DOE/RL-2014-44
Draft A

Integrated Remedial Design Report/Remedial Action Work Plan for 100-F/IU

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

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

Approved for Public Release;
Further Dissemination Unlimited

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Terms

amsl	above mean sea level
ARAR	applicable or relevant and appropriate requirement
bgs	below ground surface
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
COC	contaminant of concern
Cr(VI)	hexavalent chromium
CUL	cleanup level
DOE	U.S. Department of Energy
DOE-RL	DOE Richland Operations Office
DQO	data quality objective
DWS	drinking water standard
EAF	Experimental Animal Farm
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
ESD	Explanation of Significant Differences
FS	feasibility study
HASP	health and safety plan
HHE	human health and the environment
IC	institutional control
LIGO	Laser Interferometer Gravitational-Wave Observatory
LRA	lead regulatory agency
MNA	monitored natural attenuation
MTCA	“Model Toxics Control Act—Cleanup” (WAC 173-340)
NCP	National Contingency Plan (40 CFR 300, “National Oil and Hazardous Substances Pollution Contingency Plan”)
NPL	“National Priorities List” (40 CFR 300, Appendix B)
O&M	operations and maintenance
OU	operable unit

QA	quality assurance
RA	remedial action
RAO	remedial action objective
RAWP	remedial action work plan
RD	remedial design
RDR	remedial design report
RI	remedial investigation
ROD	record of decision
RTD	removal, treatment (as required), and disposal
RWP	radiological work permit
SAP	sampling and analysis plan
STOMP	Subsurface Transport Over Multiple Phases
TCE	trichloroethene
TPA	Tri-Party Agreement
TPH	total petroleum hydrocarbon
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
UU/UE	unlimited use/unrestricted exposure

1 Introduction

The U.S. Department of Energy (DOE) Hanford Site is a 1,517 km^2 (586 mi^2) federal facility located in southeastern Washington State along the Columbia River (Figure 1-1). For administrative purposes, the Hanford Site was divided into four National Priorities List (NPL) sites (40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan," hereafter referred to as the National Contingency Plan [NCP], Appendix B) under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) in 1989, one of which is the 100 Area. In anticipation of the NPL (40 CFR 300, Appendix B) listing, DOE, the U.S. Environmental Protection Agency (EPA), and the Washington State Department of Ecology (Ecology) entered into the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al., 1989a), hereinafter called the Tri-Party Agreement (TPA), in May 1989, which established a procedural framework and schedule for developing, implementing, and monitoring CERCLA response actions and *Resource Conservation and Recovery Act of 1976* compliance and permitting on the Hanford Site.

The 100 Area (CERCLA site identification number WA38900900076) includes the river corridor areas of the Hanford Site in Benton County, Washington. The 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and 100-IU-6 Operable Units (OUs), hereinafter referred to as 100-F/IU, are part of the Hanford Site 100 Area. 100-F/IU comprises approximately 380 km^2 (145 mi^2) and can be divided into two primary areas of use: the 100-F Reactor Area and the 100-IU-2 and 100-IU-6 Areas. The 100-F Area encompasses approximately 2.8 km^2 (1.1 mi^2) and includes the F Reactor operating region. Within the 100-F Area are the 100-FR-1 and 100-FR-2 Source OUs. Groundwater contamination from these two source OUs is included in the 100-FR-3 Groundwater OU. The 100-IU-2/IU-6 Area includes the 100-IU-2 and 100-IU-6 Source OUs, and encompasses a large area outside of Hanford's primary reactor operating areas (Figure 1-1). This integrated remedial design report (RDR)/remedial action work plan (RAWP) addresses all five 100-F/IU OUs.

Contaminated groundwater originating from Central Plateau source OUs extends to the groundwater beneath the 100-IU-2/IU-6 Area. Groundwater contamination at 100-IU-2/IU-6 is addressed by the CERCLA decisions for the groundwater OUs (200-PO-1 and 200-BP-5) associated with the Central Plateau sources of contamination.

The DOE Richland Operations Office (DOE-RL) is the lead agency responsible to perform the remedial actions (RAs), and EPA is the lead regulatory agency (LRA) as identified in Section 5.6 and Appendix C of the TPA (Ecology et al., 1989a). In accordance with the TPA (Ecology et al., 1989a), Article XIV, Paragraph 54, DOE developed and proposed RAs for 100-F/IU through previous investigations and remedial decisions. The 100-F/IU remedial investigation (RI)/feasibility study (FS) report (DOE/RL-2010-98, *Remedial Investigation/Feasibility Study for the 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and 100-IU-6 Operable Units*) was the basis for the proposed plan. A 60-day public comment period for the proposed plan (DOE/RL-2012-41, *Proposed Plan for Remediation of the 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and 100-IU-*6 *Operable Units*) occurred from June 9 through August 11, 2014. The proposed plan and responsiveness summary resulted in a record of decision (ROD) for 100-F/IU.

