1226089

DOE/RL-2012-41
Revision 0

[0085353]

Proposed Plan for Remediation of the 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and 100-IU-6 Operable Units

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

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

CH2MHILL
Plateau Remediation Company
P.O. Box 1600
Richland, Washington 99352

RECEIVED
JUN 09 2014
EDMC

Approved for Public Release;
Further Dissemination Unlimited

Pgs-55

DOE/RL-2012-41
Revision 0

Proposed Plan for Remediation of the 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and 100-IU-6 Operable Units

Project No: 100-F/IU Document Type: PLAN Program/Project: SGRP

J. J. Virgin
CH2M HILL Plateau Remediation Company

Date Published
May 2014

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

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

CH2MHILL
Plateau Remediation Company
P.O. Box 1600
Richland, Washington 99352

APPROVED
By Lee Ann Snyder at 6:13 am, May 22, 2014

Release Approval Date

Approved for Public Release;
Further Dissemination Unlimited

TRADEMARK DISCLAIMER

Reference herein to any specific commercial product, process, or service by tradename, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors.

This report has been reproduced from the best available copy.

Printed in the United States of America

River Corridor Remediation at the Department of Energy Hanford Site — EPA Region 10

Proposed Plan for Remediation of the 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and 100-IU-6 Operable Units

DOE/RL-2012-41, Rev. 0
June 2014

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

Public Comment Period
June 9 to August 11, 2014

How You Can Participate:

Read this Proposed Plan and review documents in the Administrative Record at. http://pdw.hanford.gov/arpir/.

Comment on this Proposed Plan by mail or e-mail on or before August 11, 2014.

Kim Ballinger, U.S. Department of Energy, Richland Operations Office
P.O. Box 550, A7-75
Richland, WA 99352
E-mail: 100FIUPP@rl.gov

See page 37 for more information about public involvement and contact information.

Figure 1. 100-F/IU Location within the Hanford Site[1]

Inside this Plan

Introduction....1
Site Background....4
Site Characteristics....8
Scope and Role....16
Summary of Site Risks....18
Remedial Action Objectives....23
Summary of Remedial Alternatives....24
Evaluation of Remedial Alternatives 29
Preferred Remedial Alternative....33
Community Participation....37
Proposed Cleanup Levels for Preferred Alternatives....38
Acronym List....41
Glossary....43
References/Bibliography....47

Introduction

The U.S. Department of Energy (DOE) and U.S. Environmental Protection Agency (EPA) invite the public and Tribal Nations to comment on this ***Proposed Plan***[2] for cleanup of contaminated soil in four source ***operable units (OUs)*** (100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6) and contaminated ***groundwater*** in one OU (100-FR-3) in the 100 Area of the Hanford Site located near Richland, Washington. These five OUs are referred to collectively as 100-F/IU (Figure 1). DOE has completed its investigation of ***waste sites***, many of which have already been remediated, and the groundwater through the ***remedial investigation (RI)/feasibility study (FS)*** process. The RI/FS concluded that waste sites and some contaminants in the groundwater require ***remedial action*** due to unacceptable risk to human health and the

[1] "IU" stands for isolated units; "FR" stands for F Reactor. The five operable units are collectively referred to as 100-F/IU.

[2] Important technical and administrative terms are used throughout this Proposed Plan. When these terms are first used, they appear in ***bold italics***. Explanations of these terms are provided in the Glossary at the end of this Proposed Plan.

environment (HHE). This Proposed Plan addresses the contamination in 304 waste sites in the four source OUs, as well as the contaminated groundwater in the 100-FR-3 OU.

DOE is issuing this Proposed Plan to summarize and seek public and Tribal Nations input on the cleanup alternatives considered and on the ***preferred alternatives*** proposed for implementation. This Proposed Plan presents the evaluation of several remedial alternatives and presents the preferred alternatives. The alternatives were developed to address remediation of the 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 Source OUs and the 100-FR-3 Groundwater OU. Soil contamination (source) remedial alternatives that were evaluated include Alternative S-1 (***No Action***) and Alternative S-2 (***Removal, Treatment, and Disposal [RTD]*** and ***Institutional Controls [ICs]***). Alternatives evaluated for groundwater include Alternative GW-1 (No Action), Alternative GW-2 (***Monitored Natural Attenuation [MNA]*** and ICs), Alternative GW-3 (***Pump-and-Treat*** with In Situ Treatment and MNA), and Alternative GW-4 (Enhanced Pump-and-Treat).

Public and Tribal Nations input on this Proposed Plan will help DOE and EPA select a remedy for cleanup of contamination in the 100-FR-1, 100-FR-2, 100-IU-2, 100-IU-6, and 100-FR-3 OUs. Following consideration of public and Tribal Nations input on the preferred alternatives or other alternatives presented in this Proposed Plan, a ***Record of Decision (ROD)*** will be issued by DOE and EPA identifying the final alternative selected for implementation.

Tribal Nations and Public Involvement

Input from the Tribal Nations and the public on this Proposed Plan will be considered during selection of the final remedy. Comments on the Proposed Plan will be accepted during the comment period (see sidebar on left side of page 1). For additional information regarding how to participate, see the "Community Participation" section of this Proposed Plan.

Remedial Investigation/Feasibility Study for the 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and 100-IU-6 Operable Units (DOE/RL-2010-98), hereafter called the 100-F/IU RI/FS report, and other supporting information used to evaluate alternatives and develop the preferred alternatives are contained in the ***Administrative Record*** files for the 100-FR-1, 100-FR-2, 100-IU-2, 100-IU-6 and 100-FR-3 OUs, which can be viewed online at http://pdw.hanford.gov/arpir/. The administrative records for each OU are available at the link under "Predefined Searches," "Select by Operable Unit." Printed copies of this Proposed Plan and the 100-F/IU RI/FS are available at the various information repositories identified in the "Community Participation" section of this Proposed Plan.

After all input submitted during the comment period has been reviewed and considered, a ROD will be issued that identifies the remedy selected. This input could result in the selection of a final remedial action that differs from the preferred alternatives. A summary of significant comments received and the responses will be published in the ***responsiveness summary*** issued with the ROD, which is scheduled for completion later in 2014.

Agencies Role

DOE is the lead agency and the party responsible for conducting the selected remedy. DOE is issuing this Proposed Plan as part of the public participation requirements under Section 117(a) "Public Participation," "Proposed Plan," of the ***Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)*** (commonly known as "Superfund") and the ***Code of Federal Regulations (CFR)*** "***National Oil and Hazardous Substances Pollution Contingency Plan***" (commonly known as the "National Contingency Plan," or NCP) (40 CFR 300.430[f][2]). CERCLA establishes the broad federal authority for conducting cleanup at Superfund sites, and the NCP (40 CFR 300) includes the procedures and expectations for cleanup.

EPA is the lead regulatory agency for 100-F/IU, and the Washington State Department of Ecology (Ecology) is the non-lead regulatory agency and provides input to EPA on cleanup decisions.

Preferred Alternatives

Based on the results of the detailed and comparative evaluation of alternatives, the preferred alternatives are Alternative S-2 (RTD and ICs) for source areas (soil) and Alternative GW-2 (MNA and ICs) for groundwater. RTD is used to excavate contaminated soil from waste sites. MNA is used for strontium-90, nitrate, trichloroethene (TCE), and hexavalent chromium (Cr[VI]) in groundwater. ICs are used to control access to residual contaminants in soil and groundwater.

These preferred alternatives meet the statutory requirements under CERCLA and the NCP (40 CFR 300) to select remedies that are protective of human health and the environment and comply with ***applicable or relevant and appropriate requirements (ARARs)*** (unless a statutory waiver is justified), are cost effective, and use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable.

In addition to the preferred alternatives, other alternatives were evaluated in the 100-F/IU RI/FS report (DOE/RL-2010-98, Section 10.2). Each alternative includes a combination of actions, all of which are explained briefly in this Proposed Plan and more fully in the 100-F/IU RI/FS report (DOE/RL-2010-98, Section 9.2).

National Environmental Policy Act Values

DOE policy calls for ***National Environmental Policy Act of 1969 (NEPA)*** values to be incorporated into DOE's CERCLA documentation (DOE O 451.1B Chg 3, *National Environmental Policy Act Compliance Program*). NEPA values include (but are not limited to) consideration of the cumulative ecological, cultural, historical, and socioeconomic impacts of the proposed remedial alternative. NEPA values were incorporated into the FS. For the remedy alternatives evaluated, environmental impacts include temporary short-term disturbance (e.g., increased traffic, noise levels, and fugitive dust) within limited areas. DOE expects minimal, if any, long-term impacts to air quality, natural and historical resources, transportation, socioeconomic values, or environmental justice.

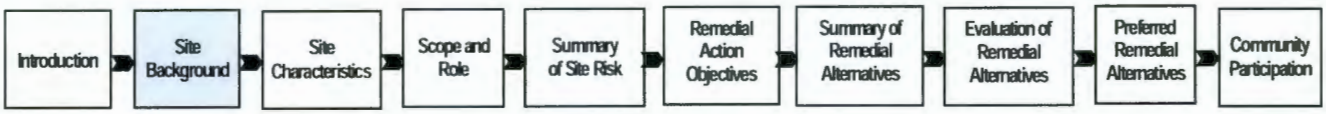
Proposed Plan Organization

The subsequent sections of this Proposed Plan provide the following discussions:

- **Site Background:** Provides facts about site contamination, investigations, interim remedial actions, and previous public participation.
- **Site Characteristics:** Includes descriptions of land and groundwater use, physical features impacting remedy selection, and the nature and extent of contamination of waste sites and the groundwater.
- **Scope and Role:** Discusses how the waste site and groundwater remedial actions fit into the overall Hanford Site cleanup strategy; provides descriptions of prior and planned cleanup actions.
- **Summary of Site Risks:** Identifies ***contaminants of concern (COCs)***, results of the ***baseline risk assessment***, and land and groundwater use assumptions.
- ***Remedial Action Objectives (RAOs)*:** Describes what the proposed site cleanup is expected to accomplish.
- **Summary of Remedial Alternatives:** Identifies options for attaining the identified RAOs.
- **Evaluation of Remedial Alternatives:** Provides comparison of the options using CERCLA criteria.

- **Preferred Remedial Alternatives:** Provides an explanation of rationale for selecting the preferred alternatives and affirmation that they are expected to fulfill statutory and regulatory requirements.
- **Community Participation:** Provides information on how the Tribal Nations and the public can provide input to the remedy selection process.

The following graphic is included before each new section to indicate where the new section fits within this Proposed Plan:



Site Background

The Hanford Site is a 1,517 km^2 (586 mi^2) federally owned property located within the semiarid, shrub-steppe Pasco Basin of the Columbia Plateau in south central Washington State. In 2000, Presidential Proclamation 7319, *Establishment of the Hanford Reach National Monument*, under authority of the *American Antiquities Act of 1906*, set aside about half of the Hanford Site for preservation as the Hanford Reach National Monument (HRNM), including lands in the River Corridor within about 0.4 km (0.25 mi) of the Columbia River (Figure 2). Historical nuclear material production and processing at the Hanford Site released contamination to the environment, resulting in areas of contaminated soil and groundwater that pose a risk to HHE. To facilitate cleanup, the Hanford Site has been divided into three areas: River Corridor, Central Plateau Outer Area, and Central Plateau Inner Area.

The area of the Hanford Site that borders the Columbia River is referred to as the River Corridor (Figure 2). The River Corridor, which spans approximately 570 km^2 (220 mi^2), 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 100-F/IU (Figure 2) is the largest of the six River Corridor areas. For River Corridor cleanup decisions, the 100-F/IU includes the 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and 100-IU-6 OUs.

The F Reactor area encompasses approximately 2.8 km^2 (1.1 mi^2) adjacent to the Columbia River in the northeast portion of the Hanford Site, adjacent to the Columbia River. The reactor's primary mission was plutonium production. The water-cooled nuclear reactor, associated structures, and processes that generated solid and liquid wastes were the primary sources of contamination at the 100-F Area. Solid waste was placed in unlined burial grounds. Liquid contaminants were released to the environment via retention basins, trenches, cribs, ditches, and through outfall piping to the Columbia River. The secondary mission of the 100-F Area was the Experimental Animal Farm, a biological laboratory used to examine the effects of radiation and radioactive contamination on plants, animals, and fish. The waste sites within the F Reactor area are included in the 100-FR-1 and 100-FR-2 OUs. Groundwater contamination from these source OUs is part of the 100-FR-3 OU.

Operation of F Reactor (1945 through 1965) (Figure 3) and associated processes generated large quantities of liquid and solid waste. Large volumes of river water were used as cooling water during reactor operations. The river water was treated to remove particulates and with sodium dichromate to reduce corrosion. Cooling water contaminants included fuel particles, fission and irradiation byproducts, and hexavalent chromium (Cr(VI)). Solid wastes consisted of sludge, reactor components, and various other contaminated items associated with reactor operations. Waste generated from reactor operations was contaminated with ***radionuclides***, hazardous chemicals, or both.

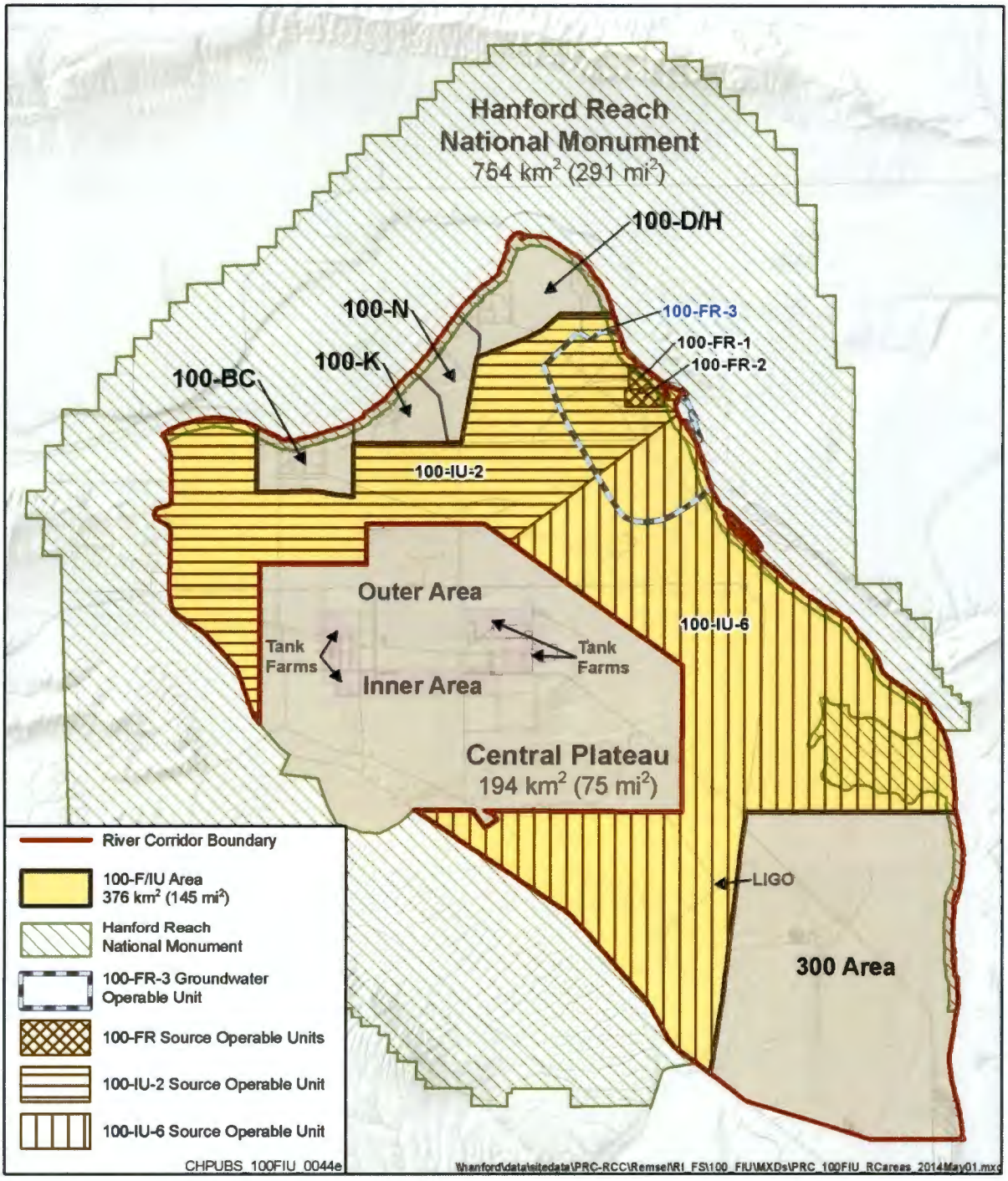


Figure 2. Hanford Site River Corridor

Figure 3. 100-F Area during Operations (1962)

The 100-IU-2 and 100-IU-6 OUs include the waste sites within an area between and outside the reactor and production areas within the River Corridor (Figure 2). These two OUs include the pre-Hanford, agriculture-based town of White Bluffs (100-IU-2) and the Hanford town site (100-IU-6) (EPA/ROD/R10-99/039, *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington [100 Area Remaining Sites]*). During development of the Hanford Site, portions of the 100-IU-2 and 100-IU-6 OUs were used for housing and staging equipment and materials. Waste sites generally originated from industrial chemical use and include landfills, dump sites, surface ***debris***, and unplanned releases.

