◉	●
Short-term effectiveness and time to achieve RAOs	Not Evaluated	●	◉	○	○
Implementability	Not Evaluated	◉	◉	◉	○
Estimated Time to Clean Up (years)		38	18	12	10
NPV Cost (million)					
- Waste Site Treatment*	$0	$296	$400	$545	$1,155
- Groundwater	$0	$5	$13	$11	$3
Total NPV Cost (million)	$0	$301	$413	$556	$1,158
Modifying Criteria					
State acceptance	To be determined				
Community acceptance	To be determined				

Notes:

Although the remedial alternatives developed for evaluation do not have specific provisions for sustainable elements, those values can be incorporated during the remedial design phase.

◉ = Expected to perform very well against the criterion with no apparent disadvantage or uncertainty

○ = Expected to perform moderately well against the criterion but with some disadvantages or uncertainty

● = Expected to perform poorly against the criterion and may have disadvantages or uncertainty

NPV = Net present value

The estimated time to cleanup is based on the 90th percentile or 95th percentile UCL concentration (whichever is longest) for the well with the highest uranium concentration to achieve the DWS.

*Does not include the cost for construction of an additional ERDF Super Cell at $27.1 million each.

Alternatives

Alternative 1-No Action

Alternative 2-RTD and Groundwater Monitoring

Alternative 3-RTD, Uranium Sequestration, and Groundwater Monitoring

Alternative 4-RTD, Uranium Sequestration, Focused Deep RTD, and Groundwater Monitoring

Alternative 5-RTD, Expanded RTD for Uranium and Groundwater Monitoring

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternatives 3 and 4 would perform best with respect to this criterion because of a higher level of active treatment. For affected waste sites, Alternatives 3 and 4 propose a wider range of technologies to achieve reduction of toxicity, mobility, or volume through sequestration (phosphate injection and infiltration) and solidification (void filling of 3.2 km [2 mi] of the 11.3 km [7 mi] of pipelines) compared to Alternative 2, which relies on RTD to 4.5 meters (15 feet) bgs and void filling, and Alternative 5, which relies on RTD and pipeline removal.

For the residual uranium in the vadose zone and PRZ that has been sustaining the uranium groundwater plume, Alternatives 3 and 4 provide relatively equivalent reduction of toxicity, mobility, or volume by employing uranium sequestration throughout the treatment area, versus groundwater monitoring in Alternative 2, and deep RTD in Alternative 5. For Alternatives 2 and 3, a phased project implementation approach would be required to evaluate delivery methods for the uranium sequestration chemical (phosphate) to maximize chemical-to-waste contact in the vadose zone and PRZ. This approach will increase the certainty in the chemical delivery method or demonstrate that there is no reliable means for chemical delivery.

Short-Term Effectiveness

Alternative 3 would have the best short-term effectiveness because of a balance in achieving RAOs within a reasonable timeframe while minimizing safety challenges to workers and offsite exposure. No detrimental impacts to the community are associated with Alternatives 2 through 5 because actions are taken onsite. Regarding Alternatives 2 through 5, potential impacts to workers could include generation of dust during RTD; however, dust suppression measures would be included in the remedial design to reduce this effect. However, through 300 Area specific experience (implementing interim actions),dust suppression measures have resulted in increased transport of uranium to groundwater and subsequently to the Columbia River. Nevertheless, it can be assumed that potential impacts to workers from implementing any actions onsite would be controlled and mitigated through effective health and safety procedures and the use of adequate personal protective equipment.

Because Alternatives 4 and 5 include RTD to depths greater than 4.6 m (15 ft), there would be an increase in safety challenges compared to implementing a less invasive approach. Because these alternatives rely on deep RTD, large excavations would also lead to greater amounts of greenhouse gas emissions from equipment and transportation of material to and from the disposal site, and to and from the backfill material mining and waste site locations. From the standpoint of achieving the uranium DWS in the aquifer in a reasonable timeframe, Alternative 2 performs poorly compared to Alternatives 3 through 5 because the uranium DWS would not be achieved until about 2052. Alternatives 3 through 5 are expected to achieve RAOs within a shorter timeframe. The certainty of achieving the uranium DWS in groundwater in a shorter timeframe is greatest for Alternative 5 because it relies solely on RTD to remove uranium contaminated waste in the vadose zone and PRZ, but it provides the greatest challenges because of the deep excavation.

Implementability

Alternatives 2 through 5 are all considered readily implementable although Alternative 5 is ranked lower because of the technical challenges associated with excavation at depths greater than 4.6 m (15 ft). Alternative 3 and to a lesser degree Alternative 4 have uncertainties associated with delivering phosphate to the waste in the vadose zone and PRZ, but this is viewed as lesser issue than the deep excavation required in Alternative 5 and would be overcome by using the phased project implementation approach.

No significant technical or administrative challenges are associated with the proposed alternatives. Actions such as RTD and surface capping have been implemented extensively at the Hanford Site. Vendors and materials for implementation of pipeline void filling and uranium sequestration activities are readily available.

Although uranium sequestration has been successfully demonstrated in the laboratory and on a limited pilot scale at the Hanford Site, a phased project implementation approach for large-scale waste site treatment is anticipated. This approach will increase the certainty in delivering the chemical to the waste in the most effective and appropriate manner.

Cost

Estimated design, construction, O&M, and decommissioning costs were developed for each alternative. O&M costs were estimated based on an alternative-specific remedial timeframe from 10 to 38 years. The total estimated net present value (NPV) costs are $301 million for Alternative 2 ($296 for waste sites and $5 million for groundwater), $413 million for Alternative 3 ($400 for waste sites and $13 million for groundwater), $556 million for Alternative 4 ($545 for waste sites and $11 million for groundwater) and $1,158 million for Alternative 5 ($1,155 for waste sites and $3 million for groundwater).