The 100-F/IU ROD (EPA and DOE, 2014, *Record of Decision Hanford 100 Area Superfund Site 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and 100-IU-6 Operable Units*) was signed by EPA and DOE in September 2014. The selected remedies were chosen in accordance with CERCLA, as amended by the *Superfund Amendments and Reauthorization Act of 1986*, the TPA (Ecology et al., 1989a), and, to the extent practicable, the NCP (40 CFR 300). The selected remedies for the five OUs include a combination of no further action; removal, treatment (as required), and disposal (RTD); monitored natural attenuation

(MNA); and institutional controls (ICs) to address the contaminants of concern (COCs). RTD is a remedy for waste sites in the 100-IU-2 and 100-IU-6 OUs only. ICs restricting excavation and prohibiting irrigation are identified for specified 100-FR-1 and 100-FR-2 OU waste sites to prevent exposure until levels protective of unlimited use/unlimited exposure (UU/UE) are met. ICs restricting groundwater use from the 100-FR-3 OU until levels protective of UU/UE are achieved are also identified.

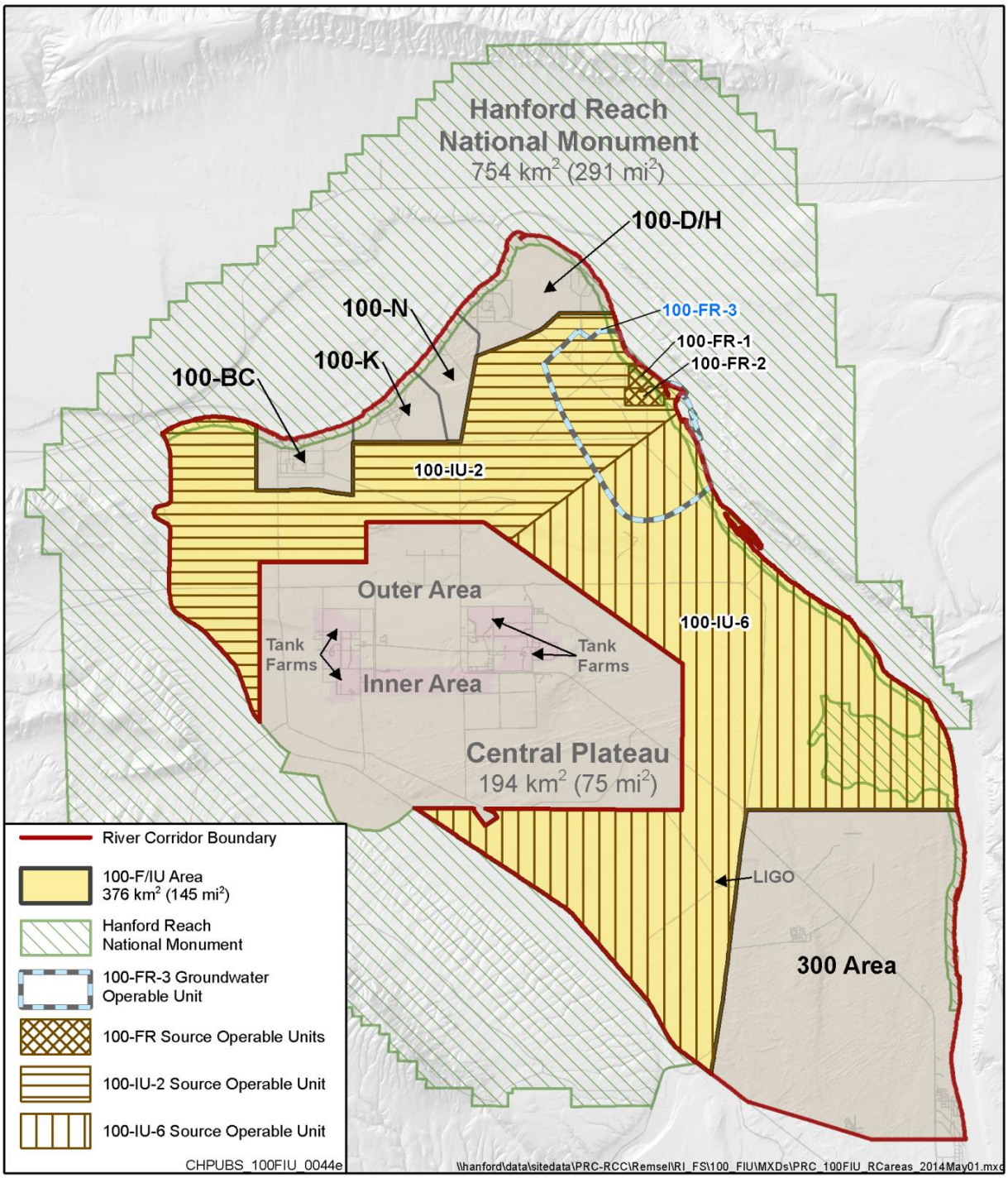

Figure 1-1. 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and 100-IU-6 Operable Units