Contaminated groundwater originating from Central Plateau source OUs extends to the unconfined aquifer beneath the 100-IU-2 and 100-IU-6 OUs. This contamination will be addressed by the CERCLA decisions for the groundwater OUs (200-PO-1 and 200-BP-5) associated with the Central Plateau.

Investigations

Two ***limited field investigations (LFIs)*** have been conducted in 100-F/IU. *Limited Field Investigation Report for the 100-FR-1 Operable Unit* (DOE/RL-93-82) and *Limited Field Investigation Report for the 100-FR-3 Operable Unit* (DOE/RL-93-83) were initiated for the 100-FR-1 and 100-FR-3 OUs. These LFIs were an initial step in characterizing the nature and extent of contamination in the soil and groundwater, as well as the threat that the contaminants posed to HHE. LFIs were not conducted for the 100-FR-2, 100-IU-2, and 100-IU-6 OUs. As a result of the LFIs and the associated qualitative risk assessments, substantial work to remove contaminated soil and facilities has been completed under the interim RODs.

Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan, Addendum 4: 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and 100-IU-6 Operable Units (DOE/RL-2008-46-ADD4) summarized the current knowledge of the contamination and identified additional data needs to support final remedial decisions. The data needs were met by completing RI field work in 2011, the results of which are documented in the 100-F/IU RI/FS report (DOE/RL-2010-98).

Previous Cleanup Actions and Decisions

A total of 158 facilities were used in 100-F/IU to support operations, with the majority of these within the 100-F Area. Of the 158 facilities, 146 have been demolished or removed. Facilities that were used during reactor operations (retention basin, reactor stack, office and storage buildings, maintenance shops, process plants, electric substation, storage tanks, and pump stations) comprise most of the demolished or removed facilities. The only facilities remaining within the 100-F Area include the F Reactor building within a safe storage enclosure and an emergency siren. The remaining active facilities and infrastructure within the 100-IU-2 and 100-IU-6 OUs include guard stations, an export water line, and emergency sirens. Decommissioning activities in 100-F/IU included removal of buildings and structures under the following action memoranda:

- 1997 – *Action Memorandum: 100 B/C Area Ancillary Facilities and the 108-F Building Removal Action, U.S. Department of Energy Hanford Site, Richland, WA* (EPA and DOE, 1997)
- 1998 – *Action Memorandum 105-F and 105-DR Reactor Buildings and Ancillary Facilities* (Ecology et al., 1998)

Waste site remedial actions began in the late 1990s. Radioactive liquid effluent waste sites were remediated first because they were the primary contributors to contamination at the 100-F Area. Most of the high-priority liquid waste sites in the 100-F Area were remediated by 2002, followed by the remediation of burial grounds and other remaining site types. Waste site remediation has been conducted in the 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 OUs under the following interim remedial actions:

- 1995 – *Interim Remedial Action Record of Decision for the 100-BC-1, 100-DR-1, and 100-HR-1 Operable Units, Hanford Site, Benton County, Washington* (EPA/ROD/R10-95/126)
- 1997 – *Amendment to the Interim Remedial Action Record of Decision for the 100-BC-1, 100-DR-1, and 100-HR-1 Operable Units, Hanford Site, Benton County, Washington* (EPA/AMD/R10-97/044) (Note: This amendment added the 100-FR-1 and 100-FR-2 waste sites to the interim remedial action ROD for the 100-BC-1, 100-DR-1, and 100-HR-1 OUs [EPA/ROD/R10-95/126].)
- 1999 – *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington (100 Area Remaining Sites)* (EPA/ROD/R10-99/039)
- 2000 – *Interim Remedial Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-2, 100-HR-2, and 100-KR-2 Operable Units, Hanford Site (100 Area Burial Grounds), Benton County, Washington* (EPA/ROD/R10-00/121)
  - 2000 – *Explanation of Significant Differences for the 100 Area Remaining Sites Record of Decision:100-IU-6 Operable Unit* (EPA/ESD/R10-00/045)
  - 2004 – *Explanation of Significant Differences for the 100 Area Remaining Sites Interim Remedial Action Record of Decision* (EPA et al., 2004)

- 2009 – *Explanation of Significant Differences for the 100 Area Remaining Sites Interim Remedial Action Record of Decision: Hanford Site, Benton County, Washington* (EPA et al., 2009)
- 2011 – *100 Area "Plug-In" and Candidate Waste Sites for Fiscal Year 2010* (EPA et al., 2011)
- 2012 – *100 Area "Plug-In" and Candidate Waste Sites for Fiscal Year 2011* (EPA et al., 2012)

As of March 2013, interim remediation has been completed for all wastes sites in the 100-FR-1 and 100-FR-2 OUs and for the majority of waste sites in the 100-IU-2 and 100-IU-6 OUs. Post-cleanup confirmation sampling results at these sites were evaluated and demonstrate that the proposed cleanup levels identified in this Proposed Plan have been met.

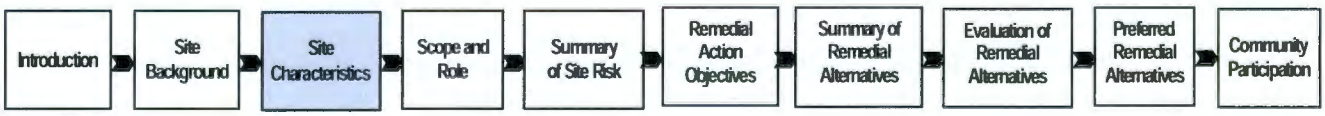
Previous Public Participation

Hanford Federal Facility Agreement and Consent Order Hanford Public Involvement Plan (DOE et al., 2012) outlines ways that the public can become involved in Hanford Site cleanup decision making and summarizes information about government and public organizations involved with Hanford Site issues, including the State of Oregon and the Hanford Advisory Board (a federally chartered advisory board comprised of representatives of diverse stakeholders concerned with Hanford Site cleanup). The historical input and advice from all parties relative to the 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and 100-IU-6 OUs were reviewed in the development of this Proposed Plan.

In addition to consulting with the Tribal Nations and continuing ongoing dialogue with stakeholders, DOE, EPA, and Ecology (also known as the ***Tri-Parties***) conducted formal public involvement during the previous interim remedial action decision processes for cleanup in the 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and 100-IU-6 OUs, as well as for deactivation and decommissioning of buildings in 100-F/IU conducted pursuant to CERCLA removal authority.

Previous Tribal Nations Participation

The Hanford Site is located on land ceded to the United States under separate treaties with the Confederated Tribes and Bands of the Yakama Nation and the Confederated Tribes of the Umatilla Indian Reservation. The Nez Perce Tribe also secured rights at what is now the Hanford Site in a separate treaty. In addition, DOE consults with the Wanapum Band of Indians, who were historical residents on Hanford lands. DOE and EPA invited the Tribal Nations to formal consultation on the proposed River Corridor cleanup actions. DOE and EPA have worked with Tribal Nations staff during the RI/FS process.



Site Characteristics

This section presents information on 100-F/IU surface features, current land and groundwater uses, the contamination release conceptual model, and groundwater contaminant plumes.

Site Features and Land and Groundwater Use

The 100-F/IU is mostly comprised of undeveloped land (Figure 4). The F Reactor remains in ***interim safe storage***. The Hanford school and White Bluffs bank are two historic structures preserved in the 100-IU-6 and 100-IU-2 OUs, respectively.

The 100-F/IU is being used for waste management, environmental monitoring, waste site remediation, and conservation and restoration activities. The segment of the Columbia River adjacent to 100-F/IU is used for a variety of recreational activities.

The raw water supply for the 100 and 200 Areas is provided from the Columbia River through a series of pump houses, reservoirs, and pipelines. This water distribution system is known as the water export system. A large part of this system intersects the 100-F/IU portion of the River Corridor.

Many communities downstream of the 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 Laser Interferometer Gravitational-Wave Observatory (LIGO) is located within 100-F/IU (see Figure 4). The LIGO operates under a DOE permit granted to the National Science Foundation that expires in 2018, unless the permit is extended or terminated. Based on evaluations performed to support the permit granted by DOE, the land occupied by LIGO was excluded from further consideration in the RI/FS because no contaminated sites were identified.

Physical Features Impacting Remedy Selection

The topography of the reactor area in the 100-F Area is relatively flat, with elevations generally between 120 and 128 m (394 and 420 ft) above mean sea level inland from the Columbia River. The area has been disturbed and graded extensively since reactor construction began in 1943 and continues through present-day waste site remediation activities that restore natural contours.

The topography within the 100-IU-2/IU-6 OUs varies widely. Portions of this region are relatively flat, but it includes Gable Butte and Gable Mountain, which rise approximately 60 m (200 ft) and 180 m (590 ft), respectively, above surrounding land.

The ***vadose zone*** at the 100-F Area comprises up to 15 m (49 ft) of unconsolidated gravel and sand of the Hanford formation. The unconfined upper aquifer ranges from a saturated thickness of 1 m (3 ft) in the southwestern 100-F Area to 8 m (25 ft) in the eastern portion of 100-F. The low-permeability Ringold Formation upper mud unit forms a continuous base of the aquifer at the 100-F Area.

Groundwater flows toward the east-northeast in the northern portion of the 100-F Area, toward the east in the southwestern portion, and approximately parallel to the river in the southeastern 100-F Area. Groundwater flow is not always directed toward the river, as the ***hydraulic gradients*** change direction in response to river stage. This interaction with the river not only affects groundwater flow patterns but also contaminant transport rates, groundwater geochemistry, contaminant concentrations, and ***attenuation rates***.

The thickness of the vadose zone in the 100-IU-2/IU-6 OUs ranges from near zero adjacent to the Columbia River to greater than 107 m (350 ft). The uppermost aquifer is unconfined and comprises the Ringold Formation unit E, the Hanford formation, or the Cold Creek unit. The base of the unconfined aquifer is one of several low-permeability units in the Ringold Formation. Groundwater flows west to east beneath the southern portion of the 100-IU-2/IU-6 OUs, discharging to the Columbia River at the eastern edge of the Hanford Site.

Groundwater in the unconfined aquifer discharges to the Columbia River via upwelling through the riverbed and riverbank seeps. The rate of discharge from the Hanford Site aquifer is very low compared to the flow of the river. 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. When the river stage drops to a low elevation, riverbank seeps appear.

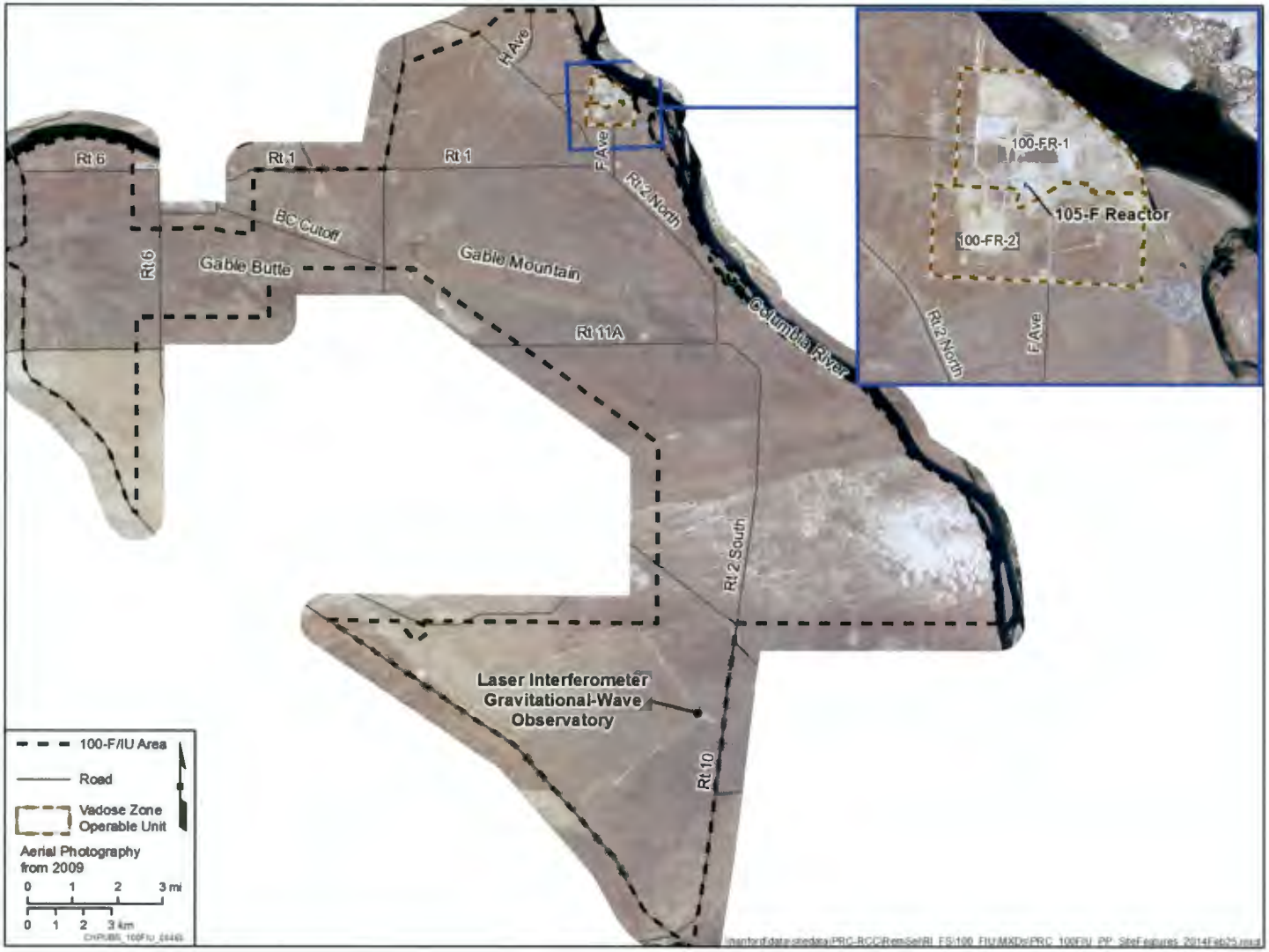


Figure 4. Features of 100-F/IU

Waste Site Contamination

The liquid waste discharged to the 100-FR-1 and 100-FR-2 waste sites contained nitrate, radionuclides, metals, anions, and organic chemicals. Mobile contaminants, such as nitrate and Cr(VI), have migrated through the vadose zone to the groundwater. Contaminants in solid waste disposed in burial grounds included radionuclides from facility operations and nitrate from Experimental Animal Farm waste. The solid wastes were buried up to 8 m (25 ft) below ground surface (bgs).

Figures 5 and 6 show the locations of the waste sites in the 100-F/IU OUs that had been remediated as of March 2013 under interim action RODs. Figure 7 shows the location of the sites that have not been remediated under interim RODs as of March 2013.

Groundwater Contamination

Groundwater contaminants at levels that exceed federal and state standards in the 100-FR-3 OU are nitrate, Cr(VI), TCE, and strontium-90. Waste sites in the 100-FR-1 and 100-FR-2 OUs that were the source of groundwater contaminants have been removed. Natural processes, including degradation, radioactive decay, and dispersion, are causing contaminant concentrations to decline in groundwater. The locations of the groundwater contaminant plumes that are included in the 100-FR-3 OU are shown on Figure 8.

Nitrate. Nitrate contamination of groundwater in the 100-FR-3 OU is greater than the 45 mg/L ***drinking water standard (DWS)*** over an area of approximately 1,060 ha (2,620 ac). The Experimental Animal Farm was a source of this contamination because nitrate is a component of animal waste. The nitrate contamination was likely transported inland during operations when an effluent discharge resulted in groundwater mounding and changes in hydraulic gradients. Concentrations of nitrate range from 0.91 to 139 mg/L.

Cr(VI). Cr(VI) in the 100-FR-3 OU exceeds the 10 µg/L Washington State surface water quality standard over an area of approximately 16 ha (41 ac). DOE used the surface water quality standard of 10 µg/L as a screening level to assess the potential for Cr(VI) to reach the river above the surface water quality standard. Concentrations of Cr(VI) range from 2.2 to 93 µg/L. Cr(VI) concentrations are generally below the ***Model Toxics Control Act (MTCA)*** (*Washington Administrative Code* [WAC] 173-340, "Model Toxics Control Act—Cleanup") Method B groundwater cleanup level of 48 µg/L in the relatively small plume near the river. While the plume exceeds the 10 µg/L water quality standard in the groundwater, aquifer tubes and pore water samples indicate infrequent exceedances of this level near the surface water interface.

TCE. The source of TCE contamination in the 100-FR-3 OU is believed to have been from a number of waste sites, including a group of waste sites west of the 100-F Area that have been remediated. The area of groundwater with TCE concentrations greater than the 4.0 µg/L MTCA (WAC 173-340) cleanup level is approximately 99 ha (246 ac). Concentrations of TCE range from 0.25 to 20 µg/L.