Alternatives 2 through 5 do not include costs associated with providing additional onsite waste disposal capacity. A cost of $27.1 million is associated with construction of a new ERDF Super Cell for disposal of the excavated materials from the waste sites, which has not been added to the overall cost estimates.

These cost estimates were prepared to meet the -30 to +50 percent range of accuracy recommended in CERCLA RI/FS Guidance (EPA/540/G-89/004). The cost estimates were developed in accordance with *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* (EPA 540/R-00-002) and *Cost Estimating Procedure for Response Action Decision-Making* (PRC-PRO-EP-40282). The final cost of the project will depend on final design, selected scope of work, actual labor and material costs, competitive market conditions, implementation schedule, and other factors.

The cost estimates for each alternative include allowances for capital costs, O&M costs, and periodic costs. Capital costs consist primarily of expenditures incurred to construct the remedial action. Capital costs also include all labor, equipment, and material costs. Annual O&M costs include labor, equipment, and materials, and monitoring; extraction, injection, and treatment systems O&M; and waste disposal. Periodic costs occur only once every few years (5-year reviews, equipment replacement, and well rehabilitation and replacement) or expenditures that occur only once during the entire remedial timeframe (decommissioning costs). A total NPV cost and total non-discounted cost are presented. These two cost categories facilitate comparisons between alternatives with different remedial action timeframes. The NPV cost represents the dollars that would need to be set aside today, at the defined interest rate, to ensure that funds would be available in the future as they are needed to perform the remedial action. Present worth costs were estimated using the real discount rate published by the Office of Management and Budget Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs, effective through January 2011 (Office of Management and Budget Circular No. A-94).

Preferred Alternative

Based on information currently available, DOE and EPA recommend Alternative 3—RTD, Uranium Sequestration and Groundwater Monitoring as the preferred alternative. Alternative 3 meets threshold criteria and provides the best balance of tradeoffs relative to the other alternatives for the balancing criteria. DOE expects Alternative 3 to satisfy the following statutory requirements of CERCLA §121(b):

- Protect human health and the environment
- Comply with ARARs
- Be cost-effective
- Use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable
- Satisfy the preference for treatment as a principal element

Because of the uncertainty in effectively applying the phosphate to the contaminated areas, the remedy will be implemented in two phases to determine whether the delivery of phosphate to the contamination is a viable technology for uranium sequestration. The phased approach to remedial actions is presented in *Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents* (EPA 540-R-98-031). The following is a summary of the guidance:

- Phased approach to cleanup is appropriate where complex groundwater contamination problems are present at a site (uranium geochemistry)
- Phased response actions can be implemented by one action that is implemented in more than one phase (in one decision document)

Phase I of this alternative will determine the ability of sequestration technology to reduce the amount of mobile uranium in the vadose zone sediments that could enter the groundwater. If Phase I is successful, then phosphate will be applied to the remaining areas identified for uranium sequestration. Otherwise, the approach for the groundwater will be implemented as identified under Alternative 2. Alternative 2 is appropriate because the groundwater cleanup levels will be achieved in 38 years (a reasonable timeframe), there will be minimal impacts to the Columbia River, and the area will be maintained under ICs that restrict groundwater use. The recommendation of Alternative 3 as the preferred alternative may change in response to comments received.

The following information will be included in the ROD, according to CERCLA guidance:

- The ultimate RAO is achieving the DWS for uranium in groundwater (30 μg/L).
- Uranium sequestration will be implemented in phases to determine whether it is a viable technology to reduce the uranium mass flux in the vadose zone and PRZ to the groundwater, which will allow uranium concentrations in groundwater to decrease below the DWS. Uranium sequestration will be implemented for the remainder of the waste sites if the technology is proven viable during Phase I. If not, groundwater monitoring, as identified under Alternative 2, will be implemented.

- The estimated time period for implementing Phase 1 Target Area for uranium sequestration is approximately 4 years. During the first 2 years, vadose zone and PRZ soil samples will be collected for uranium extraction tests with the goal of demonstrating at least 50 percent reduction in the amount of mobile uranium. Groundwater monitoring will be performed over a period of 4 years to confirm the effectiveness of the technology.
- Institutional controls and groundwater monitoring will be maintained until the cleanup standards are met.

The waste sites listed in Table 6 below will be addressed in accordance with the preferred alternative.

Table 6. Waste Sites to Be Remediated under the Preferred Alternative

Technology/Approach	Waste Site[a]
RTD (0 to 4.5 m [0 to15 ft] or less) - 62 waste sites	300-15, 300-175, 300-2, 300-214, 300-22, 300-255, 300-263, 300-265, 300-269, 300-277, 300-279, 300-280, 300-281, 300-282, 300-284, 300-283, 300-286, 300-287, 300-288, 300-289, 300-290, 300-291, 300-292, 300-293, 300-294, 300-296, 300-32, 300-34, 300-39 , 309-TW-1, 300-TW-2, 300-TW-3, 309-WS-1, 309-WS-2, 309-WS-3, UPR-300-5, 300-4, 300-5, 300-7, 300-9, 316-3[b], 323 TANK 1, 323 TANK 2, 323 TANK 3, 323 TANK 4, 325 WTF, 331 LSLT1, 331 LSLT2, 340 Complex, 400 PPSS, 400-37, 400-38, 600-290:2, 600-290, 600-63, 618-11, UPR-300-10, UPR-300-12, UPR-300-2, UPR-300-48, 300-295, 600-367
Deep RTD (0 to attainment of cleanup levels) - 4 waste sites	300 RLWS, 300 RRLWS, 300-11, 300-257
Uranium Sequestration - 6 waste sites	316-1, 316-2, 316-5, 618-1, 618-2, 618-3
Waste Sites to Be Remediated under Existing Interim ROD - 43 waste sites	300-121, 300-123, 300-16, 300-16:1, 300-16:2, 300-16:3, 300-218, 300-219, 300-224, 300-24, 300-249, 300-251, 300-258, 300-264, 300-268, 300-270, 300-273, 300-274, 300-276, 300-28, 300-40, 300-43, 300-46, 300-48, 300-6, 300-80, 307 Retention Basins, 313 ESSP, 333 WSTF, 3712 USSA, 600-117, 618-10, UPR-300-1, UPR-300-11, UPR-300-38, UPR-300-39, UPR-300-4, UPR-300-40, UPR-300-42, UPR-300-45, UPR-600-22, 300-25, 316-4
Consolidated Sites - 40 waste sites	300-131, 300-132, 300-133, 300-134, 300-135, 300-136, 300-137, 300-138, 300-139, 300-140, 300-141, 300-142, 300-143, 300-144, 300-145, 300-146, 300-147, 300-148, 300-149, 300-150, 300-81, 300-82, 300-83, 300-84, 300-92, 333 ESHTSSA, UPR-300-44, UPR-600-1, UPR-600-10, UPR-600-2, UPR-600-3, UPR-600-4, UPR-600-5, UPR-600-6, UPR-600-7, UPR-600-8, UPR-600-9, 333 LHWSA, UPR-300-13, UPR-300-14