Achievement of UU/UE will occur when the cleanup levels (CULs) have been attained. This is defined as attaining shallow zone CULs and CULs for the protection of groundwater and surface water. For ICs applied to restrict groundwater use at the 100-FR-3 OU, UU/UE will be attained when CULs for the protection of groundwater and surface water are achieved. The process for demonstrating attainment of CULs is described in the Soil Addendum and the Groundwater Addendum. For ICs applied to deep zone radiological contamination at specified 100-FR-1 and 100-FR-2 OU waste sites, UU/UE will be achieved when the cumulative excess lifetime cancer risk is less than 1×10^{-4} based on direct contact exposure, as calculated in the 100-F/IU RI/FS report (DOE/RL-2010-98), using the verification sampling data from the RA documented with the waste site reclassification form. These timeframes for decay are shown in Table 8 of the 100-F/IU ROD (EPA and DOE, 2014). For ICs applied to restrict irrigation, UU/UE will be achieved when the soil CUL for protection of groundwater and surface water is achieved for the site.

RAs for the five OUs will minimize the release or threat of release of hazardous substances that pose a risk to human health and the environment (HHE). Completion of the RAs will provide an end state consistent with the 100-F/IU ROD (EPA and DOE, 2014). The following interim action decisions have been implemented for the 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 OUs:

- 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 RA 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* (DOE et al., 2011)
- 2012 – *100 Area "Plug-In" and Candidate Waste Sites for Calendar Year 2011* (DOE et al., 2012)
- 2013 - *100 Area "Plug-In" and Candidate Waste Sites for Calendar Year 2012* (DOE et al., 2013)

These interim actions are replaced with this final action remedy.

1.1 Purpose

This Integrated RDR/RAWP, along with the Soil and Groundwater Addenda, describes how the site remedies will be designed, installed, and operated to meet the remedial action objectives (RAOs) identified in the 100-F/IU ROD (EPA and DOE, 2014).

This Integrated RDR/RAWP establishes the general size, scope, and character of the RA and identifies the common technical requirements. This document includes the following three parts:

1. An integrated RDR/RAWP that contains common information to support remedy implementation
2. An addendum containing information specific to waste site remedies for the 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 OUs
3. An addendum containing information specific to groundwater remedies for the 100-FR-3 OU

The Integrated RDR/RAWP identifies the information detailed in the soil and groundwater remedy-specific addenda.

Each addendum includes additional implementing documents as indicated on Figure 1-2. The work scopes for the two addenda have been split for ease of implementation, based on the services provided by the two remediation contractors. The two addenda include the following scope:

- RDR/RAWP for 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 OU soils (herein referred to as the Soil Addendum). The Soil Addendum describes the work elements, performance measurements, construction management and oversight, and schedule specific to RTD and associated ICs of waste sites within the 100-IU-2 and 100-IU-6 OUs.
- RDR/RAWP for 100-FR-3 OU groundwater (herein referred to as the Groundwater Addendum). The Groundwater Addendum describes the work elements, performance measurements, construction management and oversight, and schedule specific to MNA at the 100-FR-3 OU.