Strontium-90. Facilities producing biological waste materials contaminated with strontium-90 included the Experimental Animal Farm and the radioecology laboratory. Strontium-90 was also present in discharges to the 116-F-14 and 116-F-2 liquid disposal sites, and in solid waste disposed of at various burial grounds, including the 118-F-6 site. Concentrations of strontium-90 in groundwater above the 8 ***picocuries*** per liter (pCi/L) DWS are present in an area of 7.3 ha (18 ac). Concentrations of strontium-90 range from 0.36 to 26 pCi/L.

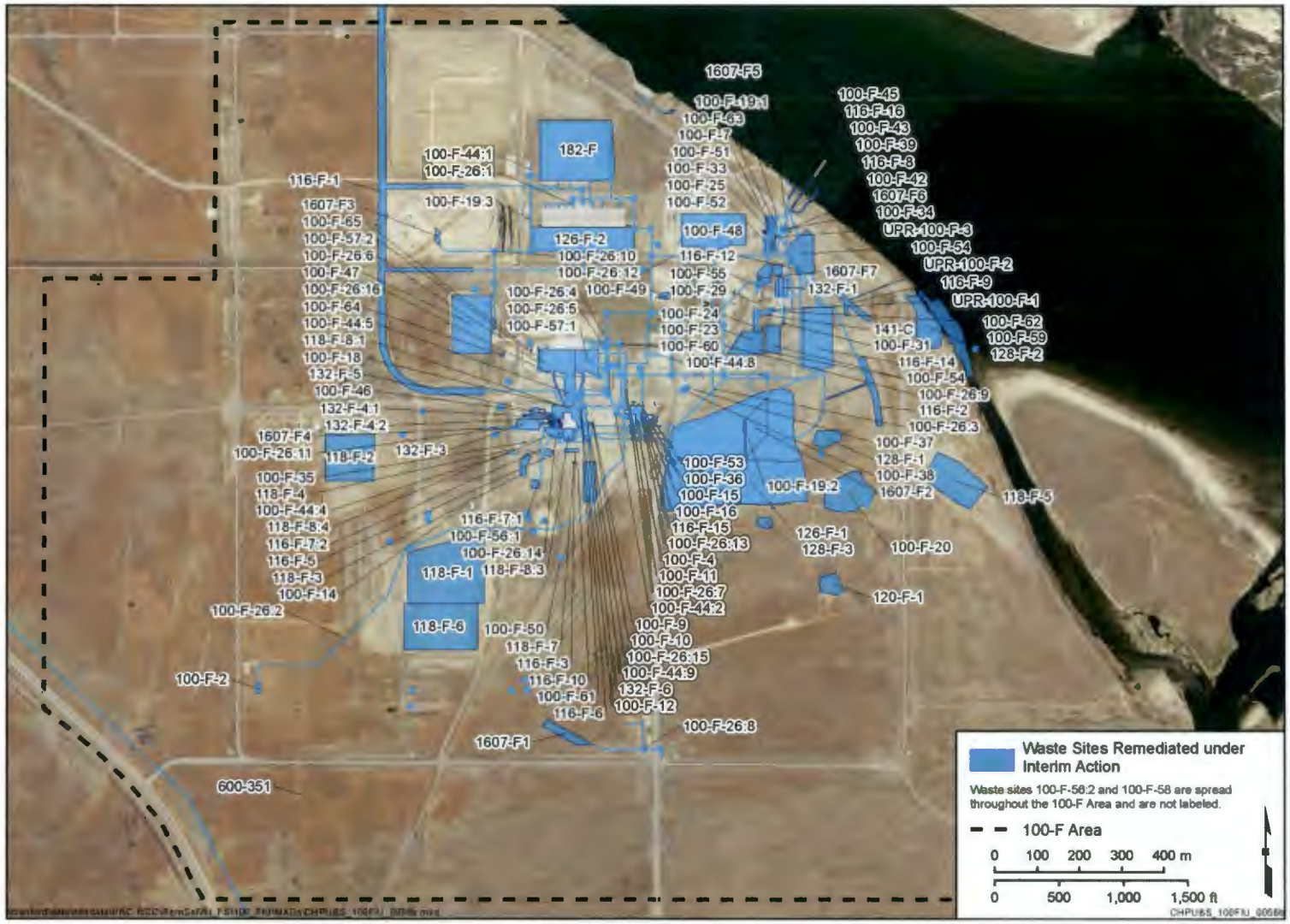


Figure 5. Waste Sites Remediated as of March 2013 under Interim Action RODs in the 100-FR-1 and 100-FR-2 OUs

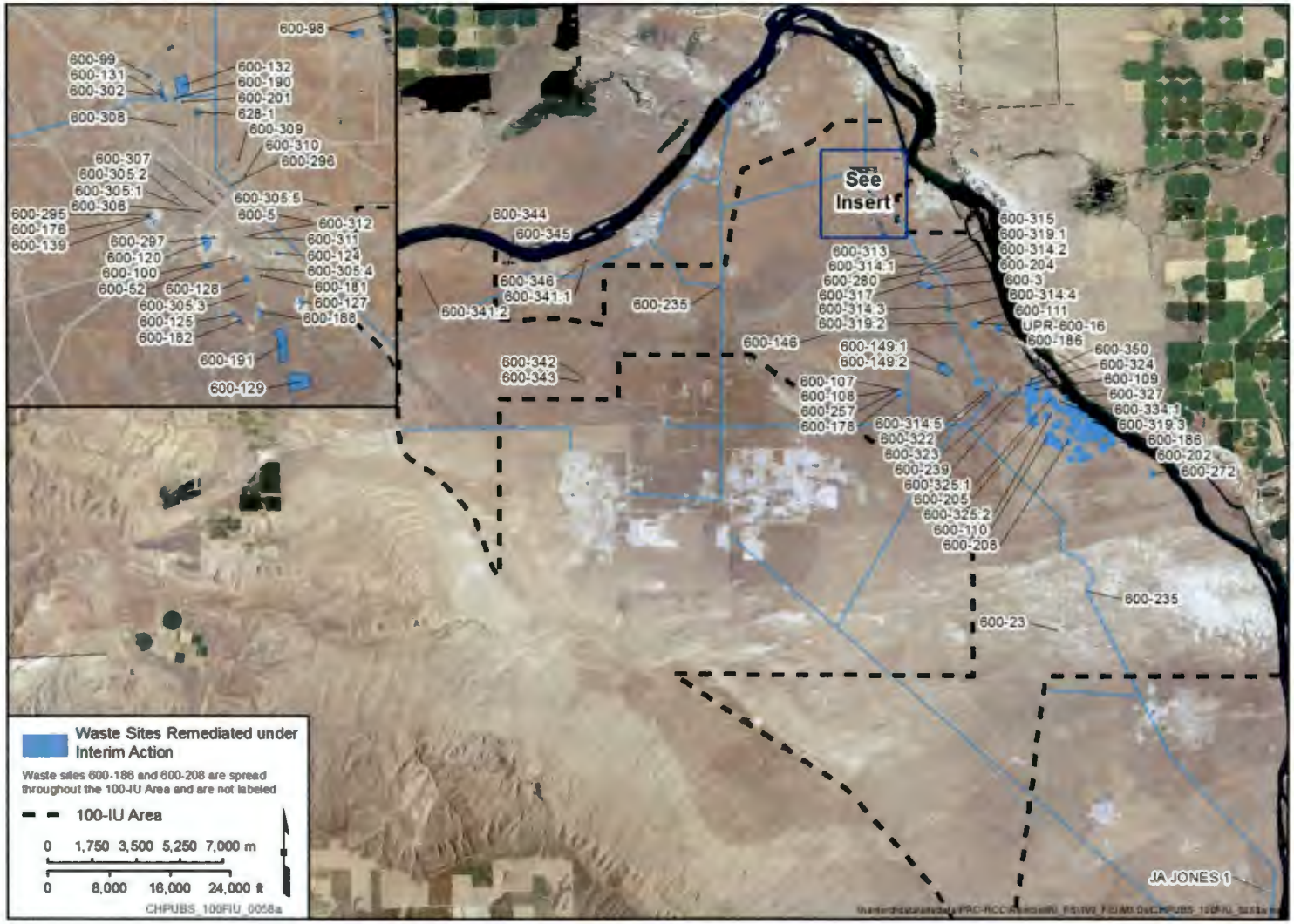


Figure 6. Waste Sites Remediated as of March 2013 under Interim Action RODs in the 100-IU-2 and 100-IU-6 OUs

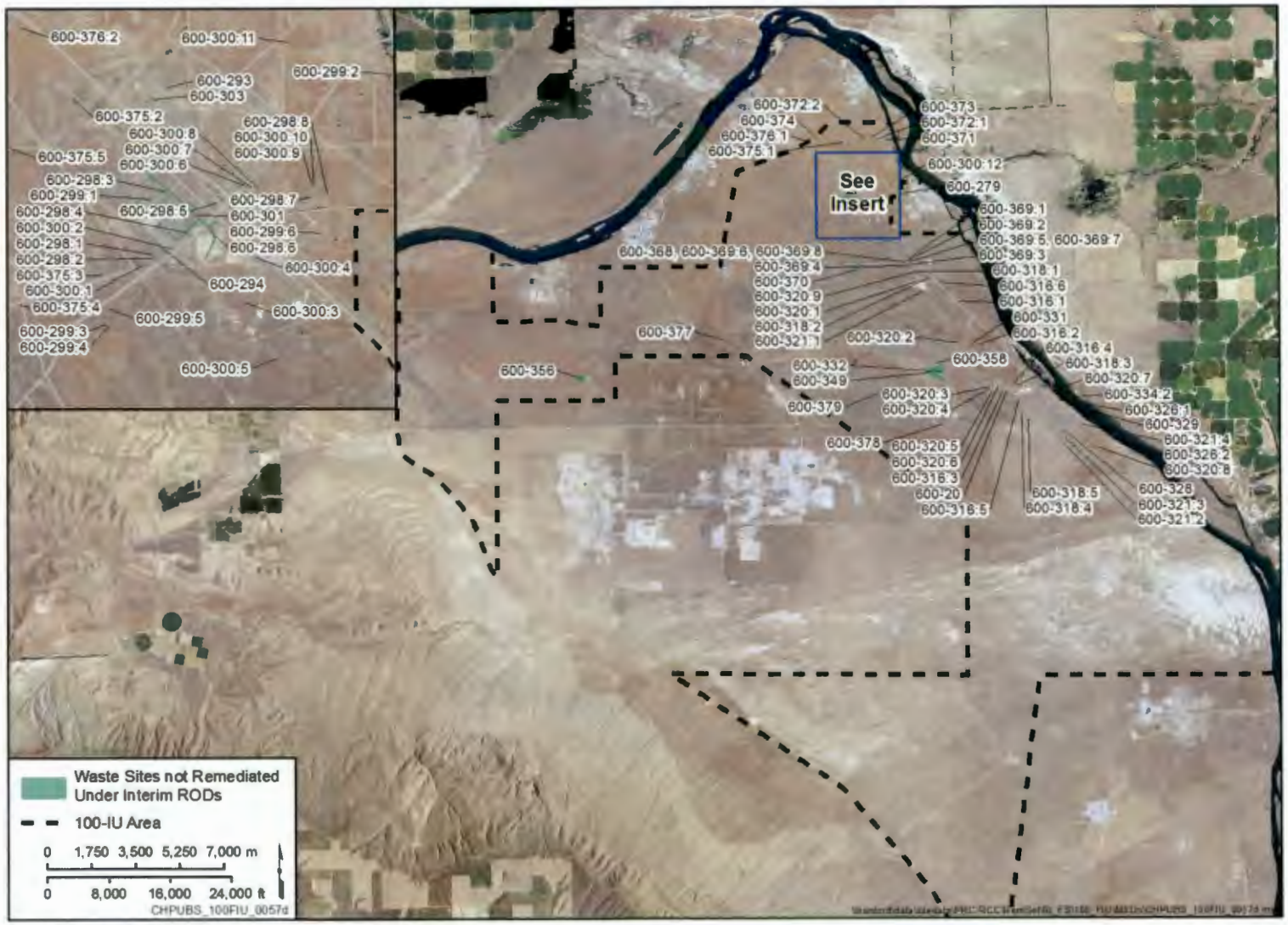


Figure 7. Waste Sites Not Remediated Under Interim RODs as of March 2013 in the 100-IU-2 and 100-IU-6 OUs

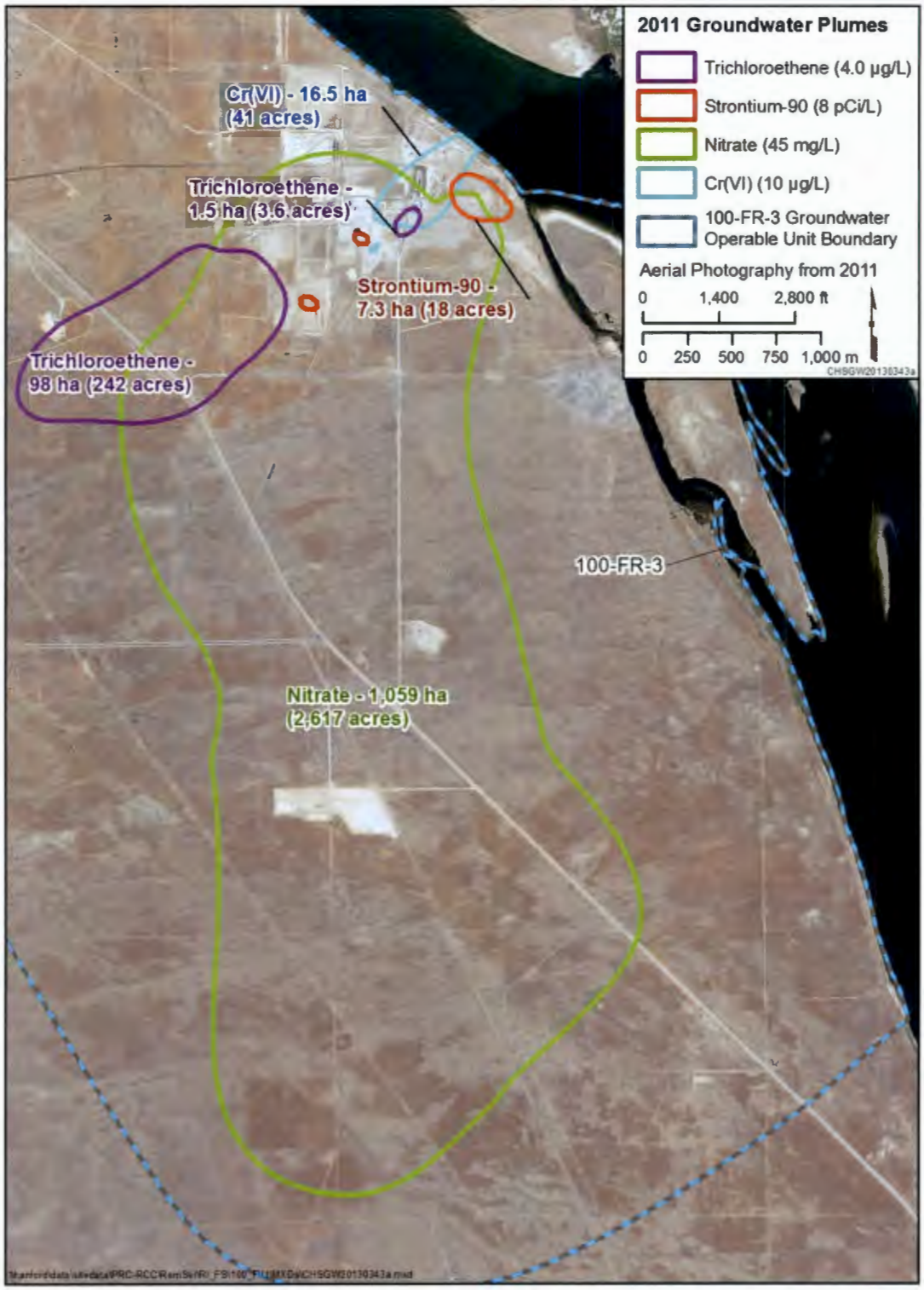


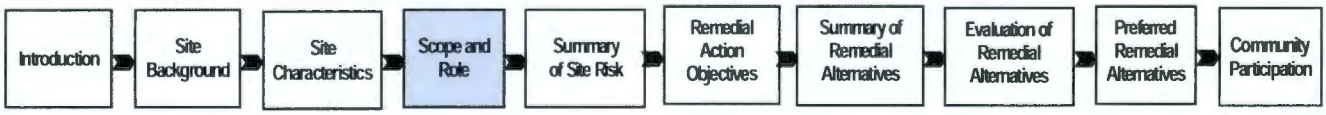
Figure 8. Groundwater Contaminant Plumes in the 100-FR-3 OU

Groundwater Beneath the 100-IU-2 and 100-IU-6 OUs. As shown on Figure 9, contaminated groundwater originating from Central Plateau source OUs extends to the unconfined aquifer beneath the 100-IU-2 and 100-IU-6 OUs. Contaminant plumes under the 100-IU-2 and 100-IU-6 OUs include iodine-129, nitrate, and tritium. These groundwater contaminant plumes will be addressed through the CERCLA process based on the groundwater OUs (200-PO-1 and 200-BP-5) covering the area where the contaminants were released. The evaluation of the nature and extent of groundwater contamination at the overall Hanford Site is summarized in *Hanford Site Groundwater Monitoring for 2011* (DOE/RL-2011-118).