Total waste sites - 155

a. Remediation of the other waste sites presented in Table 4 will be performed under the ongoing Interim Remedial Action for 300-FF-2 waste sites.

b. Waste site 316-3 is identified for RTD (0 to 4.5 m [0 to 15 ft]) is also identified for uranium sequestration for deep contamination.

Other Environmental Laws

The following regulations are applicable to the remediation of the 300 Area waste sites and groundwater.

National Environmental Policy Act Values

Under DOE's CERCLA/NEPA Policy, DOE relies on the CERCLA process for review of actions to be taken under CERCLA (i.e., no separate NEPA document or NEPA process is ordinarily required [Cook, 2002]). NEPA values are incorporated into DOE's CERCLA documentation (DOE O 451.1.1b, Chg 2, June 25, 2010); NEPA values include (but are not limited to) consideration of the cumulative, ecological, cultural, historical, and socioeconomic impacts of the proposed remedial action. NEPA values were incorporated into the analysis in the respective feasibility studies and the conclusions will be included in the CERCLA ROD.

For the remedies evaluated in this Proposed Plan, environmental impacts include temporary short-term disturbance (e.g., increased traffic, noise levels, and fugitive dust) of approximately 3.1 km^2 (1.2 mi^2, 760 ac) for a disturbed industrial area that has low to marginal habitat quality.

Long-term impacts identified for the remedies include potential aesthetic and visual impacts, should the backfilled areas not be adequately contoured and vegetated to blend with the surrounding area. DOE expects minimal or no long-term impacts to air quality, natural resources, and historical resources; transportation; socioeconomic values; or disadvantaged communities concerned with environmental justice.

RCRA Corrective Action

In accordance with the Tri-Party Agreement, past practice site cleanup (remediation) is intended to satisfy both CERCLA remedial action and RCRA corrective action requirements. In addition to fulfilling CERCLA requirements, this preferred remedial action is intended to fulfill DOE's corrective action obligations under RCRA and Washington State's *Hazardous Waste Management Act*. DOE and EPA agreed that the preferred alternative (i.e., remedy) would satisfy the requirements of both CERCLA and RCRA corrective action.

Although this is not a ***Model Toxics Control Act*** cleanup, the state of Washington has concluded that this Proposed Plan fulfills its seven standards for a final remedy:

- Protect human health and the environment.
- Comply with the cleanup standards.
- Comply with applicable state and federal laws.
- Provide for compliance monitoring.
- Use the permanent solution to the maximum extent practicable.
- Provide for a reasonable restoration timeframe.
- Consider public concerns

Community Involvement

Public input is a key element in the DOE's decision-making process. Tribal Nations and the public are encouraged to read and provide comments on any of the alternatives presented in this proposed plan, including the preferred alternative. The public comment period for this proposed plan extends from MMMM DD, 2012, through MM/DD/YYYY, 2012. Comments on the preferred alternative, other alternatives, or any element of this proposed plan will be accepted through MMMM DD, 2012. Send ccomments to Paula Call, U.S. Department of Energy, Richland Operations Office, at:

Mail: P.O. Box 550, A7-75
Richland, WA 99352

Email: paula.call@rl.doe.gov

A public meeting will be scheduled to discuss this proposed plan and the alternatives within it. The date and meeting location will be identified and the public will be notified.

To request a meeting in your area, please contact Paula Call no later than MM/DD/YYYY. After the public comment period, DOE will consider the comments regarding the proposed plan and information gathered during the comment period and then make a decision.

The preferred alternative could be modified or another alternative selected. The DOE and EPA will then prepare a CERCLA ROD. This ROD will identify the chosen alternative (i.e., remedy) and include a responsiveness summary containing agency responses to comments.

(Month) Public Comment Period

SUN	MON	TUE	WED	THU	FRI	SAT
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	28	30	31			

Hanford Public Information Repository Locations

Administrative Record and Public Information Repository:
2440 Stevens Center Place
Room 1101, Richland, WA
Phone: (509) 376-2530
Website address:
http://www2.hanford.gov/arpir/

Portland
Portland State University
Bradford Price and Millar Library
1975 SW Park Avenue
Portland, OR
Attn: Liz Paulus (503) 725-3000
Map: http://www.pdx.edu/map.html

Seattle
University of Washington
Suzallo Library
PO Box 352900
Government Publications Division
Seattle, WA 98195
Attn: David Maack (206) 543-4664
Map: http://tinyurl.com/m8ebj

Richland
U.S. Department of Energy Public Reading Room
Washington State University, Tri-Cities
Consolidated Information Center
Room 101-L
2770 University Drive, Richland, WA
Attn: Janice Parthree (509) 372-7443
Map: http://tinyurl.com/2axam2