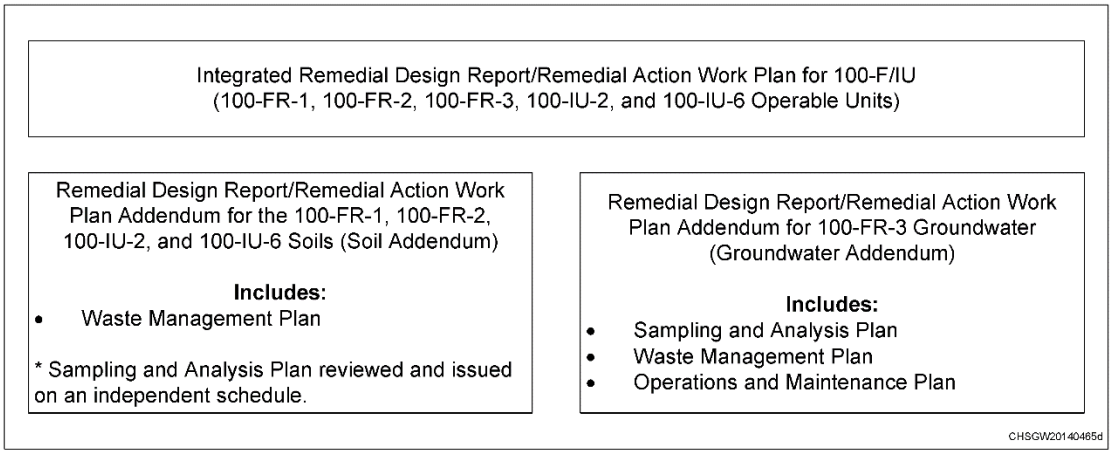

Figure 1-2. 100-F/IU Record of Decision Implementation Document Structure

Implementation, maintenance, and periodic inspection requirements for ICs at the Hanford Site are described in approved work plans and DOE/RL-2001-41, *Sitewide Institutional Controls Plan for Hanford CERCLA Response Actions and RCRA Corrective Actions*, hereinafter called the Sitewide IC Plan. Unique ICs identified in the 100-F/IU ROD (EPA and DOE, 2014) prohibiting irrigation and/or

excavation at identified 100-FR-1 and 100-FR-2 OU waste sites, and controlling access to 100-FR-3 OU contaminated groundwater will be included in, and implemented through, the Sitewide IC Plan (DOE/RL-2001-41).

The Integrated RDR/RAWP, including the Soil Addendum and Groundwater Addendum, serves as the RDR.

The Integrated RDR/RAWP and Soil and Groundwater Addenda are being submitted in accordance with the 100-F/IU ROD (EPA and DOE, 2014) and Section 11.6 of the TPA Action Plan (Ecology et al., 1989b, *Hanford Federal Facility Agreement and Consent Order Action Plan*).

1.2 Scope

This Integrated RDR/RAWP and Soil and Groundwater Addenda provide the plan and schedule for design, construction, and monitoring activities necessary for successful implementation of the RA selected in the 100-F/IU ROD. The selected remedies for the five OUs are described in Table 1-1.

Table 1-1. Major Components of the Selected Remedy

100-FR-1 OU	100-FR-2 OU	100-FR-3 OU	100-IU-2 OU	100-IU-6 OU
ICs[a]	ICs[a]	MNA for hexavalent chromium, nitrate, strontium-90, and trichloroethene in groundwater[c]	RTD at waste sites[b]	RTD at waste sites[b]
		ICs[a,c]		

a. Details are described in the Integrated Remedial Design Report/Remedial Action Work Plan (this document).

b. Details are described in the Soil Addendum.

c. Details are described in the Groundwater Addendum.

IC = institutional control

MNA = monitored natural attenuation

OU = operable unit

RTD = removal, treatment (as required), and disposal

RTD will be used to remove contaminated soil, structures, and debris from 100-IU-2 and 100-IU-6 OU waste sites via excavation; treat material, as necessary, to meet disposal facility requirements; protect workers and prevent unacceptable environmental releases; and dispose of waste. Waste will be disposed at Hanford's Environmental Restoration Disposal Facility (ERDF). The remediated sites will be backfilled, recontoured, and planted with native vegetation.

MNA will be implemented for groundwater COCs hexavalent chromium (Cr(VI)), nitrate, strontium-90, and trichloroethene (TCE) in the 100-FR-3 OU. These groundwater COCs will be monitored until CULs are met.

ICs will be established to control access to residual contamination in soil and groundwater above standards for UU/UE. In the 100-FR-1 and 100-FR-2 OUs, ICs are identified to prohibit irrigation and/or deep excavation at specified waste sites. In 100-IU-2 and 100-IU-6, access restriction ICs will be

implemented for waste sites identified for RTD until the CULs have been met. In the 100-FR-3 OU, ICs will restrict well drilling and groundwater use.

Contaminated groundwater that migrates into 100-F/IU from other areas is not part of the 100-FR-3 OU and is not addressed by the 100-F/IU ROD (EPA and DOE, 2014).

The Laser Interferometer Gravitational-Wave Observatory (LIGO) is located within the 100-IU-6 OU (Figure 1-1). LIGO operates under a DOE permit granted to the National Science Foundation that expires in 2018, unless the permit is extended or terminated. The Hanford town school and White Bluffs bank are two historic structures preserved in the 100-IU-6 and 100-IU-2 OUs, respectively. Historic structures and LIGO are not part of the 100-F/IU addressed by this Integrated RDR/RAWP.

1.3 Site Description and Background

The Hanford Site is divided into numerically designated areas. These areas served as the location for reactor, chemical separation, and related activities for production and purification of special nuclear materials and other nuclear activities. The reactors and their support facilities were located along the south shore of the Columbia River in the 100 Area, due to the need for large quantities of water to dissipate the heat generated during reactor operations. The 200 Area, located about 11 km (7 mi) from the Columbia River, contained all the facilities used to separate, isolate, store, and ship the plutonium. The 300 Area, located adjacent to and north of the city of Richland, contained the reactor fuel manufacturing plants and the research and development laboratories. The 400 Area, located 8 km (5 mi) northwest of the 300 Area, contained the Fast Flux Test Facility designed for testing liquid metal reactor systems. The 600 Area consisted of facilities that served more than one specific area or, in some cases, the entire project.