Principal Threat Wastes

Principal threat wastes are those source materials with concentrations 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. Contaminated groundwater is generally not considered to be source material.

Principal threat wastes associated with 100-F/IU, such as fuel fragments and concentrated liquid sodium dichromate, have been removed through earlier cleanup actions. No waste sites remain in the source OUs with principal threat waste.



Scope and Role

This Proposed Plan addresses releases in the following OUs:

- 100-FR-1 Source OU
- 100-FR-2 Source OU
- 100-FR-3 Groundwater OU
- 100-IU-2 Source OU
- 100-IU-6 Source OU

This section describes the role of the 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and 100-IU-6 OUs in the scope of the Hanford Site cleanup strategy.

Hanford Site Overall Cleanup Strategy

This Proposed Plan is part of a cleanup strategy to complete remediation of the Hanford Site. The River Corridor and the Central Plateau (Figure 2) are the two main geographic areas for cleanup work on the Hanford Site. The River Corridor includes the former reactor operations and fuel fabrication areas adjacent to the Columbia River. The Central Plateau includes the former fuel-processing facilities and numerous waste disposal facilities. The objective of the cleanup strategy is to ensure that cleanup actions address all threats to HHE in accordance with regulatory requirements.

The intent of the Hanford cleanup strategy is to shrink the Hanford Site waste management footprint to the Central Plateau. The strategy includes remediation of waste sites and restoration of groundwater that is protective of HHE, including the Columbia River, and restores groundwater to beneficial use wherever practicable.

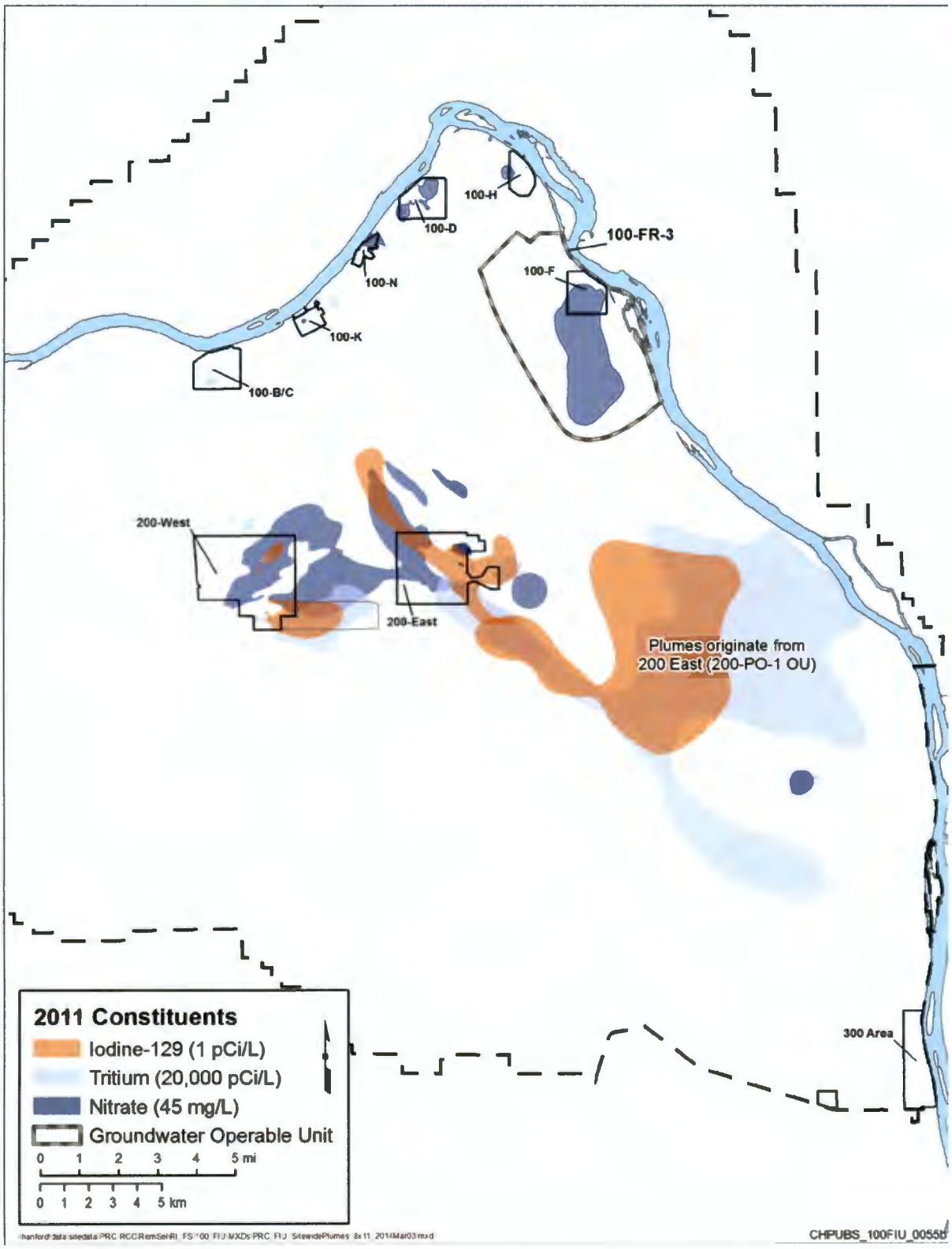
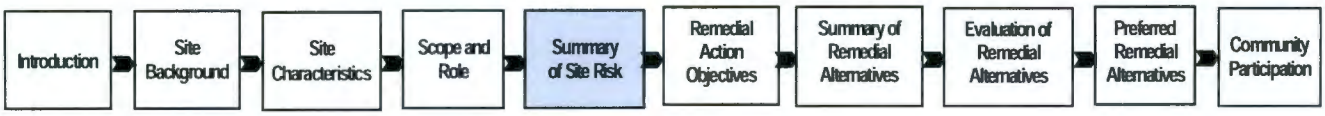


Figure 9. Groundwater Contaminant Plumes Beneath 100-IU-2 and 100-IU-6 OUs



Summary of Site Risks

A baseline risk assessment was conducted to characterize current and potential threats to HHE and to provide information that could be used in the development and evaluation of remedial alternatives. The River Corridor Baseline Risk Assessment (DOE/RL-2007-21, *River Corridor Baseline Risk Assessment, Volumes I and II: Ecological and Human Health Risk Assessment* [hereafter called the RCBRA]) and the Columbia River Component (DOE/RL-2010-117, *Columbia River Component Risk Assessment, Volume I: Screening-Level Ecological Risk Assessment* and *Columbia River Component Risk Assessment, Volume II: Baseline Human Health Risk Assessment* [hereafter called the CRC]) were conducted to characterize current and potential future risks to HHE that may be posed by contamination in the River Corridor, including the OUs discussed in this Proposed Plan. These risk assessments provide information for use in the development and evaluation of remedial alternatives and provide the basis for action. The results of the RCBRA and the CRC are summarized in the 100-F/IU RI/FS report (DOE/RL-2010-98).

The risk evaluation for specific waste sites in the RI/FS relies on a comprehensive review of all available data for each waste site, including field data, radiological surveys, process history, analogous site information, personal interviews, engineering drawings and as-builts, and any other information identified during the development of the RI/FS. For the OUs proposed for remediation, the data review indicated that there is an unacceptable risk, thus providing a basis for action.

Land and Groundwater Use Assumptions

Land use in the River Corridor is controlled by DOE, with the U.S. Fish and Wildlife Service (USFWS) managing the HRNM. DOE and the USFWS manage this federally owned land to protect natural and cultural resources while cleanup activities are being conducted. Such management is consistent with *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement* (DOE/EIS-0222-F) and *Supplement Analysis, Hanford Comprehensive Land-Use Plan Environmental Impact Statement* (DOE/EIS-0222-SA-01) for the Hanford Site. This joint management also reflects the requirements of the USFWS management plan (USFWS, 2008, *Hanford Reach National Monument: Final Comprehensive Conservation Plan and Environmental Impact Statement; Adams, Benton, Grant and Franklin Counties, Washington*) for the HRNM. Both DOE and the USFWS expect that this joint management of the Hanford Site will continue for many years into the future and that the property will remain under federal ownership. In June 2000, the HRNM was established within the boundaries of the Hanford Site (Figure 2). *Establishment of the Hanford Reach National Monument* (Clinton, 2000) mandates preservation of the natural and cultural resources within the HRNM and specifically included the possibility of adding lands to the HRNM as they are remediated.

DOE's reasonably anticipated future use of the 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 OUs is conservation and preservation. EPA believes that other uses, including residential use, are reasonably anticipated future land use for these areas. In the preferred alternatives, DOE and EPA have proposed residential-based cleanup levels. The residential cleanup levels also allow for conservation and preservation uses and minimize the need for ICs and long-term monitoring.

The NCP establishes an expectation to "return useable ground waters to their beneficial uses wherever practicable, within a time frame that is reasonable given the particular circumstances of the site" (NCP [40 CFR 300.430(a)(1)(iii)(F)]). The Tri-Parties' goal for Hanford Site groundwater is to attain the regulatory goals by returning groundwater to its beneficial use as a potential future drinking water source.

Groundwater from the 100-FR-3 OU is currently contaminated above DWSs, and withdrawal for uses other than monitoring is prohibited by groundwater use restrictions currently in place. Groundwater in the risk evaluation was evaluated assuming potential future use for drinking water and other domestic activities. Contaminant concentrations were also compared to aquatic criteria because groundwater discharges to the Columbia River via riverbank seeps and upwelling through the river bottom.

Current and Future Exposure Scenarios

Exposure to contamination in 100-F/IU is currently controlled by DOE's site controls to prevent unacceptable exposure to humans. Risk to site workers is managed through health and safety programs.

For purposes of assessing future potential risk, various human exposure scenarios were evaluated in the RCBRA (DOE/RL-2007-21, Volume II), the CRC (DOE/RL-2010-117, Volume II), and the baseline human health risk assessment in the 100-F/IU RI/FS report (DOE/RL-2010-98, Section 6.2.3). These exposure scenarios were evaluated to reflect a range of land uses. For the purpose of establishing cleanup levels, EPA and DOE have agreed to use the residential scenario.

Residential Scenario. The residential scenario for exposure to chemicals used Washington State's MTCA cleanup levels (WAC 173-340) for unrestricted use. The residential risk scenario assessment for exposure to radionuclides was based on a 30-year residential exposure. Each of these risk assessment scenarios is described below.

For assessing risks from chemicals in soil, MTCA Method B (WAC 173-340-740, "Unrestricted Land Use Soil Cleanup Standards") levels are used. MTCA Method B considers direct contact exposure of a child through incidental soil ingestion. It also considers the inhalation pathway based on exposure to adults and children from inhalation of vapors and dust in ambient air. Calculations of these MTCA cleanup standards (identified as the soil ***preliminary remediation goals [PRGs]***) are described in the 100-F/IU RI/FS report (DOE/RL-2010-98, Section 8.1.4).

For assessing risks from radionuclides in soil, the residential risk scenario assumes that exposure to soil within the top 4.6 m (15 ft) occurs over a 30-year period. A residence is established on the waste site and the resident receives exposure from direct contact with the soil from the remediated waste site and through the food chain. This includes potential exposure through external radiation, incidental soil ingestion, and inhalation of ambient dust particulates. The food chain pathway includes exposure from consumption of fruits and vegetables grown in a backyard garden, and consumption of meat (beef and poultry) and milk from livestock raised in a pasture. Uptake of contamination into crops and livestock is assumed to occur from contamination present in the soil. Contaminants in soil are transported through the soil column, into the underlying groundwater, and to a hypothetical downgradient well located at the waste site boundary that is used for drinking water consumption, irrigation of crops, and watering of livestock, and for consumption of fish raised in a pond of water from the downgradient well. An additional evaluation was performed for groundwater use assuming that the only exposure was through use of groundwater as a drinking water source.

Groundwater. Groundwater contamination risk within the 100-FR-3 OU was evaluated using two different methods. Concentrations of chemicals and radionuclides that were measured over the last 5 years were compared to federal and state DWSs. In addition, chemicals were compared to MTCA Method B groundwater cleanup levels. These are the standards and cleanup values established to protect human health. Groundwater ***contaminants of potential concern (COPCs)*** for further evaluation were identified when a concentration was greater than the DWS or MTCA Method B groundwater cleanup levels.

An additional evaluation calculated human health ***excess lifetime cancer risks (ELCRs)*** and hazards using EPA's residential drinking water exposure scenario. This scenario assumes that the groundwater is used as a tap water source for a 30-year period. Potential routes of exposure include ingestion, dermal contact, and inhalation of volatiles during household activities. ***Exposure point concentrations (EPCs)*** were used to calculate ELCRs and noncancer hazards. COPCs were identified when the ELCRs and noncancer hazards were greater than the acceptable risk thresholds in MTCA and the NCP.

Contaminant Fate and Transport Modeling

Contaminant fate and transport modeling for natural conditions without groundwater remedial action was performed to simulate and predict the movement of Cr(VI), strontium-90, TCE, and nitrate. This modeling is described in Chapter 5 and Appendix F of the 100-F/IU RI/FS report (DOE/RL-2010-98).

The contaminant fate and transport modeling used the most conservative federal and state standards to predict time frames to achieve groundwater cleanup. Model predictions indicate that Cr(VI) attenuates to concentrations less than the "Water Quality Standards for Surface Waters of the State of Washington" (WAC 173-201A) within 35 years. Strontium-90 concentrations attenuate to concentrations below the DWS within 150 years. TCE concentrations attenuate to concentrations below the DWS within 50 years. Nitrate concentrations attenuate to concentrations below the DWS within 80 years.

Human Health Soil Risks

All of the interim remediated waste sites in the 100-F/IU source OUs with closeout verification data from the shallow vadose zone from 0 to 4.6 m (0 to 15 ft) bgs were evaluated in the risk assessment presented in Chapter 6 of the 100-F/IU RI/FS report (DOE/RL-2010-98). The 118-F-6 site had residual strontium-90 contamination above risk thresholds at a depth of 2 to 4 m (6.6 to 13.1 ft) bgs.

Fifteen remediated waste sites in the 100-FR-1 and 100-FR-2 OUs contain residual contamination deeper than 4.6 m (15 ft) bgs that presents a potential risk from inadvertent exposure through deep excavation activities. A risk assessment using a residential exposure scenario for radionuclides was used to identify where unacceptable exposure could occur if the contamination was brought to the surface. These fifteen waste sites (100-F-10, 100-F-19:1, 100-F-19:2, 100-F-19:3, 100-F-29, 100-F-34, 116-F-12, 116-F-14, 116-F-2, 116-F-6, 116-F-9, 118-F-6, 118-F-8:3, 118-F-8:4, and UPR-100-F-1) report an ELCR greater than 1×10^{-4} for the deep vadose zone contamination. Radionuclides associated with historical waste disposal contribute a majority of the ELCR and include cesium-137, cobalt-60, europium-152, europium-154, nickel-63, and strontium-90. These fifteen waste sites require action (e.g., an IC) to prevent an inadvertent exposure through deep excavation activities.

Waste sites that have not been remediated were evaluated and were determined to pose an unacceptable risk to human health from direct exposure, thus providing the basis for remedial action.

Groundwater Risks

Groundwater was evaluated as a potential drinking water source through a comparison of the EPCs for each contaminant against federal and state DWSs and Washington State's groundwater cleanup levels.

A total of 20 monitoring wells are completed in the unconfined aquifer within the 100-FR-3 Groundwater OU, and these wells were evaluated in the risk assessment. Of these, 19 wells were specifically sampled during the RI to address uncertainties identified in Section 3.6.5.1 of the integrated 100 Area RI/FS work plan (DOE/RL-2008-46-ADD4). The groundwater within 100-FR-3 Groundwater OU contains nitrate at

concentrations greater than the DWS of 45,000 µg/L and TCE at concentrations greater than the risk-based level of 4.0 µg/L.

Strontium-90 has also been detected in the 100-FR-3 Groundwater OU at concentrations above the DWS of 8 pCi/L. Strontium-90 has historically been measured in well 199-F5-1 where it is present in a localized area downgradient of the 116-F-2 liquid waste disposal trench, the 116-F-14 retention basin, and the 116-F-9 animal waste leaching trench.

Contaminant concentrations in the groundwater were also compared to surface water standards for protection of aquatic organisms because groundwater discharges to the Columbia River. This comparison included state surface water quality standards for fresh water and federal ***ambient water quality criteria***. The groundwater within the 100-FR-3 Groundwater OU contains Cr(VI) concentrations greater than the state surface water quality standard (WAC 173-201A) of 10 µg/L.

Based on the results of the groundwater risk evaluation, concentrations of nitrate and strontium-90 are present at levels that exceed DWSs and are identified as COCs. TCE is present at levels that exceed the human health risk-based concentration, and it is identified as a COC. Cr(VI) is present at levels that exceed the state surface water quality standard (WAC 173-201A) and 48 µg/L human health risk-based concentration (WAC 173-340-720), and it is also identified as a COC.