Spokane
Gonzaga University Foley Center
East 502 Boone, Spokane, WA
Attn: Linda Pierce (509) 323-3834
Map: http://tinyurl.com/2c6bpm

Acronyms List

ARAR	applicable or relevant and appropriate requirement
bgs	below ground surface
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
COC	contaminant of concern
COPC	contaminant of potential concern
DOE	U.S. Department of Energy
DOE-RL	DOE, Richland Operations Office, also known as RL
DWS	drinking water standard
Ecology	Washington State Department of Ecology
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ERDF	Environmental Restoration Disposal Facility
FFTF	Fast Flux Test Facility
FS	feasibility study
HAB	Hanford Advisory Board
HCP EIS	Hanford Comprehensive Land-Use Plan Environmental Impact Statement
HI	hazard index
HRNM	Hanford Reach National Monument
IC	institutional control
MNA	monitored natural attenuation
NCP	National Contingency Plan (Cite first as "National Oil and Hazardous Substances Pollution Contingency Plan" [40 CFR 300].)
NPL	National Priorities List
NPV	net present value
O&M	operation and maintenance
OSE	orphan site evaluation
OU	operable unit

PRG	preliminary remediation goal
PRZ	periodically re-wetted zone
R&D	research and development
RAO	remedial action objective
RCBRA	*River Corridor Baseline Risk Assessment*
RI	remedial investigation
RI/FS	remedial investigation/feasibility study
ROD	record of decision
RTD	removal, treatment, and disposal
TCE	trichloroethene
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
UCL	upper confidence limit
VOC	volatile organic compound
WAC	*Washington Administrative Code*
WIDS	Waste Information Data System

Glossary

Administrative Record: The collection of information, including reports, public comments, and correspondence, used by the Agencies to select or modify an interim or final remedial action. A list of locations where the Administrative Record is available appears in the Community Participation section of this proposed plan.

Applicable or Relevant and Appropriate Requirements (ARARs): ARARs represent the body of federal and state laws, regulations, and standards governing environmental protection and facility siting that are either applicable or relevant and appropriate for the situation and must be met when cleaning up sites.

Baseline Risk Assessment: A study that identifies which contaminants are present in an area and assesses the risk they pose to human health and the environment if no remedial action is taken.

Characterization: Identification of the characteristics of a site through review of existing site information and sampling and analysis of environmental media and materials, to determine the nature and extent of contamination.

Code of Federal Regulations (CFR): The CFR is the codification of the general and permanent rules published in the Federal Register by the executive departments and agencies of the Federal Government. It is divided into 50 titles that represent broad areas subject to federal regulation. Each volume of the CFR is updated once each calendar year and is issued on a quarterly basis.

Community Relations Plan: The Community Relations Plan outlines the public participation processes implemented by the Tri-Parties under authority of the Tri-Party Agreement, and identifies several ways the public can participate in the Hanford Site cleanup decision-making process.

***Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA):** Also known as the Superfund Act, CERCLA is the federal law that establishes a program to identify, evaluate, and remediate sites where hazardous substances may have been released (e.g., leaked, spilled, or dumped) to the environment.

Contaminant of Concern (COC): Radionuclides and chemicals that exceed risk threshold values in the Baseline Risk Assessment.

Contaminant of Potential Concern (COPC): COPCs are hazardous substances that have been found, or are likely to be present in waste site or groundwater operable units that could cause adverse health effects to receptors. The effects are dependent upon the amount of the contaminant present, the toxicity of the contaminant, and how the contaminant is contacted. COPCs are evaluated to develop a list of contaminants that should be considered for remediation and to screen out contaminants that are unlikely to be a threat to human health and the environment.

Crib: A near-surface underground structure designed to receive liquid waste that can percolate directly into the soil.

Cumulative Risk: Combined risks from multiple contaminants and exposure pathways (e.g., inhalation and ingestion).

Debris: Building or construction material that has been demolished.

Deep Vadose Zone: The deep vadose zone is the region below the practical depth of surface remedy influence.

Environmental Restoration Disposal Facility (ERDF): The ERDF is the Hanford Site's state and federally approved disposal facility for most hazardous (radioactive and non-radioactive) waste and contaminated environmental media generated under a CERCLA response action.

Excess Lifetime Cancer Risk: An individual experiencing the reasonable maximum exposure has (for the Hanford Site) a less than 1 in 10,000 chance of developing cancer as a result of site-related exposure.

Hanford Advisory Board (HAB): The HAB is an independent, non-partisan, and broadly representative body whose mission is to provide recommendations and advice about the cleanup to the U.S. Department of Energy, the U.S. Environmental Protection Agency, and the Washington State Department of Ecology.

Hanford Comprehensive Land Use Plan: The purpose of this land use plan and its policies and procedures is to facilitate decision making about the site's uses and facilities over at least the next 50 years.

Hazard Index (HI): An indicator of potential noncarcinogenic consequences in humans (for example, damage to organs) caused by exposure to contaminants. The hazard index is a sum of contributions from multiple contaminants. The threshold value for toxic effects is a hazard index of 1 or more.

Institutional Controls (IC): Administrative measures to protect human health and the environment from exposure to contamination. Institutional controls are maintained until requirements are met for safe, unrestricted land use.

Limited Field Investigation*:* The collection of limited additional site data that are sufficient to support a decision on conducting an ecological risk assessment (ERA) or interim remedial measure (IRM).

Manhattan Project: In 1942, the U.S. government launched an effort to develop the first atomic bombs, which came to be known as the "Manhattan Project." Conducted in secret, the Manhattan Project would eventually employ more than 130,000 people at research and production sites located across the U.S. These sites included the Los Alamos research site in New Mexico and production facilities at Hanford in Washington State and Oak Ridge, Tennessee.

Maximum Contaminant Level (MCL): The maximum concentration of a contaminant allowed in water delivered to public drinking water systems.