The F Reactor area encompasses approximately 2.8 km^2 (1.1 mi^2). 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 outfall piping to the Columbia River. The secondary mission of the 100-F Area was the Experimental Animal Farm (EAF), a biological laboratory used to examine the effects of radiation and radioactive contamination on plants, animals, and fish. 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) 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 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.

The 100-IU-2 and 100-IU-6 OUs consist of an area between and outside the reactor and production areas within the 100 Area. The pre-Hanford agriculture-based town of White Bluffs and the Hanford Townsite were located within these OUs. Waste sites associated with pre-Hanford activities include landfills and surface debris. During development of the Hanford Site, the area was used for housing and staging equipment and materials for the Hanford Site. Waste sites generally originated from industrial chemical use and include landfills, dumpsites, surface debris, and unplanned releases.

1.3.1 Physical Setting

A detailed description of the 100-F/IU Area is presented in the 100-F/IU RI/FS report (DOE/RL-2010-98) and is summarized in the following paragraphs.

The topography of the reactor area at 100-F is relatively flat, with elevations generally between 120 and 128 m (394 and 420 ft) above mean sea level (amsl) inland from the Columbia River. The area has been disturbed and graded extensively since reactor construction through present-day waste site remediation activities. The elevation at the river shore is approximately 115 m (377 ft) amsl. A low bench of land southeast of 100-F, with elevations below 114 m (374 ft) amsl, is submerged when the river stage is above average.

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

Physical characteristics most affecting contaminant transport at 100-F are hydrogeology and the rate of infiltration. The vadose zone comprises up to 15 m (49 ft) of unconsolidated gravel and sand of the Hanford formation. The unconfined aquifer beneath 100-F comprises Hanford formation gravels that range in thickness from less than 1 m (3 ft) in southwestern 100-F to 8 m (26 ft) in eastern 100-F nearest the Columbia River. The Ringold Formation upper mud (a zone of low permeability composed of intermixed sand, clay, and silt zones) forms the base of the unconfined aquifer. The direction of groundwater flow is east-northeast in the northern part of 100-F and east-southeast in the southern part, with flow velocities ranging from 0.19 to 0.62 m/day (0.58 to 1.9 ft/day). Normal seasonal variability observed in the water table at 100-F is more than 3 m (10 ft) in wells near the river and decreases farther inland.

The hydrostratigraphy of the 100-IU-2/IU-6 OUs is variable because of the large area covered. Groundwater flows toward the east-northeast in the northern portion near the 100-F Area, toward the east in the southwestern portion, and approximately parallel to the river southeast of 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, and 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.

Recharge rates are dependent on vegetation. Currently in the 100-F Area, there is little to no vegetation; whereas, 100-IU-2/IU-6 is composed of large areas of mature vegetation. Recharge rates may be as low as 1.5 mm/yr (0.059 in./yr) where mature vegetation is present, and as high as 52 mm/yr (2.0 in./yr) on disturbed soil. There is little recharge in areas with natural vegetation due to evapotranspiration.

Groundwater in the unconfined aquifer discharges to the Columbia River via upwelling through the riverbed and riverbank seeps (Figure 1-3). 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.