Based on an assessment of the risk that soil contamination poses to groundwater and surface water, action (e.g., an irrigation prohibition) would be needed at the remediated waste site 116-F-14 for groundwater/surface water protection. This site contains residual Cr(VI) contamination exceeding the soil levels necessary for protection of surface water subject to groundwater discharge. The surface water standard applies where groundwater discharges to the Columbia River. No other soil contaminants were identified that would cause an unacceptable risk to groundwater or surface water. There were no unacceptable risks posed to groundwater quality or surface water quality in the other waste sites that make up the 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 OUs.

Ecological Risks at Upland Areas

The RCBRA (DOE/RL-2007-21, Volume I) and the 100-F/IU RI/FS report (DOE/RL-2010-98, Chapter 7) evaluated ecological risks at the 100-F/IU interim remediated waste sites with upland habitat for potential ecological risks. The 100-F/IU RI/FS used information from the RCBRA and other sources to evaluate the risk to populations and communities of ecological receptors, and it was concluded that there was no ecological risk at remediated waste sites within the 100-F/IU source OUs. The ecological risk evaluations have identified that interim remedial actions that have achieved interim action ROD cleanup levels to protect human health will also protect ecological receptors, particularly when the sizes of remedial actions are considered relative to ecological receptor home ranges. Once human health cleanup levels are achieved, residual contamination would not be sufficient to adversely impact populations and communities of ecological receptors.

Ecological Risks at Riparian and Near-Shore Areas

The RCBRA (DOE/RL-2007-21, Volume I) and the CRC (DOE/RL-2010-117, Volume I) evaluated potential ecological risks present in the riparian, near-shore, and river areas in 100-F/IU. The 100-F/IU RI/FS report (DOE/RL-2010-98, Section 7.5) used information from these risk assessments and from other sources to evaluate risk to populations and communities of ecological receptors. The 100-F/IU RI/FS evaluated contaminants present in these environments and pathways where Hanford Site operations may have released contaminants to the riparian, near-shore, and river environments. The evaluation included releases or potential releases of radionuclides, metals, and nitrate into the Columbia River from groundwater. The 100-F/IU RI/FS

concluded that there are no ecological risks from Hanford Site contamination for riparian and near-shore areas that are at levels that warrant further remedial action.

Threatened or Endangered Species

The Hanford Reach contains three species listed as threatened or endangered under the federal *Endangered Species Act of 1973*. These include the upper Columbia River spring-run Chinook salmon and steelhead, and the bull trout. The spring-run Chinook salmon do not spawn in the Hanford Reach but use it as a migration corridor. Steelhead spawning has been observed in the Hanford Reach. The bull trout is not considered a resident species and is rarely observed in the Hanford Reach. The 100-FR-3 OU contains four groundwater COCs: Cr(VI), strontium-90, nitrate, and TCE. The Columbia River rapidly dilutes groundwater contaminants to low concentrations, so the primary concern for ecological risk to aquatic biota is from exposure to groundwater via upwelling through the riverbed gravels, cobbles, and sand. As discussed in Chapter 7 and in Appendix H of the 100-F/IU RI/FS report (DOE/RL-2010-98), contaminated groundwater from the 100-FR-3 OU will have no effect on these fish species. This conclusion of no effect is because current and predicted concentrations of COCs in groundwater do not exceed toxicity thresholds for steelhead.

Contaminants of Concern

COCs are radionuclides and chemicals that pose an unacceptable threat to HHE and, therefore, need to be addressed by a remedial action. COCs are typically contaminants that exceed an acceptable risk level or a federal or state standard. The soil COCs are evaluated in Chapters 5, 6, and 7 of the 100-F/IU RI/FS report (DOE/RL-2010-98). The soil and groundwater COCs are listed in Table 1. Tables 6, 7, and 8 at the back of this Proposed Plan provide the proposed cleanup levels for the preferred alternatives.

Table 1. Soil and Groundwater COCs

Soil Radionuclides	Soil Nonradionuclides	Groundwater Radionuclides	Groundwater Nonradionuclides
Cesium-137	Aroclor 1254 (PCBs)	Strontium-90	Nitrate
Cobalt-60	Aroclor 1260 (PCBs)		Trichloroethene
Europium-152	Arsenic		Chromium (VI)
Europium-154	Benzo(a)pyrene		
Nickel-63	Chromium (VI)		
Strontium-90	Lead		
	Mercury		
	Nitrate		
	Total petroleum hydrocarbons		

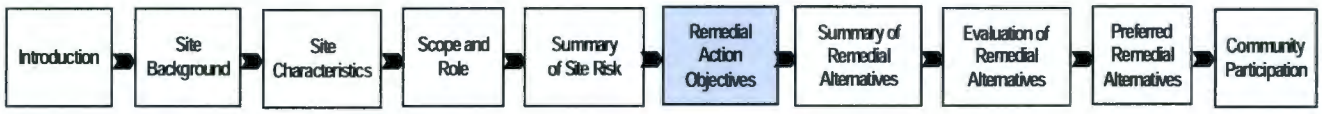
PCB = polychlorinated biphenyl

The groundwater COCs for the 100-FR-3 Groundwater OU are based on an evaluation of groundwater data. The groundwater COCs for the 100-FR-3 OU were evaluated in the 100-F/IU RI/FS report (DOE/RL-2010-98, Section 6.3). The groundwater risk evaluation identified four COCs: strontium-90, nitrate, TCE, and Cr(VI).

Conclusions

The extensive remedial actions implemented under interim action RODs have been successful in achieving risk-based cleanup goals, as evaluated in the 100-F/IU RI/FS report (DOE/RL-2010-98). Fifteen waste sites have been identified where action, such as ICs, would be needed to prevent exposure to contamination if it was brought to the surface. Waste sites that have not yet undergone remediation pose an unacceptable risk if no actions are taken.

It is DOE's and EPA's judgment that the preferred alternatives identified in this Proposed Plan, or one of the other active measures considered in this Proposed Plan, are necessary to protect public health or welfare, or the environment, from actual or threatened releases of hazardous substances, pollutants, and contaminants into the environment that may present an imminent and substantial endangerment to public health or welfare.



Remedial Action Objectives

The RAOs describe what a proposed remedial action is expected to accomplish. RAOs generally include information on the media, COCs, potential exposure pathways, and remediation goals, taking into account the current and reasonably anticipated future land use. The RAOs for the 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 OUs are RAOs #3 through #6. The RAOs for the 100-FR-3 OU are RAOs #1, #2, and #7. The RAOs are as follows:

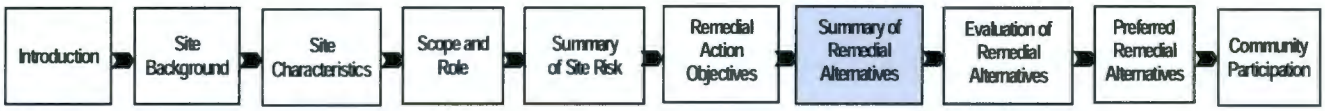
- **RAO #1:** Prevent unacceptable risk to human health from ingestion of and incidental exposure to groundwater containing contaminant concentrations above federal and state standards and risk-based thresholds.
- **RAO #2:** Prevent unacceptable risk to human health and ecological receptors from groundwater discharges containing contaminant concentrations above federal and state standards and risk-based thresholds to surface water.
- **RAO #3:** Prevent unacceptable risk from contaminants migrating and/or leaching through soil that will result in groundwater concentrations that exceed standards and risk-based thresholds for protection of surface water and groundwater.
- **RAO #4:** Prevent unacceptable risk to human health and ecological receptors from exposure to the upper 4.6 m (15 ft) of soil, structures, and debris contaminated with nonradiological constituents at concentrations above the unrestricted land-use standards for human health (provided in MTCA Method B) or soil contaminant levels protective of ecological receptors.
- **RAO #5:** Prevent unacceptable risk to human health and ecological receptors from exposure to the upper 4.6 m (15 ft) of soil, structures, and debris contaminated with radiological constituents. For human health and ecological receptors:
  - Prevent exposure to radiological constituents at concentrations at or above a dose rate limit that causes an ELCR threshold of 1×10^{-6} to 1×10^{-4} above background for the residential exposure scenario.
  - Protect ecological receptors based on a dose rate limit of 0.1 rad/day for terrestrial wildlife populations.

- **RAO #6:** Manage direct exposure to contaminated soils deeper than 4.6 m (15 ft) to prevent an unacceptable risk to HHE.
- **RAO #7:** Restore groundwater impacted from 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 releases to proposed cleanup levels, which include DWSs, within a time frame that is reasonable given the particular circumstances of the site.

Preliminary Remediation Goals

The PRGs were developed based on the RAOs and establish acceptable protective exposure levels for specific contaminants based on the media (soil or groundwater) and exposure scenario (residential activities). During the FS process, PRGs were used to assess the effectiveness of the remedial alternatives in meeting RAOs and in identifying final cleanup levels. The PRGs are presented in tables provided at the end of this Proposed Plan and list the cleanup levels to be achieved by all of the alternatives, except for No Action. PRGs were calculated for single contaminants. For sites with multiple residual contaminants, risks from individual contaminants will be added and evaluated to ensure that the waste site meets total risk limits as specified in CERCLA, the NCP, and MTCA.

Soil PRGs for direct contact human receptors are based on the residential scenario and were developed using standard approaches, consistent with state and federal guidance. Direct contact PRGs for nonradionuclides are based on risk calculations provided in Washington State MTCA (WAC 173-340) procedures using either health hazard thresholds or 1 in 1,000,000 ELCR. Direct contact PRGs for radionuclides were calculated based on acceptable radionuclide dose (15 mrem/year) and on ELCR (1 in 10,000 risk). For each radionuclide, the lower of the dose or risk-based calculations is the PRG. The soil PRGs for groundwater and surface water protection are based on model values that include irrigation to achieve drinking water protection and meet aquatic standards and are described in Section 5.7 in the 100-F/IU RI/FS report (DOE/RL-2010-98).



Summary of Remedial Alternatives

Remedial alternatives were developed in the 100-F/IU RI/FS report (DOE/RL-2010-98, Chapter 9) based on the results of a detailed technology screening. These alternatives reflect the extensive experience with waste site remediation and groundwater treatment programs that have been ongoing at Hanford Site River Corridor OUs since the 1990s. The alternatives include a range of technology groupings, as detailed in Chapter 8 and Appendix I of the 100-F/IU RI/FS report (DOE/RL-2010-98). The alternatives were developed to address source and groundwater OUs independently. Alternatives S-2 and GW- 2 are the preferred alternatives. The alternatives evaluated are as follows:

- **100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 Source OUs:**
  - Alternative S-1, No Action
  - Alternative S-2, RTD and ICs
- **100-FR-3 Groundwater OU:**
  - Alternative GW-1, No Action
  - Alternative GW-2, MNA and ICs
  - Alternative GW-3, Pump-and-Treat with In Situ Treatment and MNA

– Alternative GW-4, Enhanced Pump-and-Treat

Description of Alternatives

Alternative S-1, No Action at 100-FR-1, 100-FR-2, 100-IU-2 and 100-IU-6 OUs

Consideration of a No Action alternative is a requirement of the NCP (40 CFR 300.430[e][6]) and is included to provide a baseline for comparison against the other alternatives. Under the No Action alternative, no active remedial action would be taken to address potential threats to HHE posed by the COCs present in soil. All existing actions would cease, including ICs and monitoring.

Alternative S-2, RTD and ICs at 100-FR-1, 100-FR-2, 100-IU-2 and 100-U-6 OUs (Preferred Alternative)

Estimated capital cost: *$9.63 million*

Estimated O&M cost: *$27.9 million*

Estimated present value (discounted): *$20.6 million*

Estimated time to achieve cleanup levels: *3 to 5 years*

Alternative S-2 uses RTD at waste sites with contamination exceeding the soil cleanup levels listed in Tables 6 and 7 at the back of this Proposed Plan for protection of human health and for groundwater and surface water. Contaminated soil and debris are excavated using shallow and deep excavation technology, transported to the ***Environmental Restoration Disposal Facility (ERDF)***, and treated as necessary to meet land disposal restrictions prior to disposal at the facility. Additional components of RTD are presented in Section 9.2.3 and Table 9-2 (Chapter 9) of the 100-F/IU RI/FS report (DOE/RL-2010-98). The remediated sites will be backfilled and recontoured, followed by planting and establishing native vegetation. ICs are established and maintained as necessary to prevent exposure until levels protective of unlimited use/unlimited exposure (UU/UE) are met and as needed to protect groundwater and surface water.

ICs are mechanisms to control uses of land, facilities, and environmental media to prevent unacceptable human health and environmental exposure to residual contaminants that could pose risks above levels deemed protective. ICs generally include non-engineered restrictions on activities and access to land, groundwater, surface water, waste sites, waste disposal areas, and other areas or media that may contain hazardous substances. Common types of ICs include procedural restrictions for access, warning notices, permits, easements, deed notifications, leases and contracts, and land-use controls, such as the following:

- Controlling excavation in areas where contamination remains below 4.6 m (15 ft) bgs that exceed residential direct contact PRGs
- Preventing irrigation over or near waste sites that represent an unacceptable groundwater or surface water protection risk

Alternative S-2 requires ICs during the period before completion of the remedial action and following remedial action implementation. For Alternative S-2, drilling and excavation restrictions apply at waste sites until cleanup levels protective of UU/UE are achieved. The ICs for Alternative S-2 are identified in Table 2. For sites with ICs based on radionuclide contamination, the expected year that ICs can be removed is indicated after the site number. The concentrations of radionuclide COCs at these sites are protective of groundwater.

Table 2. Alternative S-2 — ICs at Remediated Waste Sites

Risk Driver	Institutional Controls
Waste sites with deep (greater than 4.6 m [15 ft] bgs) radiological contamination exceeding human health direct contact preliminary remediation goal levels.*	**Excavation Restrictions:** 100-F-10 — 2057 100-F-19:1 — 2113 100-F-19:2 — 2057 100-F-19:3 — 2113 100-F-29 — 2057 100-F-34 — 2113 116-F-2 — 2108 116-F-6 — 2122 116-F-9 — 2074 116-F-12 — 2113 116-F-14 — 2110 118-F-6 — 2033 118-F-8:3 — 2278 118-F-8:4 — 2059 UPR-100-F-1 — 2057
Waste site with groundwater/surface water protection risk if irrigation were applied.	**Prohibit Irrigation:** 116-F-14

* These sites have contamination at depth where human exposure is not expected and at concentrations that will not cause exceedances of drinking water standards. Institutional controls are applied to prevent material from being brought to the surface or other unacceptable exposure from drilling or digging.

With the exception of site 116-F-14, there were no threats to groundwater quality or surface water quality from waste sites in the 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 OUs. If irrigation of the land surface overlying waste sites were to occur, Cr(VI) present at waste site 116-F-14 could pose a threat to surface water quality. Residual concentrations of Cr(VI) were previously demonstrated to be protective of surface water based on interim action evaluation using a 1:1 dilution attenuation factor for groundwater-to-river contaminant migration. However, re-evaluation using current modeling parameters (and no assumed groundwater-to-river dilution/attenuation) concluded that irrigation restrictions should be applied as a conservative measure. A rough order of magnitude cost for excavation of the 116-F-14 site as an alternative to prohibiting irrigation was calculated to be $107 million and was not evaluated further as one of the alternatives. Therefore, ICs for Alternative S-2 include an irrigation prohibition above waste site 116-F-14 for groundwater/surface water protection.

Alternative GW-1 for 100-FR-3 OU, No Action

Under the No Action alternative, no active remedial action would be taken to address potential threats to HHE posed by the COCs present in the 100-FR-3 OU. All existing actions would cease, including ICs and monitoring, which would potentially allow exposure to contaminated groundwater.

Alternative GW-2 for 100-FR-3 OU, MNA and ICs (Preferred Alternative)

Estimated capital cost: *$4.93 million*

Estimated O&M cost: *$54.7 million*

Estimated present value (discounted): *$36.3 million*

Estimated time to achieve cleanup levels: *35 years for Cr(VI), 80 years for nitrate, 150 years for strontium-90, and 50 years for TCE*

Alternative GW-2 relies upon MNA processes to reduce groundwater COC concentrations during the estimated time periods to concentrations less than the cleanup levels for 100-FR-3 OU groundwater shown in Table 8 at the back of this Proposed Plan. ICs are maintained to prevent exposure to contaminated groundwater until cleanup levels are achieved.

MNA relies on natural attenuation processes that include a variety of physical, chemical, or biological processes, which, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil or groundwater. These in situ processes include biodegradation, dispersion, dilution, sorption, volatilization, radioactive decay, and chemical or biological stabilization, transformation, or destruction of contaminants. A description of MNA processes for the 100-FR-3 OU is included in Section 9.2.1.2 (Chapter 9) and Appendix M in the 100-F/IU RI/FS report (DOE/RL-2010-98).

MNA was considered for the 100-FR-3 Groundwater OU contamination based on the following considerations:

- The conditions do not currently present an actual risk to human or ecological receptors. ICs currently in place, and those proposed under this Proposed Plan will be maintained throughout the MNA period. Site monitoring will be adequate to confirm exposure mitigation.
- The source of the observed contamination is no longer contributing to the plume. The extensive source remediation conducted for 100-F/IU under the interim action RODs (1,832,000 metric tons [2,020,000 tons] of contaminated material removed) and the remaining source control recommended under Alternative S-2 will address sources contributing to groundwater contamination.
- The COC plumes are decreasing in concentration, and attenuation processes are present and operating within the plumes. This has been determined based on evaluation of historical and current groundwater data.