Model Toxics Control Act**:** The Model Toxics Control Act (RCW 70.105D) provides state standards that set cleanup regulations (WAC 173-340) for protection of human health and the environment. The standards and requirements established to implement the Act are published in Chapter 173-340 of the WAC.

Monitored Natural Attenuation (MNA): A decrease in the concentration of a contaminant because of natural processes such as radioactive decay, oxidation/reduction, biodegradation, and/or sorption. Monitoring is conducted to determine if additional cleanup activities are warranted.

National Environmental Policy Act of 1969**:** The National Environmental Policy Act (NEPA) is a U.S. environmental law that requires federal agencies to integrate environmental values into their decision-making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions.

National Oil and Hazardous Substances Pollution Contingency Plan (NCP): The first National Contingency Plan (NCP) was developed and published in 1968 to cope with potential spills in U.S. waters. Following the passage of Superfund legislation in 1980, the NCP was expanded to include the regulations covering releases at hazardous substance sites. In 1994, the NCP was revised to mirror the oil spill provisions of the *Oil Pollution Act of 1990*.

National Priorities List (NPL): A formal list of release/priority hazardous waste sites in the U.S., which are eligible for investigation and possible remediation (cleanup) under Superfund, also known as CERCLA (40 CFR 300, Appendix B). Sites are included on the list because of their potential risk to human health and the environment.

Nature and Extent of Contamination: Characteristics of contamination at a site including concentrations and degree of migration in the environment where contamination has moved.

Net Present Value: The net present value represents the dollars that would need to be set aside today, at the defined interest rate, to ensure that funds would be available in the future as they are needed to perform the remedial alternative.

No Action: Sites that can be released for unrestricted land use because they pose no unacceptable risk. A No Action alternative is required to be considered under CERCLA. It can include monitoring.

Operable Unit: A group of land disposal sites placed together for the purpose of performing a remedial investigation and feasibility study and subsequent cleanup actions. The primary criteria for placing a site into an operable unit include geographic proximity, similarity of waste characteristics and site type, and the possibility for economies of scale.

Operation and Maintenance (O&M): Long-term remedial action operations, maintenance, and institutional controls.

Picocurie (pCi): A unit of radioactivity equivalent to 1.0 x 10E-12 curies or 0.037 disintegrations per second.

Plug-in Approach: Under this approach, a standard remedy is selected that applies to waste sites with similar attributes, rather than to a specific waste site.

Preferred Alternative: The remedial action selected after an evaluation of all alternatives that is protective of human health and the environment.

Preliminary Remediation Goal (PRG): A PRG is a risk-based value for specific contaminant and exposure pathways that establish contaminant concentrations that are protective of human health and the environment. PRGs are established during the feasibility study based on scientific information and are used as a target for remedial cleanup goals. Alternatives are developed and evaluated based on how well they meet the goals. Final remediation goals are set in the record of decision and are used during the remediation of a site.

Proposed Plan: Proposed plans are provided to the public by the responsible parties to present the preferred alternative and other alternatives analyzed for remedial actions at specific waste sites. Proposed plans are based on and summarize the remedial investigation/feasibility studies for specific sites.

Radionuclide: An unstable atom that emits excess energy (decays) in the form of radioactivity (rays or particles). Depending on the type and amount of decay, prolonged exposure may be harmful.

Record of Decision (ROD): A ROD is a legally binding public document that identifies the remedy that will be used at a group of sites and why it has been selected. The **Responsiveness Summary** in the ROD contains the public comments received on the proposed actions and the Agencies' responses.

Remedial Action Objective (RAO): An RAO is a medium-specific (e.g., soil) or OU-specific goal for protecting human health and the environment that specifies the contaminant(s) of concern, the exposure route(s) and receptor(s).

Remedial Alternative: General or specific actions that are evaluated to determine the extent to which they can eliminate or minimize threats posed by contaminants to human health and the environment, comply with environmental laws and regulations, and meet other selection criteria.

Remedial Investigation/Feasibility Study (RI/FS): The RI/FS process as outlined in this proposed plan represents the methodology that the Superfund program has established for characterizing the nature and extent of risks posed by uncontrolled hazardous waste sites and for evaluating potential remedial action options.

Remedial Action: Actions performed to reduce potential harm to human health and the environment from radioactive or hazardous substances.

Remediation: Actions performed to reduce potential harm to human health and the environment from radioactive or hazardous substances.

Removal, Treatment, and Disposal (RTD): A cleanup method where soil and debris are excavated in such a way that no contaminants above the approved RAGs or concentration for direct exposure and groundwater protection remain at the Site. Excavated material is treated (as necessary) and sent to an onsite or offsite engineered facility for disposal.

Transuranic: Waste material containing any alpha-emitting radionuclide with an atomic number greater than 92, a half-life longer than 20 years, and a concentration greater than 100 nCi/g at the time of assay.

Tri-Party Agreement: The U.S. Department of Energy (DOE), U.S. Environmental Protection Agency (EPA), and Washington State Department of Ecology (Ecology) signed the *Hanford Federal Facility Agreement and Consent Order*, or Tri-Party Agreement, on May 15, 1989. The Tri-Party Agreement, as updated and modified through formal change control, is a comprehensive cleanup and compliance agreement for achieving compliance with the CERCLA remedial action provisions and with the Resource Conservation and Recovery Act (RCRA) treatment, storage, and disposal unit regulations and corrective action provisions. More specifically, the Tri-Party Agreement (1) defines and prioritizes CERCLA and RCRA cleanup commitments, (2) establishes responsibilities, (3) provides a basis for budgeting, and (4) reflects a converted goal of achieving full regulatory compliance and remediation, with enforceable milestones.

Unplanned Release (UPR): The dispersal of chemical and radioactive contaminants through material transfers, airborne disseminations, or plant or animal fecal material.

Vadose Zone: The vadose zone is the unsaturated soil column between the land surface and the groundwater.

Waste Sites: Waste sites are contaminated or potentially contaminated sites from past operations. Contamination may be contained in environmental media (e.g., soil, groundwater) or in manmade structures or solid waste (e.g., debris).