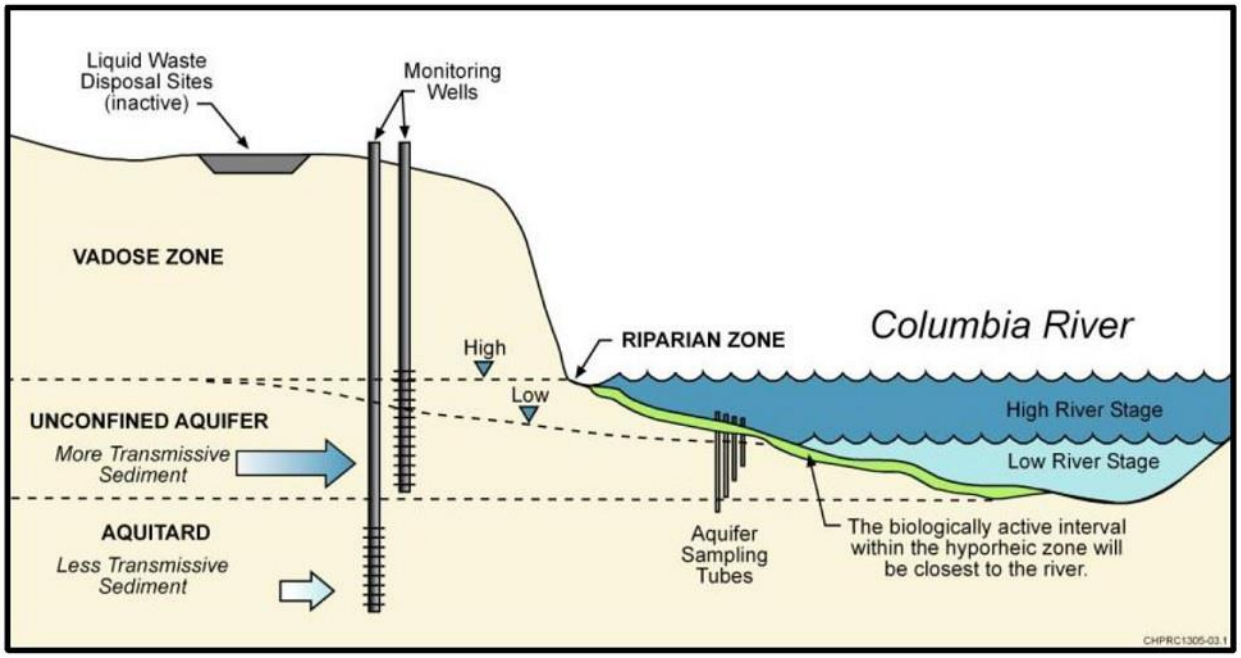

Figure 1-3. Illustration of Zone of Interaction and River Bank Seepage

1.3.2 Nature and Extent of Contamination

DOE performed two limited field investigations in the early 1990s for the 100-FR-1 and 100-FR-3 OUs (DOE/RL-93-82, *Limited Field Investigation Report for the 100-FR-1 Operable Unit*; DOE/RL-93-83, *Limited Field Investigation Report for the 100-FR-3 Operable Unit*) to characterize the nature and extent of contamination in the vadose zone and groundwater. An RI of all areas within 100-F/IU was completed in 2011. The nature and extent of waste site and groundwater contamination are summarized in the following subsections. A thorough evaluation of nature and extent for the 100-F/IU OUs is presented in the 100-F/IU RI/FS report (DOE/RL-2010-98).

1.3.2.1 Waste Site Contamination

The 100-F Reactor was supported by multiple facilities associated with services for water treatment, air filtration, nuclear fuel handling, effluent disposal, and laboratories, with various other administrative buildings. The 100-F Area also included EAF, where biological research studies were performed to examine the effects of radiation and radioactive contamination on plants, animals, and fish. Operations within 100-IU-2 and 100-IU-6 were primarily related to other uses, such as historical agricultural uses and other uses associated with human occupation.

Reactor operations and processes were the primary sources of contamination in the 100-F Area. Experimentation associated with the 100-F EAF secondary mission, coupled with waste disposal associated with the reactor, comprised secondary sources of contamination associated with the 100-F/IU Area.

Liquid wastes from reactor operations and associated facilities were released to the soil column and the Columbia River. Solid wastes were disposed in burial grounds associated with the facilities. Wastes released to or buried within the environment created secondary sources of contamination, such as liquid waste sites (ponds, trenches, cribs, and French drains), burial grounds, and numerous small miscellaneous waste sites scattered throughout the river corridor.

Low-mobility contaminants, including many metals and radionuclides, sorbed to sediment grains in the vadose zone. These contaminants were found at the greatest concentrations within and near the areas of discharge. When little or no liquid effluent was discharged to a waste site, soil contamination remained in the shallow sediment. Most of this shallow contamination has been removed during remediation activities. Sufficiently high volumes of liquid discharged into a waste site expanded the depth of contamination in the vadose zone.

Strontium-90 is a slightly mobile contaminant in the subsurface and was present in several 100-F waste sites. Facilities producing biological waste materials contaminated with strontium-90 included EAF, formerly located in the northeast portion of 100-F near the 116-F-9 and 116-F-2 Trenches, and the radioecology laboratory. Strontium-90 also was present in discharges to the 116-F-9 Trench and in solid waste disposed at various burial grounds, including the 118-F-1 and 118-F-6 Burial Grounds. Strontium-90 sorbs to sediment grains in the vadose zone and in the aquifer but also migrated into groundwater, especially at sites with a significant driving force (for example, liquid effluent disposal).

Mobile and moderately mobile contaminants include nitrate, TCE, and Cr(VI). During the period of reactor operations, large volumes of contaminated water were discharged to the soil via trenches, cribs, and leaks from pipelines and retention basins, primarily in eastern 100-F. Liquid effluent also was released through outfall piping to the Columbia River. During the operational period, large groundwater mounds helped spread mobile and moderately mobile contaminants in groundwater in a radial pattern. It is likely that groundwater carried these contaminants rapidly to the river, based on reactor operations and liquid discharge history. As early as September 1945, effluent springs began to appear along the riverbank in association with retention basin leakage. Multiple springs were identified along the 100-F shoreline during this period.