MNA for groundwater is a component of Alternative GW-2 for all of the COC plumes. The performance monitoring component includes installation of new wells, periodic sampling, laboratory analysis, and data evaluation to assess the natural attenuation processes, rates of attenuation, and overall protectiveness. Operations and maintenance (O&M) activities for this remedy include inspection, maintenance, and periodic replacement of monitoring wells. The monitoring will continue until cleanup levels are achieved.

DOE will control well drilling through excavation permits and will restrict groundwater use until such time as the groundwater achieves levels protective of UU/UE. Groundwater use is restricted through ICs to limited research purposes and for monitoring and treatment, as approved by EPA or Ecology.

Alternative GW-3 for 100-FR-3 OU, Pump-and-Treat with In Situ Treatment and MNA

Estimated capital cost: *$80.2 million*

Estimated O&M cost: *$124 million*

Estimated present value (discounted): *$177 million*

Estimated time to achieve cleanup levels: *5 years for Cr(VI), 75 years for nitrate, 150 years for strontium-90, and 10 years for TCE*

Alternative GW-3 reduces Cr(VI), nitrate, strontium-90, and TCE concentrations through an ex situ pump-and-treat system, with in situ treatment of nitrate, Cr(VI), and TCE. The strontium-90 plume and the southern portion of the nitrate plume are reduced through MNA. ICs are maintained to prevent exposure to contaminated groundwater until cleanup levels are achieved.

Pump-and-treat uses a network of extraction and injection wells targeting each of the COC plumes, combined with ex situ treatment at a central treatment facility, before reinjecting treated groundwater into the aquifer. Ex situ groundwater treatment uses ion-exchange technology for Cr(VI), nitrate, and strontium-90. Groundwater contaminated with TCE is treated using an air stripper. The groundwater pump-and-treat systems include routine and preventive maintenance programs, as well as replacement of pump-and-treat system components at the end of their design life.

In situ treatment will be accomplished by amending a portion of the treated water from the pump-and-treat system with a carbon substrate before reinjection into the upgradient portion of the nitrate, Cr(VI), and TCE plumes. The substrate type and concentration are determined during remedial design.

Alternative GW-3 uses pump-and-treat for the higher concentration northern half of the nitrate plume, and it relies on MNA to attenuate the lower concentration in the southern portion of the plume. Pump-and-treat remediation has demonstrated limited effectiveness in reducing strontium-90 concentration because of the relative immobility of strontium-90. MNA, as described under Alternative GW-2, will be used for residual strontium-90 and nitrate until concentrations are protective of UU/UE.

Alternative GW-4 for 100-FR-3 OU, Enhanced Pump-and-Treat

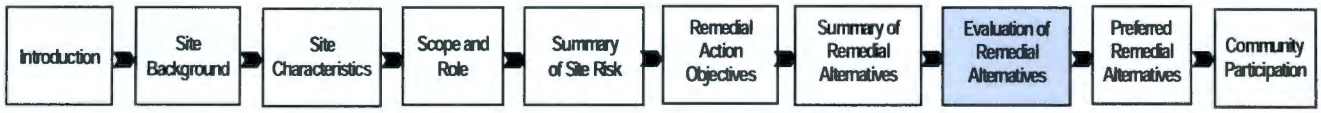
Estimated capital cost: *$96.5 million*

Estimated O&M cost: *$124 million*

Estimated present value (discounted): *$194 million*

Estimated time to achieve cleanup levels: *10 years for Cr(VI), 25 years for nitrate, 150 years for strontium-90, and 10 years for TCE*

Alternative GW-4 reduces Cr(VI), strontium-90, TCE, and nitrate concentrations through enhanced pump-and-treat for the 100-FR-3 OU plumes, including the southern, less concentrated portion of the nitrate plume. Groundwater pump-and-treat is used to control plume migration through hydraulic containment and to remediate the groundwater plume through an extensive extraction well network and treatment. The treatment system uses ion exchange for Cr(VI), strontium-90, and nitrate, and air stripping for TCE. The groundwater pump-and-treat systems include routine and preventive maintenance programs, as well as replacement of pump-and-treat system components at the end of their design life. MNA, as described under Alternative GW-2, is used for strontium-90 following the pump-and-treat period until concentrations are protective of UU/UE. ICs are maintained to prevent exposure to contaminated groundwater until cleanup levels are achieved.



Evaluation of Remedial Alternatives

As part of the FS, DOE evaluated each remedial alternative against the CERCLA threshold and balancing criteria described in the NCP (40 CFR 300.430[e][9]). Following this evaluation, a comparative analysis was performed to assess the overall performance of each alternative relative to the others. Figure 10 presents the nine CERCLA evaluation criteria. The nine criteria are categorized into three groups: threshold criteria, balancing criteria, and modifying criteria.

A remedial alternative must satisfy the two threshold criteria to be considered viable: (1) overall protection of HHE, and (2) compliance with ARARs. The five balancing criteria allow for a comparison of major tradeoffs among the alternatives. The ability of an alternative to meet the modifying criteria (state and community acceptance) will be evaluated after the Tribal Nations and the public review and comment period, which is initiated with this Proposed Plan. After completion of the formal public comment period, the Tri-Parties will consider the comments received before DOE and EPA issue a ROD. The modifying criteria are an important consideration in the final evaluation of remedial alternatives.

The following sections describe the comparative evaluation of alternatives that was used to identify the preferred alternatives presented in this Proposed Plan. A more detailed comparative analysis is provided in Chapter 10 of the 100-F/IU RI/FS report (DOE/RL-2010-98). The comparative evaluation is summarized for the 100-FR-3 Groundwater OU in Table 3.

Threshold Criteria

Overall Protection of HHE. Alternatives S-1 and GW-1 (No Action) propose no remediation of waste sites or contaminated groundwater and no ICs to protect HHE. These alternatives are not protective of HHE.

For the waste sites in the 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 Source OUs, Alternative S-2 (RTD and ICs) is protective of HHE, will achieve cleanup levels within a reasonable time frame, and meets this threshold criterion. For groundwater cleanup, Alternatives GW-2, GW-3, and GW-4 are protective of HHE, will achieve cleanup within a reasonable time frame given the particular circumstances of the site, and meet this threshold criterion.

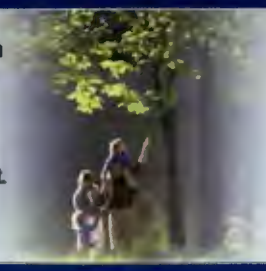
Compliance with ARARs. The ARAR identification process is based on CERCLA, the NCP (40 CFR 300), and guidance. The lead and support agencies are to identify requirements applicable or relevant and appropriate to the release or remedial action at a CERCLA site (NCP [40 CFR 300.400(g), "General"]). Alternatives S-1 and GW-1 do not require action and, therefore, ARARs are not implicated. Alternatives S-2, GW-2, GW-3, or GW-4 all will comply with ARARs. A complete list of identified potential ARARs is provided in the 100-F/IU RI/FS report (DOE/RL-2010-98, Chapter 8, Table 8-2).

CERCLA Evaluation Criteria

THRESHOLD CRITERIA

Threshold criteria mean that only those remedial alternatives that provide adequate protection of human health and the environment and comply with ARARs are eligible for selection:

1. **Overall Protection of Human Health and the Environment** is the primary objective of the remedial action and determines whether an alternative provides adequate overall protection of human health and the environment. This criterion must be met for all remedial actions.



2. **Compliance with Applicable or Relevant and Appropriate Requirements** addresses whether an alternative meets federal and state statutes or provides grounds for a waiver. This criterion must be met for a remedial alternative to be eligible for consideration.

BALANCING CRITERIA

Balancing criteria help describe technical and cost trade-offs among the various remedial alternatives:

3. **Long-Term Effectiveness and Permanence** refers to the ability of a remedy to protect human health and the environment over time, after remedial action objectives have been met.

4. **Reduction of Toxicity, Mobility, or Volume through Treatment** means the alternative is evaluated for its ability to reduce the toxicity, mobility, and volume of the hazards at a site.

5. **Short-Term Effectiveness** refers to an evaluation of the speed with which the remedy can be successful and also takes into consideration any adverse impacts on human health and the environment that may result during the construction and implementation phase of the remedial action.

6. **Implementability** refers to the technical and administrative feasibility of a remedial action, including the availability of materials and services needed to implement the selection.

7. **Cost** refers to an evaluation of the costs of each alternative.

MODIFYING CRITERIA

Modifying criteria can only be considered after public comment is received on the proposed remedy:

8. **State Acceptance** indicates whether the state concurs with, opposes, or has no comment on the proposed remedial action.

9. **Community Acceptance** assesses the public response to the proposed remedial action. Although public comment is an important part of the decision-making process, EPA is required by law to balance community concerns with the above criteria.

Figure 10. CERCLA Evaluation Criteria

Table 3. Evaluation of Groundwater Alternatives

Criterion	Alternative GW-1, No Action	Alternative GW-2, MNA and ICs	Alternative GW-3, Pump-and-Treat with In Situ Treatment and MNA	Alternative GW-4, Enhanced Pump-and-Treat
	Rating	Rating	Rating	Rating
Overall Protection of HHE	No	Yes	Yes	Yes
Compliance with ARARs	N/A	Yes	Yes	Yes
Long-Term Effectiveness and Permanence	N/A	★★★	★★★	★★★
Reduction of Toxicity, Mobility, or Volume by Treatment	N/A	★☆☆	★★☆	★★★
Short-Term Effectiveness	N/A	★★☆	★★☆	★★☆
Implementability	N/A	★★★	★★☆	★★☆
Net Present Value of Alternative (Discounted)*	**N/A**	**$36,261,000**	**$176,780,000**	**$193,814,000**

Note: The comparative evaluation metrics are defined as follows:

★★★ = Performs very well against the criterion with no apparent disadvantages or uncertainty.

★★☆ = Performs moderately well against the criterion but with some disadvantages or uncertainty.

★☆☆ = Expected to perform less well against the criterion with more disadvantages or uncertainty.

* Detailed cost estimates are presented in Appendix K of DOE/RL-2010-98, *Remedial Investigation/Feasibility Study for 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and 100-IU-6 Operable Units.*

ARAR = applicable or relevant and appropriate requirement
HHE = human health and the environment
IC = institutional control
MNA = monitored natural attenuation
N/A = not applicable

Balancing Criteria

Long-Term Effectiveness and Permanence. The long-term effectiveness and permanence criterion evaluates the risk remaining at the site after response objectives have been met. The evaluation considers (1) the magnitude of the residual risk, and (2) the adequacy and reliability of controls that may be required to manage treatment residuals or untreated waste.

For the waste sites, Alternative S-2 provides very good long-term effectiveness and permanence because COC-contaminated soil and debris exceeding cleanup levels are removed and transported to the ERDF.

Groundwater Alternatives GW-2, GW-3, and GW-4 are rated high in long-term effectiveness and permanence. The alternatives use a combination of both active treatment and natural attenuation that permanently reduce COC concentrations over different time frames. Table 4 presents the estimated remedial action time frames. At the end of the remedial time frame, the COC concentrations under each of the alternatives will be reduced to levels that are protective of HHE.

Table 4. Comparison of Remedial Action Time Frame Estimates (Years)

COC	PRG	GW-1: No Action	GW-2: MNA and ICs	GW-3: Pump-and-Treat with In Situ Treatment and MNA	GW-4: Enhanced Pump-and-Treat
Hexavalent Chromium	10 µg/L	35	35	5	10
Hexavalent Chromium	48 µg/L	20	20	5	5
Nitrate	45,000 µg/L	80	80	75	25
Trichloroethene	4 µg/L	50	50	10	10
Strontium-90	8 pCi/L	150	150	150	150

Note: The remedial action time frame estimates are based on modeling as presented in DOE/RL-2010-98, *Remedial Investigation/Feasibility Study for 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and 100-IU-6 Operable Units.*

COC = contaminant of concern
IC = institutional control
MNA = monitored natural attenuation
PRG = preliminary remediation goal (cleanup levels for groundwater)

Reduction of Toxicity, Mobility, or Volume through Treatment. Alternative S-2 does not provide reduction of toxicity, mobility, or volume through treatment, except as required for disposal of excavated soil and material.

Alternative GW-4 provides the highest reduction of toxicity, mobility, or volume through treatment. The majority of the COC mass is removed from the aquifer using groundwater extraction and treatment. Groundwater extraction and injection wells are also used to contain the COC plumes, preventing their migration into uncontaminated areas. Alternative GW-3 provides a moderate degree of toxicity, mobility, or volume reduction because it employs treatment of contaminants in groundwater extracted from the northern portion of the 100-FR-3 OU plumes but relies on MNA for the southern portion of the nitrate plume. Alternative GW-2 relies on MNA rather than active treatment; therefore, it is rated the lowest.

Short-Term Effectiveness. This criterion assesses the time to achieve RAOs and any adverse effects during the construction and implementation phases of remedial actions, including potential impact to workers, the public, and the environment.

The short-term effectiveness for Alternative S-2 rates moderately well. Risks to the community are low because of the remote location of the waste sites. Potential risk occurs during material handling and from excavation sidewall instability. Environmental risk and risks to workers are controlled and minimized using engineering measures and personal protective equipment. The RAOs for the waste sites are met in a short time frame.

Groundwater Alternatives GW-2, GW-3, and GW-4 are expected to perform moderately well relative to this criterion, and all are rated the same (Table 3). Although Alternatives GW-3 and GW-4 achieve cleanup levels sooner for Cr(VI), nitrate, and TCE, the time frames for each of these three groundwater alternatives to achieve the cleanup level for strontium-90 are similar. Alternative GW-2 has a lower potential for adverse impact to the community, workers, or the environment because there is less construction-related activity in comparison to Alternatives GW-3 and GW-4.

Implementability. The criterion of implementability is used to compare the technical and administrative feasibility of the remedial alternatives. Factors considered include the availability of materials and services

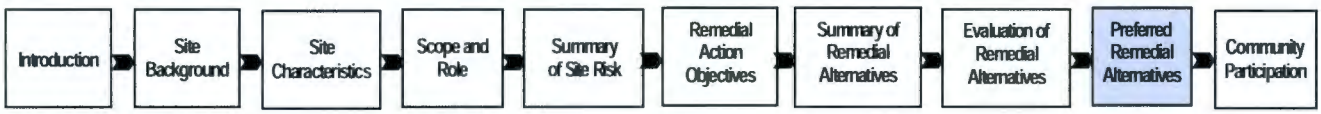
needed to implement the remedy components. Alternative S-2 is readily implementable because the excavation required for RTD of the waste sites has been proven, materials and services are readily available, and minimal administrative challenges exist.

Alternative GW-2 is more readily implemented than Alternatives GW-3 or GW-4 because it involves only the installation of additional monitoring wells. Alternatives GW-3 and GW-4 are both moderately implementable because they require installation of a greater number of wells and treatment systems, which represents a moderate technical challenge. The in situ treatment for Alternative GW-3 does require specialized biological reagents, but it is a proven technology. All of the groundwater alternatives present minimal administrative challenges.

Cost. The costs for the groundwater alternatives are the lowest for Alternative GW-2 and the highest for Alternative GW-4. Estimated design, construction, O&M, and decommissioning costs were developed for each alternative. The O&M costs were estimated based on the alternative-specific remedial time frames. The total present value costs are $20.6 million for Alternative S-2, $36.3 million for Alternative GW-2, $177 million for Alternative GW-3, and $194 million for Alternative GW-4.

Modifying Criteria

State and community input received to date have been considered in the development of this Proposed Plan. Modifying criteria will be considered after receiving comments from the Tribal Nations and the public on this Proposed Plan and assessing any state concerns. In the final balancing of tradeoffs between alternatives upon which the final remedy selection is based, modifying criteria and balancing criteria are both important.



Preferred Remedial Alternatives

Alternatives S-2 (RTD and ICs) and GW-2 (MNA and ICs) are the preferred alternatives. These alternatives are recommended because they achieve protection of HHE through RTD of waste sites and MNA of groundwater, satisfy ARARs, and, compared to the other alternatives, provide the best balance of tradeoffs under the balancing criteria.

Alternative S-2 uses RTD to remove material that is above cleanup levels needed to protect HHE. This is accomplished using standard construction practices for excavation and secure transport of materials to ERDF, treatment as necessary to meet any land disposal restrictions, and disposal of the material in a secure environment. The implementation of an RTD remedy at waste sites meets RAOs #3, #4, #5, and #6 for preventing unacceptable risk to HHE. Specific waste site ICs that would be implemented under Alternative S-2 are listed in Table 5. The irrigation IC meets RAO #3 by preventing migration and or leaching of contaminants to groundwater and surface water. The excavation restriction IC meets RAO #6 to prevent unacceptable risk by managing direct exposure. Table 5 lists all of the waste sites in the 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 OUs and how each would be specifically addressed under the preferred alternatives.