References/Bibliography

40 CFR 50, "National Primary and Secondary Ambient Air Quality Standards," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title40-vol2/xml/CFR-2010-title40-vol2-part50.xml.

40 CFR 61, "National Emission Standards for Hazardous Air Pollutants," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title40-vol8/xml/CFR-2010-title40-vol8-part61.xml.

40 CFR 141, "National Primary Drinking Water Regulations," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title40-vol22/xml/CFR-2010-title40-vol22-part141.xml.

40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan," Appendix B, "National Priorities List," *Code of Federal Regulations*. Available at: http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&sid=18f0b1cc10e4f8256112c20bf63afef8&rgn=div9&view=text&node=40:27.0.1.1.1.12.1.2.2&idno=40.

40 CFR 300.430, "National Oil and Hazardous Substances Pollution Contingency Plan," "Remedial Investigation/Feasibility Study and Selection of Remedy," *Code of Federal Regulations*. Available at: http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&sid=203c197ca1d43436f7aedd98dc8b2b30&rgn=div8&view=text&node=40:27.0.1.1.1.5.1.7&idno=40.

40 CFR 761, "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title40-vol30/xml/CFR-2010-title40-vol30-part761.xml.

50 USC 2582, "Requirement to Develop Future Use Plans for Environmental Management Programs," *United States Code*. Available at: http://law.onecle.com/uscode/50/2582.html.

65 FR 37253, "Establishment of the Hanford Reach National Monument," *Federal Register*, Vol. 65, No. 114, pp. 37253-37257, June 13, 2000. Available at: http://www.gpo.gov/fdsys/pkg/FR-2000-06-13/pdf/00-15111.pdf.

American Antiquities Act of 1906, 16 USC 431-433. Available at: http://www.nps.gov/history/local-law/anti1906.htm.

Archeological and Historic Preservation Act of 1974, Pub. L. 93-291, as amended, 16 USC 469a-1 – 469a-2(d). Available at: http://www.nps.gov/history/local-law/fhpl_archhistpres.pdf.

Clean Water Act of 1977, 33 USC 1251, et seq. Available at: http://epw.senate.gov/water.pdf.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601, et seq. Available at: http://uscode.house.gov/download/pls/42C103.txt.

Cook, Beverly, 2002, "DOE Policies on Application of NEPA to CERCLA and RCRA Cleanup Actions" (memorandum to Secretarial Officers and Heads of Field Organizations), Environment, Safety and Health, U.S. Department of Energy, Washington, D.C., July 11. Available at: http://www.gc.energy.gov/NEPA/documents/CERCLA-RCRA-NEPAguidance.pdf.

DOE, 1991, *618-9 Burial Ground Expedited Response Action*, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/index.cfm?content=findpage&AKey=E0012793.

DOE and USFWS, 2006, *Memorandum of Understanding Between the United States Department of Energy and the United States Fish and Wildlife Service Regarding Implementation of Executive Order 13186, "Responsibilities of Federal Agencies to Protect Migratory Birds,"* U.S. Department of Energy and U.S. Fish and Wildlife Service, Washington, D.C., August 3. Available at: http://www.fws.gov/migratorybirds/Partnerships/DOEMOUfinalsignature.pdf.

DOE O 451.1B Chg 1, 2001, *National Environmental Policy Act Compliance Program*, U.S. Department of Energy, Washington, D.C. Available at: https://www.directives.doe.gov/directives/current-directives/451.1-BOrder-bc1/view.

DOE/RL-92-24, 2001, *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes*, Rev. 4, 2 vols., U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at:
http://www2.hanford.gov/arpir/?content=findpage&AKey=0096062.
http://www2.hanford.gov/arpir/?content=findpage&AKey=0096061.

DOE/RL-92-43, 1993, *Phase I Remedial Investigation Report for the 300-FF-1 Operable Unit*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at:
http://www5.hanford.gov/arpir/?content=findpage&AKey=D196106258.
http://www5.hanford.gov/arpir/?content=findpage&AKey=D196106270.

DOE/RL-93-21, 1994, *Phase I Remedial Investigation Report for the 300-FF-5 Operable Unit*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www2.hanford.gov/arpir/?content=findpage&AKey=D196095808. http://www2.hanford.gov/arpir/?content=findpage&AKey=D196096243. http://www2.hanford.gov/arpir/?content=findpage&AKey=D196096266.

DOE/RL-94-85, 1995, *Remedial Investigation/Feasibility Study Report for the 300-FF-5 Operable Unit*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www2.hanford.gov/arpir/?content=findpage&AKey=D196019032.

DOE/RL-96-12, 1996, *Hanford Site Background: Part 2, Soil Background for Radionuclides*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www2.hanford.gov/arpir/?content=findpage&AKey=D1808987.

DOE/RL-96-17, 2009, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, Rev. 6, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0095436.

DOE/RL-96-42, 2001, *Limited Field Investigation Report for the 300-FF-2 Operable Unit*, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-99-40, 2000, *Focused Feasibility Study for the 300-FF-2 Operable Unit*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D8352321.

DOE/RL-2001-47, 2004, *Remedial Design Report/Remedial Action Work Plan for the 300 Area*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D5651492.

DOE/RL-2007-21, 2010, *River Corridor Baseline Risk Assessment, Volume II: Human Health Risk Assessment*, Parts 1 and 2, Draft C, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0084096. http://www5.hanford.gov/arpir/?content=findpage&AKey=0084095.

DOE/RL-2008-11, 2008, *Remedial Investigation Work Plan for Hanford Site Releases to the Columbia River*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0810240394.

DOE/RL-2008-36, 2008, *Remediation Strategy for Uranium in Groundwater at the Hanford Site 300 Area, 300-FF-5 Operable Unit*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www2.hanford.gov/arpir/?content=findpage&AKey=0810240397.