A relatively low concentration of Cr(VI) contaminated waste was discharged to the subsurface at 100-F because of the production facility design. There was a much longer period of using dry dichromate powder to mix corrosion control solutions for 105-F Reactor water treatment, as compared to other 100 Area reactors, and installation of newer equipment during the plant upgrades diminished the opportunity for leaks of the concentrated 70 percent solution. However, delivery of the 70 percent solution into the storage tanks at 185/190-F, waste site 100-F-57, was not completely efficient, and yellowish-stained soil around the storage tank location indicated some losses. The fraction of delivered 70 percent solution lost to the subsurface is not known. However, current concentrations observed in groundwater do not indicate the presence of a highly concentrated, persistent source. Cr(VI) contaminated waste sites in 100-FR-1 and 100-FR-2, including 100-F-57, were remediated during interim RAs, and known Cr(VI) sources were removed.

EAF was a source of nitrate contamination because nitrate is a common component of animal urine and feces. A portion of the nitrate that reached groundwater near the animal pens was transported inland as a result of the groundwater mounding caused by reactor operations.

The source of TCE contamination in and near 100-F has not been definitely identified, but it is suspected to be one of a group of waste sites west of 100-F. TCE can be present as a gas in the vadose zone and as a dissolved species in soil moisture and groundwater.

Most of the 100-F contaminated vadose zone materials have been removed during previous RAs. Remaining vadose zone material consists of radionuclide contamination above background at a depth greater than 4.6 m (15 ft) below ground surface (bgs) following implementation of the interim action ROD. All 100-F waste sites addressed under the interim action RODs have been remediated or were determined not to require remediation.

Waste sites and facilities in the 100-IU-2 and 100-IU-6 OUs were mainly associated with housing and staging equipment and material for the Hanford project; most of the area was previously occupied by homesteads and farms. The area includes roads, railroads, a fire station, fuel stations, storage facilities, an old concrete batch plant site, storage vaults in the east end of Gable Mountain, and pre-Hanford Site farm sites and landfills (e.g., pre-1943 municipal and farm waste sites). Contamination in this area generally originated from light industrial chemical use and agriculture, rather than nuclear material production and chemical processing.

Remediation under the interim action ROD has been completed for most of the 100-IU-2/IU-6 waste sites. The remaining waste sites were not the type that received concentrated or high-volume liquid waste that typically contributes to groundwater contamination.

Although the TCE groundwater plume southwest of 100-F may have originated from 100-IU-2/IU-6, no current source remains. No other groundwater contaminant plumes originate in 100-IU-2/IU-6, but contamination from other OUs is present (e.g., tritium from 200-PO-1). These constituents will be evaluated further in their respective OUs.

1.3.2.2 Groundwater Contamination

Groundwater contaminants that exceed federal or state drinking water standards (DWSs) or ambient water quality criteria in the 100-FR-3 OU are Cr(VI), nitrate, TCE, and strontium-90 (Figure 1-4). Groundwater contaminants do not exceed federal or state ecological protection standards near the river or where groundwater discharges into the river at 100-F. Pore water at the Hanford Townsite (100-IU-2/IU-6) is contaminated with tritium from a groundwater plume originating in the 200 East Area.

Cr(VI) in the 100-FR-3 OU exceeds the 10 µg/L Washington State surface water quality standard over an area of approximately 29 ha (72 ac) based on 2013 data. The maximum concentration of Cr(VI), measured in 2013, was 25.5 µg/L (DOE/RL-2014-32, *Hanford Site Groundwater Monitoring Report for 2013*). Cr(VI) concentrations are currently below the 2007 WAC 173-340, "Model Toxics Control Act—Cleanup," hereinafter called MTCA, Method B, groundwater CUL of 48 µg/L in the relatively small plume near the river. While the plume exceeds the 10 µg/L state surface water quality standard in the groundwater, aquifer tubes and pore water samples indicate infrequent exceedances of this level near the surface water interface.

Former sources of Cr(VI) in 100-F included facilities near the reactor building, trenches, and retention basins near the Columbia River and pipelines from the reactor building to these near-river facilities, primarily in northern and eastern 100-F. The current distribution of Cr(VI) in groundwater (Figure 1-4) shows no obvious relation to the locations of former sources. The contamination apparently migrated and attenuated before most of the groundwater monitoring wells were installed in the early 1990s. Cr(VI) associated waste sites have been remediated, and groundwater concentrations are expected to continue declining.