Table 5. Waste Sites Included in the Preferred Alternatives

Technology/Approach	Operable Unit (Number of Waste Sites)	Waste Site
No additional action needed to meet selected remedy requirements	100-FR-1 (92)	100-F-4, 100-F-7, 100-F-9, 100-F-11, 100-F-12, 100-F-16, 100-F-18, 100-F-23, 100-F-24, 100-F-25, 100-F-26:1, 100-F-26:2, 100-F-26:3, 100-F-26:4, 100-F-26:5, 100-F-26:6, 100-F-26:7, 100-F-26:8, 100-F-26:9, 100-F-26:10, 100-F-26:11, 100-F-26:12, 100-F-26:13, 100-F-26:14, 100-F-26:15, 100-F-26:16, 100-F-31, 100-F-33, 100-F-36, 100-F-37, 100-F-38, 100-F-39, 100-F-42, 100-F-43, 100-F-44:1, 100-F-44:2, 100-F-44:4, 100-F-44:5, 100-F-44:8, 100-F-44:9, 100-F-45, 100-F-46, 100-F-47, 100-F-48, 100-F-49, 100-F-51, 100-F-52, 100-F-53, 100-F-54, 100-F-55, 100-F-56:1, 100-F-56:2, 100-F-57:1, 100-F-57:2, 100-F-58, 100-F-59, 100-F-60, 100-F-61, 100-F-62, 100-F-63, 100-F-64, 100-F-65, 116-F-1, 116-F-3, 116-F-4, 116-F-5, 116-F-7:1, 116-F-7:2, 116-F-8, 116-F-10, 116-F-11, 116-F-15, 116-F-16, 118-F-8:1, 126-F-2, 128-F-2, 132-F-1, 132-F-3, 132-F-4:1, 132-F-4:2, 132-F-5, 132-F-6, 141-C, 182-F, 1607-F2, 1607-F3, 1607-F4, 1607-F5, 1607-F6, 1607-F7, UPR-100-F-2, UPR-100-F-3
	100-FR-2 (18)	100-F-2, 100-F-14, 100-F-15, 100-F-20, 100-F-35, 100-F-50, 118-F-1, 118-F-2, 118-F-3, 118-F-4, 118-F-5, 118-F-7, 120-F-1, 126-F-1, 128-F-1, 128-F-3, 1607-F1, 600-351
	100-IU-2 (45)	600-5, 600-52, 600-98, 600-99, 600-100, 600-120, 600-124, 600-125, 600-127, 600-128, 600-129, 600-131, 600-132, 600-139, 600-176, 600-181, 600-182, 600-188, 600-190, 600-191, 600-201, 600-295, 600-296, 600-297, 600-302, 600-305:1, 600-305:2, 600-305:3, 600-305:4, 600-305:5, 600-306, 600-307, 600-308, 600-309, 600-310, 600-311, 600-312, 600-341:1, 600-341:2, 600-342, 600-343, 600-344, 600-345, 600-346, 628-1
	100-IU-6 (43)	600-3, 600-23, 600-107, 600-108, 600-109, 600-110, 600-111, 600-146, 600-149:1, 600-149:2, 600-178, 600-186, 600-202, 600-204, 600-205, 600-208, 600-235, 600-239, 600-257, 600-272, 600-280, 600-313, 600-314:1, 600-314:2, 600-314:3, 600-314:4, 600-314:5, 600-315, 600-317, 600-319:1, 600-319:2, 600-319:3, 600-322, 600-323, 600-324, 600-325:1, 600-325:2, 600-327, 600-334:1, 600-350, JA JONES 1, UPR-600-11, UPR-600-16

Table 5. Waste Sites Included in the Preferred Alternatives

Technology/Approach	Operable Unit (Number of Waste Sites)	Waste Site
Removal, treatment, and disposal to proposed cleanup levels	100-IU-2 (39)	600-279, 600-293, 600-294, 600-298:1, 600-298:2, 600-298:3, 600-298:4, 600-298:5, 600-298:6, 600-298:7, 600-298:8, 600-299:1, 600-299:2, 600-299:3, 600-299:4, 600-299:5, 600-299:6, 600-300:1, 600-300:2, 600-300:3, 600-300:4, 600-300:5, 600-300:6, 600-300:7, 600-300:8, 600-300:9, 600-300:10, 600-300:11, 600-300:12, 600-301, 600-303, 600-316:1, 600-316:2, 600-316:3, 600-316:4, 600-316:5, 600-316:6, 600-370, 600-371, 600-372:1, 600-372:2, 600-373, 600-374, 600-375:1, 600-375:2, 600-375:3, 600-375:4, 600-375:5, 600-376:1, 600-376:2
	100-IU-6 (52)	600-20, 600-318:1, 600-318:2, 600-318:3, 600-318:4, 600-318:5, 600-320:1, 600-320:2, 600-320:3, 600-320:4, 600-320:5, 600-320:6, 600-320:7, 600-320:8, 600-320:9, 600-321:1, 600-321:2, 600-321:3, 600-321:4, 600-326:1, 600-326:2, 600-328, 600-329, 600-331, 600-332, 600-334:2, 600-349, 600-356, 600-358, 600-368, 600-369:1, 600-369:2, 600-369:3, 600-369:4, 600-369:5, 600-369:6, 600-369:7, 600-369:8, 600-370, 600-371, 600-372:1, 600-372:2, 600-373, 600-374, 600-375:1, 600-375:2, 600-375:3, 600-375:4, 600-375:5, 600-377, 600-378, 600-379
Institutional controls (Prohibit irrigation; waste sites with groundwater/surface water protection risk if irrigation were applied)	100-FR-1 (1)	116-F-14
Excavation restrictions (Waste sites with deep [greater than 4.6 m [15 ft] below ground surface] radiological contamination exceeding human health direct contact proposed cleanup levels)	100-FR-1 (14)	100-F-10, 100-F-19:1, 100-F-19:2, 100-F-19:3, 100-F-29, 100-F-34, 116-F-2, 116-F-6, 116-F-9, 116-F-12, 116-F-14, 118-F-8:3, 118-F-8:4, UPR-100-F-1
	100-FR-2 (1)	118-F-6

Alternative GW-2 achieves substantial risk reduction through a combination of MNA and ICs. MNA provides mechanisms to restore groundwater to proposed cleanup levels and meets RAOs #1, #2, and #7. Implementation of Alternative GW-2 includes installation of new wells, periodic sampling, laboratory analysis, and data evaluation to assess the natural attenuation processes, rates of attenuation, and overall protectiveness.

Alternative S-2 was the only soil alternative that passed threshold criteria, which is a statutory requirement for selection. It performs well for the balancing criteria and has demonstrated effectiveness for waste site remediation under interim actions. Alternative GW-2 is the most easily implemented and has the lowest cost while maintaining protectiveness of HHE.

DOE believes that the preferred alternatives meet the threshold criteria and provide the best balance of tradeoffs among the other alternatives with respect to the balancing criteria. DOE expects the preferred alternatives to satisfy the following statutory requirements of CERCLA Section 121(b), "Cleanup Standards," "General Rules":

(1) be protective of HHE, (2) comply with ARARs (or justify a waiver), (3) be cost effective, and (4) use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. CERCLA criteria for preference for treatment as a principal element are achieved for RTD through treatment to meet land disposal restriction requirements. Treatment did not significantly reduce the time frame to achieve RAOs for groundwater.

The preferred alternatives could be modified or another alternative selected through consideration of public comment on this Proposed Plan. After public comment, the EPA, in coordination with DOE, will then prepare a CERCLA ROD. This ROD will identify the selected remedy. A responsiveness summary containing agency responses to comments received during the public comment period will be made available with issuance of the ROD.

State Acceptance

The Washington State Department of Ecology, the support regulatory agency, has concurred with the Preferred Alternatives (Alternative S-2 and Alternative GW-2) identified by DOE and EPA in this Proposed Plan.

Community Participation

Public input is a key element in DOE's decision-making process. The 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 alternatives.

The Administrative Record for this proposed remedial action decision is available for review at http://pdw.hanford.gov/arpir/. Printed copies of this Proposed Plan and the 100-F/IU RI/FS report are available at the repositories listed at the right.

The comment period for this Proposed Plan extends from June 9 through July 9, 2014. Since the stakeholders have already requested a 30-day extension, comments on the preferred alternatives, other alternatives, or any element of this Proposed Plan or support information will be accepted through August 11, 2014. Please send comments to the following:

Mail: Kim Ballinger
U.S. Department of Energy, Richland Operations Office
P.O. Box 550, MSIN A7-75
Richland, WA 99352
Email: 100FIUPP@RL.gov

A Public Meeting is currently planned for June 25, 2014 in Hood River, Oregon. The meeting will be held at the Best Western, 1108 E Marina Drive. A poster session will begin at 6:00 P.M., followed by information presentations. Acceptance of verbal comments begins at 7:30 P.M. The meeting will also be available as a webinar at the following address: https://www3.gotomeeting.com/register/842987390.

To request a meeting in your area, please contact Christopher Guzzetti (509-376-9529) no later than June 30, 2014.

After the public comment period, DOE and EPA will consider the comments received regarding this Proposed Plan and the information gathered during the comment period.

Hanford Public Information Repository Locations

Administrative Record and Public Information Repository
2440 Stevens Center Place
Room 1101, Richland, WA 99352
Phone: (509) 376-2530
Website: http://pdw.hanford.gov/arpir/

Portland
Portland State University
Branford P. Millar Library
1875 SW Park Avenue
Portland, OR 97207-1151
Phone: (503) 725-4542
Map: http://www.pdx.edu/map.html

Seattle
University of Washington
Suzzallo Library
Government Publications Department
P.O. Box 352900
Seattle, WA 98195-2900
Phone: (206) 543-5597
Map: http://tinyurl.com/m8ebj

Richland
Washington State University, Tri-Cities
Consolidated Information Center
Room 101-L, 2770 University Drive
Richland, WA 99352
Phone: (509) 375-3308
Map: http://reading-room.labworks.org/Directions.aspx

Spokane
Gonzaga University
Foley Center Library
East 502 Boone Ave.
Spokane, WA 99258
Phone: (509) 313-6110
Map: http://tinyurl.com/2c6bpm

Proposed Cleanup Levels for Preferred Alternatives

Table 6. 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 OUs Proposed Soil Cleanup Levels (PRGs) for Protection of Human Health

Contaminant	Hanford Site Background Concentration[a]	Proposed Cleanup Levels (≤4.6 m [15 ft] bgs)	
		PRG	Exposure Driver
Radionuclides (pCi/g)			
Cesium-137	1.1	4.4	Direct contact residential scenario
Cobalt-60	0.0084	1.4	Residential remedial action goal, DOE/RL-96-17
Europium-152	--	3.3	Residential remedial action goal, DOE/RL-96-17
Europium-154	0.033	3.0	Residential remedial action goal, DOE/RL-96-17
Nickel-63	--	608	Direct contact residential scenario
Strontium-90	0.18	2.3	Direct contact residential scenario
Chemicals (mg/kg)			
Arsenic	6.5	20	WAC 173-340-900, Table 740-1, Method A
Hexavalent Chromium	--	240	Direct contact, MTCA Method B
Lead	10.2	250	WAC 173-340-900, Table 740-1, Method A
Mercury	0.013	24	Direct contact, MTCA Method B
Nitrate	52	568,000	Direct contact, MTCA Method B
Aroclor 1254	--	0.50	Direct contact, MTCA Method B
Aroclor 1260	--	0.50	Direct contact, MTCA Method B
Benzo(a)pyrene	--	0.14	Direct contact, MTCA Method B
TPH–Diesel Range	--	2,000	WAC 173-340-900, Table 740-1, Method A
TPH–Motor Oil (High Boiling)	--	2,000	WAC 173-340-900, Table 740-1, Method A

Sources: DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area.*

WAC 173-340, "Model Toxics Control Act—Cleanup."

WAC 173-340-900, "Model Toxics Control Act—Cleanup," "Tables."

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.*

bgs = below ground surface
MTCA = *Model Toxics Control Act*
PRG = preliminary remediation goal
TPH = total petroleum hydrocarbon
WAC = *Washington Administrative Code*

Table 7. 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 OUs Proposed Soil Cleanup Levels (PRGs) for Protection of Groundwater and Surface Water

Contaminant	Proposed Groundwater and Surface Water Protection Cleanup Levels (Ground Surface to Water Table)[a]		
	100-FR-1 and 100-FR-2	100-IU-2	100-IU-6
	Residential Irrigation	Residential Irrigation	Residential Irrigation
Radionuclides (pCi/g)			
Cesium-137	—[b]	—[b]	—[b]
Cobalt-60	—[b]	—[b]	—[b]
Europium-152	—[b]	—[b]	—[b]
Europium-154	—[b]	—[b]	—[b]
Nickel-63	—[b]	—[b]	—[b]
Strontium-90	24,600[c]	64,200[c]	104,000[c]
Chemicals (mg/kg)			
Arsenic	—[b]	—[b]	—[b]
Hexavalent Chromium	2.0	2.0	2.0
Lead	—[b]	—[b]	—[b]
Mercury	—[b]	—[b]	—[b]
Nitrate	1,790	6,360	11,300
Aroclor 1254	—[b]	—[b]	—[b]
Aroclor 1260	—[b]	—[b]	—[b]
Benzo(a)pyrene	—[b]	—[b]	—[b]
TPH–Diesel Range	2,000[d]	2,000[d]	2,000[d]
TPH–Motor Oil (High Boiling)	2,000[d]	2,000[d]	2,000[d]

a. Soil cleanup levels for the protection of groundwater and surface water were calculated based on site-specific data and specific parameters using the STOMP code with a one-dimensional model for all contaminants. The cleanup levels for contaminated soil in the top 4.6 m (15 ft) will be the more conservative of the human health (Table 6) and groundwater and surface water protection (Table 7). For contaminated soil at depths greater than 4.6 m (15 ft) bgs, cleanup levels are protective of groundwater and surface water.

For highly mobile contaminants (distribution coefficient less than 2), the model assumes that the entire vadose zone from ground surface to groundwater is contaminated. For less mobile contaminants (distribution coefficient greater than or equal to 2), the model assumes that the top 70 percent is contaminated and the bottom 30 percent is not contaminated. For the residential scenario, a groundwater recharge rate of approximately 72 mm/year was used representing an irrigated condition. Model details are contained in DOE/RL-2010-98, *Remedial Investigation/Feasibility Study for 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and 100-IU-6 Operable Units* (Section 5.7 and Table 5.4).

b. The cleanup level for groundwater and surface water protection is not identified because model predictions indicate that there is no breakthrough of the analyte within 1,000 years; therefore, the analyte will not impact groundwater or surface water at levels that pose a risk.

Table 7. 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 OUs Proposed Soil Cleanup Levels (PRGs) for Protection of Groundwater and Surface Water

Contaminant	Proposed Groundwater and Surface Water Protection Cleanup Levels (Ground Surface to Water Table)[a]		
	100-FR-1 and 100-FR-2	100-IU-2	100-IU-6
	Residential Irrigation	Residential Irrigation	Residential Irrigation

c. Strontium-90 cleanup levels were calculated based on a model that assumes a distribution across the entire vadose zone. This is an exception to footnote "a" because of data that indicated strontium-90 was distributed throughout the vadose zone at some locations in these operable units.

d. The proposed cleanup level for TPHs is a default screening level obtained from WAC 173-340-900, "Tables," Table 747-5, "Residual Saturation Screening Levels for TPH."

STOMP = Subsurface Transport Over Multiple Phases

TPH = total petroleum hydrocarbon

WAC = *Washington Administrative Code*

Table 8. Proposed Cleanup Levels for 100-FR-3 Groundwater for All Alternatives (Other than No Action)

Contaminant of Concern	Units	Proposed Cleanup Level	Basis for Cleanup Level
Strontium-90	pCi/L	8	DWS
Hexavalent chromium[a]	µg/L	10/48	WAC 173-201A/WAC 173-340-720
Trichloroethene	µg/L	4	WAC 173-340-720
Nitrate[b]	µg/L	45,000	DWS

Sources:

DWS are from 40 CFR 141, "National Primary Drinking Water Regulations."

WAC 173-201A, "Water Quality Standards for Surface Waters of the State of Washington."

WAC 173-340-720, "Model Toxics Control Act—Cleanup," "Groundwater Cleanup Standards."

a. Cleanup levels for hexavalent chromium are 48 µg/L in the upland groundwater and 10 µg/L where groundwater discharges to surface water.

b. Nitrate may be expressed as nitrate-nitrogen (NO_3-N) or as nitrate (NO_3). The DWSs for NO_3-N and NO_3 are 10,000 and 45,000 µg/L, respectively.

CFR = *Code of Federal Regulations*

DWS = drinking water standard

WAC = *Washington Administrative Code*

Acronym 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
CRC	Columbia River Component
Cr(VI)	hexavalent chromium
DOE	U.S. Department of Energy
DWS	drinking water standard
Ecology	Washington State Department of Ecology
ELCR	excess lifetime cancer risk
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ERDF	Environmental Restoration Disposal Facility
FS	feasibility study
HHE	human health and the environment
HRNM	Hanford Reach National Monument
IC	institutional control
LFI	limited field investigation
LIGO	Laser Interferometer Gravitational-Wave Observatory
MNA	monitored natural attenuation
MTCA	*Model Toxics Control Act—Cleanup* (WAC 173-340)
NCP	National Contingency Plan ("National Oil and Hazardous Substances Pollution Contingency Plan" [40 CFR 300])
NEPA	*National Environmental Policy Act of 1969*
O&M	operations and maintenance
OU	operable unit
PCB	polychlorinated biphenyl
PRG	preliminary remediation goal

RAO	remedial action objective
RCBRA	River Corridor Baseline Risk Assessment
RCRA	*Resource Conservation and Recovery Act of 1976*
RI	remedial investigation
ROD	Record of Decision
RTD	removal, treatment, and disposal
STOMP	Subsurface Transport Over Multiple Phases
TCE	trichloroethene
TPH	total petroleum hydrocarbon
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
Tri-Parties	U.S. Department of Energy, U.S. Environmental Protection Agency, and Washington State Department of Ecology
UU/UE	unlimited use/unlimited exposure
USFWS	U.S. Fish and Wildlife Service
WAC	*Washington Administrative Code*

Glossary

Administrative Record: Collection of information (including reports, public comments, and correspondence) that contains the documents that form the basis for selection of a response action. A list of locations where the Administrative Record is available appears in the "Community Participation" section of this Proposed Plan.