DOE/RL-2009-10, 2010, *Hanford Site Cleanup Completion Framework*, Rev. 0, U.S. Department of Energy, Richland, Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=1008190506.

DOE/RL-2009-16, 2009, *300-FF-5 Groundwater Operable Unit Infiltration Test Sampling and Analysis Plan*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2009-30, 2010, *300 Area Decision Unit Remedial Investigation/Feasibility Study Work Plan for the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www2.hanford.gov/arpir/?content=findpage&AKey=0084376.

DOE/RL-2010-95, 2011, *Remedial Investigation/ Feasibility Study for the 100-DR-1, 100-DR-2, 100-HR-1, 100-HR-2, and 100-HR-3 Operable Units*, U.S. Department of Energy, Richland Operation Office, Richland, Washington.

DOE/RL-2010-99, 2011, *Remedial Investigation/Feasibility Study Report for the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units*, Draft A, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

ECF-HANFORD-11-0038, 2011, *Soil Background Data for Interim Use at the Hanford Site*, CH2M HILL Plateau Remediation Company, Richland, Washington.

Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.hanford.gov/?page=90&parent=91.

Ecology, EPA, and DOE, 2002, *Hanford Site Tri-Party Agreement Public Involvement Community Relations Plan*, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.hanford.gov/files.cfm/crp.pdf.

Endangered Species Act of 1973, Pub. L. 93-205, as amended, 7 USC 136, 16 USC 1531, et seq. Available at: http://www.nmfs.noaa.gov/pr/pdfs/laws/esa.pdf.

EPA, 1991, *A Guide to Principal Threat and Low Level Wastes*, Quick Reference Fact Sheet, OSWER Publication 9380.3-06FS, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C. Available at: http://www.epa.gov/superfund/health/conmedia/gwdocs/pdfs/threat.pdf.

EPA, 1991, *Action Memorandum: 316-5 Process Trenches, U.S. Department of Energy (DOE) Hanford Site, Richland, Washington*, U.S. Environmental Protection Agency, Richland, Washington. Available at: http://www5.hanford.gov/arpir/index.cfm?content=findpage&AKey=D196068241.

EPA/540/G-88/003, 1988, *Guidance on Remedial Actions for Contaminated Ground Water at Superfund Sites*, Interim Final, OSWER Directive 9283.1-2, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C. Available at: http://www.epa.gov/superfund/policy/remedy/pdfs/540g-88003-s.pdf.

EPA/540/G-89/004, 1988, *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*, Interim Final, OSWER Directive 9355.3-01, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C. Available at: http://epa.gov/superfund/policy/remedy/pdfs/540g-89004-s.pdf.

EPA 540-R-00-002, 2000, *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study*, OSWER 9355.0-75, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C. Available at: http://epa.gov/superfund/policy/remedy/sfremedy/rifs/costest.htm.

EPA 540-R-98-031, 1999, *A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents*, OSWER 9200.1-23P, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C. Available at: http://www.epa.gov/superfund/policy/remedy/rods/index.htm.

EPA/ROD/R10-01/119, 2001, *EPA Superfund Record of Decision: Hanford 300-Area, Benton County, Washington*, U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.epa.gov/superfund/sites/rods/fulltext/r1001119.pdf.

EPA/ROD/R10-96/143, 1996, *Record of Decision for the 300-FF-1 and 300-FF-5 Operable Units, Hanford Site, Benton County, Washington*, U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Olympia, *National Environmental Policy Act of 1969*, 42 USC 4321, et seq. Available at: http://www.fhwa.dot.gov/environment/nepatxt.htm.

Migratory Bird Treaty Act of 1918, 16 USC 703-712, Ch. 128, July 13, 1918, 40 Stat. 755, as amended. Available at: http://www.animallaw.info/statutes/stusmba.htm.

National Environmental Policy Act of 1969, 42 USC 4321, et seq. Available at: http://www.fhwa.dot.gov/environment/nepatxt.htm.

National Historic Preservation Act of 1966, Pub. L. 89-665, as amended, 16 USC 470, et seq. Available at: http://www.achp.gov/docs/nhpa%202008-final.pdf.

Native American Graves Protection and Repatriation Act of 1990, Pub. L. 101-601, as amended, 25 USC 3001, et seq. Available at: http://www.nps.gov/history/local-law/FHPL_NAGPRA.pdf.

OMB Circular No. A-94, 2009, "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs" (memorandum for Heads of Executive Departments and Establishments), as revised, Office of Management and Budget, Washington, D.C. Available at: http://www.whitehouse.gov/sites/default/files/omb/assets/a94/a094.pdf.

PNL-8971, 1993, *Three-Dimensional Conceptual Model for the Hanford Site Unconfined Aquifer System, FY 1993 Status Report*, Pacific Northwest Laboratory, Richland, Washington. Available at: http://www.osti.gov/energycitations/servlets/purl/10116050-9Pd7wr/native/10116050.pdf.

PNNL-12261, 2000, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-East Area and Vicinity, Hanford Site, Washington*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0906180659.

PNNL-15127, 2005, *Contaminants of Potential Concern in the 300-FF-5 Operable Unit: Expanded Annual Groundwater Report for Fiscal Year 2004*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D7748359.

PNNL-15293, 2005, *Evaluation of the Fate and Transport of Tritium Contaminated Groundwater from the 618-11 Burial Ground*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-15293.pdf.

PNNL-16008, *Site Characterization Plan: Uranium Stabilization through Polyphosphate Injection*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-16008.pdf.

PNNL-16435, 2007, *Limited Field Investigation Report for Uranium Contamination in the 300-FF-5 Operable Unit at the 300 Area, Hanford Site, Washington*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=DA06586011.

PNNL-16454, 2007, *Current Conditions Risk Assessment for the 300-FF-5 Groundwater Operable Unit*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www2.hanford.gov/arpir/?content=findpage&AKey=DA06587277.

PNNL-16571, 2007, *Treatability Test Plan for 300 Area Uranium Stabilization through Polyphosphate Injection*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-16571.pdf.

PNNL-16761, 2007, *Evaluation and Screening of Remedial Technologies for Uranium at the 300-FF-5 Operable Unit, Hanford Site, Washington*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-16761.pdf.

PNNL-16805, 2007, *Investigation of the Hyporheic Zone at the 300 Area, Hanford Site*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=DA06586145.

PNNL-17031, 2007, *A Site-Wide Perspective on Uranium Geochemistry at the Hanford Site*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0911240713.

PNNL-17034, 2008, *Uranium Contamination in the Subsurface Beneath the 300 Area, Hanford Site, Washington*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-17034.pdf.

PNNL-17480, 2008, *Challenges Associated with Apatite Remediation of Uranium in the 300 Area Aquifer*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-17480.pdf.

PNNL-17793, 2008, *Uranium Contamination in the 300 Area: Emergent Data and Their Impact on the Source Term Conceptual Model*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-17793.pdf.

PNNL-18529, 2009, *300 Area Uranium Stabilization Through Polyphosphate Injection: Final Report*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-18529.pdf.

PNNL-19461, 2010, *Evaluation of Reagent Emplacement Techniques for Phosphate-based Treatment of the Uranium Contamination Source in the 300 Area: White Paper*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-19461.pdf.

RCW 43.21C, "State Environmental Policy," *Revised Code of Washington*, Olympia, Washington. Available at: http://apps.leg.wa.gov/RCW/default.aspx?cite=43.21C.

RCW 70.105, "Hazardous Waste Management," *Revised Code of Washington*, Olympia, Washington. Available at: http://apps.leg.wa.gov/RCW/default.aspx?cite=70.105.

Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq. Available at: http://www.epa.gov/epawaste/inforesources/online/index.htm.

Safe Drinking Water Act of 1974, Public Law 93-523, as amended, 42 USC 300f, et seq. Available at: http://uscode.house.gov/download/pls/42C6A.txt.

USFWS, 2008, *Hanford Reach National Monument: Final Comprehensive Conservation Plan and Environmental Impact Statement Adams, Benton, Grant and Franklin Counties, Washington*, U.S. Fish and Wildlife Service, Burbank, Washington. Available at: http://astro.berkeley.edu/~kalas/ethics/documents/environment/final-ccp-no-maps.pdf.

WAC 173-200, "Water Quality Standards for Groundwaters of the State of Washington," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-200.

WAC 173-201A, "Water Quality Standards for Surface Waters of the State of Washington," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-201A.

WAC 173-340, "Model Toxics Control Act—Cleanup," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-340.

340-360, "Selection of Cleanup Actions."

340-708, "Human Health Risk Assessment Procedures."

340-700, "Overview of Cleanup Standards."

340-720, "Groundwater Cleanup Standards."

340-740, "Unrestricted Land Use Soil Cleanup Standards."

340-7493, "Site-Specific Terrestrial Ecological Evaluation Procedures."

340-900, "Tables."

WAC 246-290, "Group A Public Water Supplies," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=246-290.

WHC-MR-0391, 1992, *Field Trip Guide to the Hanford Site*, Westinghouse Hanford Company, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D196136627.

WHC-SD-EN-TI-052, 1992, *Phase I Hydrogeologic Summary of the 300-FF-5 Operable Unit, 300 Area*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. Available at: http://www5.hanford.gov/arpir/index.cfm?content=findpage&AKey=D196121502.

WHC-SD-EN-TI-279, 1994, *Summary of Remedial Investigations at the 307 Retention Basins and 307 Trenches (316-3), 300-FF-2 Operable Unit*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. Available at: http://www5.hanford.gov/arpir/index.cfm?content=findpage&AKey=E0037657.

Land Use References

64 FR 61615, "Record of Decision: Hanford Comprehensive Land-Use Plan Environmental Impact Statement (HCP EIS)," *Federal Register,* Vol. 64, No. 218, pp. 61615-61625, November 12, 1999. Available at: http://www.gpo.gov/fdsys/pkg/FR-1999-11-12/pdf/99-29325.pdf.

73 FR 55824, "Amended Record of Decision for the Hanford Comprehensive Land-Use Plan Environmental Impact Statement," *Federal Register*, Vol. 73, No. 18, pp. 55824-55826, September 26, 2008. Available at: http://www.gpo.gov/fdsys/pkg/FR-2008-09-26/pdf/E8-22676.pdf.

DOE/EIS-0222-F, 1999, *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement*, U.S. Department of Energy, Washington, D.C. Available at:
http://www5.hanford.gov/arpir/?content=findpage&AKey=D199158842.
http://www5.hanford.gov/arpir/?content=findpage&AKey=D199158843.
http://www5.hanford.gov/arpir/?content=findpage&AKey=D199158844.
http://www5.hanford.gov/arpir/?content=findpage&AKey=D199158845.
http://www5.hanford.gov/arpir/?content=findpage&AKey=D199158846.
http://www5.hanford.gov/arpir/?content=findpage&AKey=D199158847.

DOE/EIS-0222-SA-01, 2008, *Supplement Analysis: Hanford Comprehensive Land-Use Plan Environmental Impact Statement*, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www.hanford.gov/files.cfm/SAwith_signed-R1.pdf.

Distribution

	MS	Quantity
U.S. Department of Energy, Richland Operations Office		
K.M. Thompson	A6-36	1
DOE Public Reading Room	H2-53	1
CH2M HILL Plateau Remediation Company (Electronic Distribution)		
M.J. Cherry		
D.E. Dooley		
M.H. Doornbos		
B.H. Ford		
D.L. Foss		
T.J. Mooney		
R.S. Popielarczyk		
Publications Technical Library		
Administrative Record	H6-08	1
Document Clearance	H6-08	1

This page intentionally left blank.