Ambient water quality criteria: As defined by EPA, "...the suggested maximum allowable concentration of a chemical in surface water for the protection of aquatic life and human health."

Applicable or relevant and appropriate requirements (ARARs): "Applicable requirements" mean those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable. "Relevant and appropriate requirements" mean that those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. Only those state standards that are identified in a timely manner and are more stringent than federal requirements may be relevant and appropriate.

Attenuation rate: The rate at which concentrations of a contaminant decrease because of natural processes such as radioactive decay, oxidation/reduction, biodegradation, and/or sorption.

Baseline risk assessment: A study to characterize the current and potential threats to HHE if no remedial action is taken at the site. It is also used to help establish acceptable exposure levels for use in developing remedial alternatives and to determine the need, or basis, for action.

***Code of Federal Regulations* (CFR):** 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.

***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, pollutants, or contaminants have been released (e.g., leaked, spilled, or dumped) to the environment or where there is a substantial threat of such a release.

Contaminant of concern (COC): Radionuclides and chemicals that exceed risk threshold values and are addressed by cleanup actions at the site.

Contaminant of potential concern (COPC): COPCs are hazardous substances, pollutants, or contaminants that have been found, or are likely to be present that could potentially represent risk to HHE. The effects depend upon the amount of the contaminant present, the toxicity of the contaminant, and how the contaminant is or might be 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 HHE.

Debris: Building waste or construction material.

Drinking water standard (DWS): The maximum allowable concentration of a chemical or radionuclide constituent in drinking water that is protective of human health. The DWS, described in 40 CFR 141, is also known as the "maximum contaminant level."

Environmental Restoration Disposal Facility (ERDF): The Hanford Site's onsite CERCLA-approved facility for the disposal of hazardous (radioactive and nonradioactive) waste and contaminated environmental media in accordance with a CERCLA response action decision documents and ERDF waste acceptance criteria.

Excess lifetime cancer risk (ELCR): Potential carcinogenic effects that are characterized by estimating the additional ("excess") probability of cancer incidence in a population of individuals for a specific lifetime from projected contamination intakes (and exposures) and chemical-specific, dose response data (i.e., slope factors).

Explanation of significant differences: Differences in the remedial action that significantly change but do not fundamentally alter the remedy selected in the ROD with respect to scope, performance, or cost.

Exposure point concentration (EPC): A conservative estimate of the average chemical concentration in an exposure medium.

Groundwater: Water in a saturated zone or geologic stratum beneath the land surface or beneath a surface water body.

Hydraulic gradient: The slope of the water table along a groundwater flow path.

Institutional control (IC): Non-engineered instruments (e.g., administrative or legal measures) to protect HHE from exposure to contamination. ICs are maintained until requirements are met for safe, unrestricted land use.

Interim safe storage: The first stage of final disposition. It consists of (1) ensuring that facility hazardous substances are and will remain safe and secure; and (2) reducing the footprint of the reactor building to the primary shield wall, and sealing all openings such that the facility is in an environmentally safe and secure condition prior to initiation of disposition.

Limited field investigation (LFI): LFIs are an initial step in characterizing the nature and extent of contamination in the vadose zone, structures, and debris that received radioactive liquid effluent discharges. The limited data were sufficient to support a decision on conducting an interim remedial measure.

Model Toxics Control Act (MTCA): MTCA (RCW 70.105D, "Hazardous Waste Cleanup--Model Toxics Control Act") provides Washington State's standards and statutory requirements for addressing releases and threats of releases of hazardous substances into the environment. The standards and requirements established to implement MTCA are published in WAC 173-340.

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

***National Environmental Policy Act of 1969* (NEPA):** An 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. Federal agencies conducting CERCLA actions may rely on the CERCLA process for environmental reviews that are functionally equivalent and are not required to engage in a separate NEPA analysis, such as preparation of environmental assessments and environmental impact statements (40 CFR 1500, "Purpose, Policy, and Mandate;" O'Leary, 1994, "National Environmental Policy Act Policy Statement").

"National Oil and Hazardous Substances Pollution Contingency Plan" (NCP): The NCP (40 CFR 300) provides the organizational structure and procedures for preparing for and responding to discharges of oil and releases of hazardous substances, pollutants, and contaminants.

National Priorities List: The list, compiled by EPA pursuant to CERCLA Section 105 ("National Contingency Plan"), of uncontrolled hazardous substance releases in the United States that are priorities for long-term remedial evaluation and response.

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

Operable unit (OU): A discrete portion of the Hanford Site, as identified in Section 3.3 of the ***Tri-Party Agreement*** Action Plan (Ecology et al., 1989b, *Hanford Federal Facility Agreement and Consent Order Action Plan*). An OU at Hanford is a group of land disposal sites placed together for the purposes of performing am RI/FS and subsequent cleanup actions. The primary criteria for placement of a site into an OU include geographic proximity, similarity of waste characteristics and site type, and the possibility for economies of scale.

Picocurie (pCi): A unit of radioactivity equivalent to 1×10^{-12} curies or 0.037 disintegrations per second.

Preferred alternative: The remedial action proposed after an evaluation of a range of viable alternatives. The preferred alternative must be protective of human health and the environment and comply with applicable or relevant and appropriate requirements (unless a statutory waiver is justified), is cost effective, and use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable.

Preliminary remediation goal (PRG): An ARAR-specified or risk-based concentration for a contaminant that is protective of HHE for a specified exposure pathway. PRGs are established during the FS, are based on scientific information, and are used as a target for remedial cleanup levels. Alternatives are developed and evaluated based on how well they meet PRGs. Final cleanup levels are set in the ROD and are used during the remediation of a site.

Proposed Plan: A document that briefly describes the remedial alternatives analyzed, proposes a preferred remedial action alternative, and summarizes the information relied upon to select the preferred alternative. The Proposed Plan provides the public with an opportunity to comment on the preferred alternative, as well as the other alternatives under consideration.

Pump-and-treat: The extraction of contaminated groundwater and treatment of contaminants with one or more of an assortment of technologies.

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, exposure may be harmful.

Record of Decision (ROD): The CERCLA document used to select the method of remedial action to be implemented at a site after the FS/Proposed Plan process has been completed.

Remedial action: Actions consistent with permanent remedy taken instead of, or in addition to, removal action in the event of a release or threatened release of a hazardous substance into the environment, to prevent or minimize the release of hazardous substances so they do not migrate to cause substantial danger to present or future public health or welfare or the environment.

Remedial action objective (RAO): Specifies contaminants and media of concern, potential exposure pathways, and remediation goals.

Remedial investigation/feasibility study (RI/FS): The RI is a process to determine the nature and extent of the problem presented by releases or threats of releases of hazardous substances, and it includes the gathering of sufficient information to determine the necessity for remedial action and to support evaluation of remedial alternatives. The FS is a study to develop and evaluate options for remedial action.

Removal, treatment, and disposal (RTD): A cleanup method where soil and debris are excavated in such a way that no contaminants above the approved remedial action levels or concentration remain. Excavated material is treated (if required for disposal) and sent to an onsite or offsite engineered facility for disposal.

Responsiveness summary: The responsiveness summary is made available with the ROD and contains the significant public comments received on the Proposed Plan and responses.

Tri-Parties: Three agencies composed of the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA), and the Washington State Department of Ecology (Ecology).

Tri-Party Agreement: DOE, EPA, and Ecology signed the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) on May 15, 1989. The general purposes of the agreement are as follows: to ensure that environmental impacts are thoroughly investigated and appropriate response actions taken as necessary to protect HHE; to provide a framework for permitting of treatment, storage and disposal units; ensure compliance with the *Resource Conservation and Recovery Act of 1976* (RCRA) and the Washington Hazardous Waste Management Act for treatment, storage, and disposal units; to establish a procedural framework and schedule for developing, prioritizing, implementing and monitoring appropriate response actions at the Hanford Site in accordance with CERCLA, the NCP, Superfund guidance and policy, RCRA and RCRA guidance and policy; and to facilitate cooperation, exchange of information and coordinated participation of the parties in such actions.

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

Waste sites: Any location that may require action to mitigate a potential human health or environmental impact and includes contaminated or potentially contaminated sites from past operations. Contamination may be contained in environmental media (e.g., soil or groundwater) or in manmade structures or solid waste (e.g., debris).

References/Bibliography

40 CFR 141, "National Primary Drinking Water Regulations," *Code of Federal Regulations*. Available at: http://www.ecfr.gov/cgi-bin/text-idx?SID=d2e85ff265b49d8e97c0cd3292841953&node=40:24.0.1.1.3&rgn=div5.

40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan," *Code of Federal Regulations*. Available at: http://www.ecfr.gov/cgi-bin/text-idx?SID=d2e85ff265b49d8e97c0cd3292841953&node=40:29.0.1.1.1&rgn=div5.

Appendix B, "National Priorities List."

40 CFR 300.5, "Definitions."

40 CFR 300.400, "General."

40 CFR 300.430, "Remedial Investigation/Feasibility Study and Selection of Remedy."

40 CFR 1500, "Purpose, Policy, and Mandate," *Code of Federal Regulations*, Available at: http://www.ecfr.gov/cgi-bin/text-idx?SID=4aa29efc28658023dd2df98dd5c42ea4&node=40:34.0.3.3.1&rgn=div5.

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

Clinton, W.J., 2000, *Establishment of the Hanford Reach National Monument*, Memorandum to the Secretary of Energy, Office of the Press Secretary, Washington, D.C., June 9. Available at: http://clinton6.nara.gov/2000/06/2000-06-09-memorandum-on-hanford-reach-national-monument.html.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601, et seq. Available at: http://epw.senate.gov/cercla.pdf.

Section 105, "National Contingency Plan."

Section 117(a), "Public Participation," "Proposed Plan."

Section 121(b), "Cleanup Standards," "General Rules."

DOE O 451.1B Chg 3, 2012, *National Environmental Policy Act Compliance Program*, U.S. Department of Energy, Washington, D.C. Available at: http://energy.gov/sites/prod/files/DOEO4511B_011912.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://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D199158842.
http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D199158843.
http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D199158844.
http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D199158845.
http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D199158846.
http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=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://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=DA06917281.

DOE, Ecology, and EPA, 2012, *Hanford Federal Facility Agreement and Consent Order Hanford Public Involvement Plan*, U.S. Department of Energy, Richland Operations Office; Washington State Department of Ecology; and U.S. Environmental Protection Agency, Richland, Washington. Available at: http://www.hanford.gov/files.cfm/FacAgreementand-Consent-Order_FINAL.pdf.

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://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0096062. http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0096061.

DOE/RL-93-82, 1995, *Limited Field Investigation Report for the 100-FR-1 Operable Unit*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196005401.

DOE/RL-93-83, 1994, *Limited Field Investigation Report for the 100-FR-3 Operable Unit*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196084471.

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://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=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://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1112281625.

DOE/RL-2007-21, 2012, *River Corridor Baseline Risk Assessment, Volume I: Ecological Risk Assessment*, Volume 1, Parts 1 and 2, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0093215. http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0093214.

DOE/RL-2007-21, 2011, *River Corridor Baseline Risk Assessment, Volume II: Human Health Risk Assessment*, Volume II, Parts 1 and 2, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0093676. http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0093675.

DOE/RL-2008-46-ADD4, 2010, *Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan, Addendum 4: 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and 100-IU-6 Operable Units*, Rev. 0 REISSUE, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1006220804.

DOE/RL-2010-98, 2012, *Remedial Investigation/Feasibility Study for the 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and 100-IU-6 Operable Units*, Draft A, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0090560.

DOE/RL-2010-117, 2012, *Columbia River Component Risk Assessment, Volume I: Screening-Level Ecological Risk Assessment*, Volume I, Part 1, Rev. 0, Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0092299.

DOE/RL-2010-117, 2012, *Columbia River Component Risk Assessment, Volume II: Baseline Human Health Risk Assessment*, Volume II, Part 1, Rev. 0, Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0090731.

DOE/RL-2011-118, 2012, *Hanford Site Groundwater Monitoring for 2011*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0091795.

ECF-HANFORD-11-0038, 2012, *Soil Background Data for Interim Use at the Hanford Site*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0088381.

Ecology, EPA, and DOE, 1989a, *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=81.

Ecology, EPA, and DOE, 1989b, *Hanford Federal Facility Agreement and Consent Order Action 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/?page=82.

Ecology, EPA, and DOE, 1998, *Action Memorandum for the 105-F and 105-DR Reactor Buildings and Ancillary Facilities, Hanford Site, Benton County, Washington*, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D198146374.

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 and DOE, 1997, *Action Memorandum: 100 B/C Area Ancillary Facilities and the 108-F Building Removal Action, U.S. Department of Energy Hanford Site, Richland, WA*, U.S. Environmental Protection Agency and U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D198146374.

EPA, Ecology, and DOE, 2004, *Explanation of Significant Differences for the 100 Area Remaining Sites Interim Remedial Action Record of Decision*, U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Olympia, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D4855290.

EPA, Ecology, and DOE, 2009, *Explanation of Significant Differences for the 100 Area Remaining Sites Interim Remedial Action Record of Decision: Hanford Site, Benton County, Washington*, U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Olympia, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0908240150.

EPA, Ecology, and DOE, 2011, *100 Area "Plug-In" and Candidate Waste Sites for Fiscal Year 2010*, U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Seattle, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0084011.

EPA, Ecology, and DOE, 2012, *100 Area "Plug-In" and Candidate Waste Sites for Fiscal Year 2011*, U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Seattle, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1202240339.

EPA/AMD/R10-97/044, 1997, *Amendment to the Interim Remedial Action Record of Decision for the 100-BC-1, 100-DR-1, and 100-HR-1 Operable Units, Hanford Site, Benton County, Washington*, U.S. Environmental Protection Agency, Region 10, Washington State Department of Ecology, and U.S. Department of Energy, Seattle, Washington. Available at: http://www.epa.gov/superfund/sites/rods/fulltext/a1097044.pdf.

EPA/ESD/R10-00/045, 2000, *Explanation of Significant Differences for the 100 Area Remaining Sites Record of Decision: 100-IU-6 Operable Unit*, U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Seattle, Washington. Available at: http://www.epa.gov/superfund/sites/rods/fulltext/e1000045.pdf.

EPA/ROD/R10-00/121, 2000, *Interim Remedial Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-2, 100-HR-2, and 100-KR-2 Operable Units, Hanford Site (100 Area Burial Grounds), Benton County, Washington*, U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Seattle, Washington. Available at: http://www.epa.gov/superfund/sites/rods/fulltext/r1000121.pdf.

EPA/ROD/R10-95/126, 1995, *Interim Remedial Action Record of Decision for the 100-BC-1, 100-DR-1, and 100-HR-1 Operable Units, Hanford Site, Benton County, Washington*, U.S. Environmental Protection Agency, Region 10, Seattle, Washington. Available at: http://www.epa.gov/superfund/sites/rods/fulltext/r1095126.pdf.

EPA/ROD/R10-99/039, 1999, *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington (100 Area Remaining Sites)*, U.S. Department of Energy, U.S. Environmental Protection Agency, Region 10, Washington State Department of Ecology, Seattle, Washington. Available at: http://www.epa.gov/superfund/sites/rods/fulltext/r1099039.pdf.

National Environmental Policy Act of 1969, 42 USC 4321, et seq. Available at: http://www.epw.senate.gov/nepa69.pdf.

O'Leary, H.R., 1994, "National Environmental Policy Act Policy Statement" (memorandum for Secretarial Officers and Heads of Field Elements), Secretary of Energy, U.S. Department of Energy, Washington, D.C., June 13. Available at: http://scms.sc.doe.gov/Docs/NEPA%20Policy%20Statement.htm.

Presidential Proclamation 7319, 2000, *Establishment of the Hanford Reach National Monument*, Administration of William J. Clinton, June 9. Available at: http://www.gpo.gov/fdsys/pkg/WCPD-2000-06-12/pdf/WCPD-2000-06-12-Pg1322.pdf.

RCW 70.105D, "Hazardous Waste Cleanup--Model Toxics Control Act," *Revised Code of Washington*, Olympia, Washington. Available at: http://apps.leg.wa.gov/RCW/default.aspx?cite=70.105D.

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

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 173-201A, "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.

WAC 173-340-720, "Groundwater Cleanup Standards."

WAC 173-340-740, "Unrestricted Land Use Soil Cleanup Standards."

WAC 173-340-900, "Tables."

This page intentionally left blank.