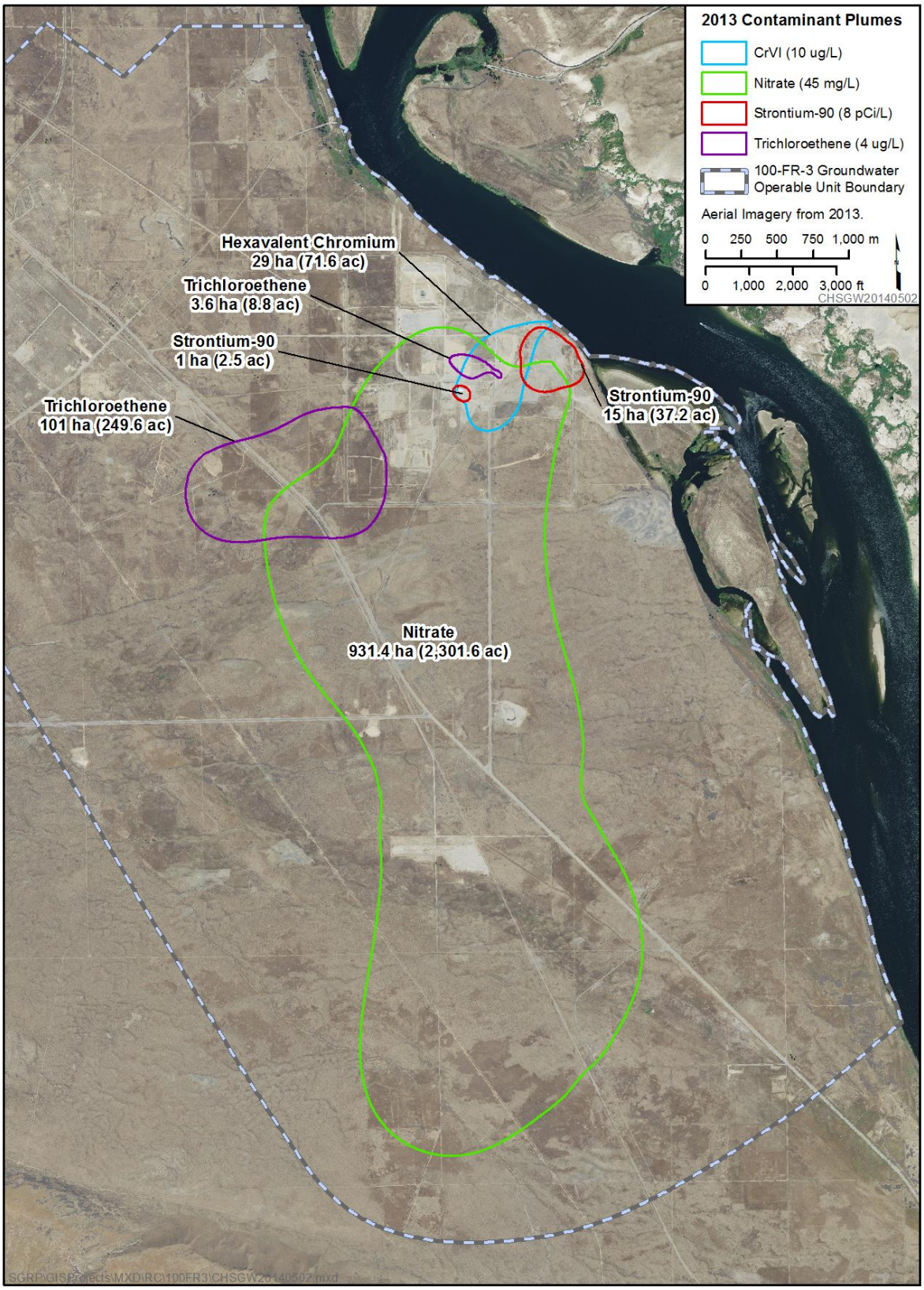

Figure 1-4. Groundwater Contaminant Plumes in the 100-FR-3 Operable Unit

Nitrate contamination of groundwater in the 100-FR-3 OU is greater than the 45 mg/L DWS[1] over an area of approximately 931 ha (2,302 ac) based on 2013 data, extending southward approximately 5 km (3.1 mi) from 100-F (Figure 1-4). The maximum concentration of nitrate measured in 2013 was 189 mg/L (DOE/RL-2014-32). Past sources of nitrate contamination included EAF (for example, 116-F-9 animal leach trench; 118-F-6 Burial Ground) and various septic tanks and leach fields located throughout 100-F. Nitrate contamination was likely transported inland during operations when an effluent discharge resulted in groundwater mounding and changes in hydraulic gradients.

Between 2002 and 2013, nitrate concentrations declined or were stable in 19 of 25 wells and increased in 5 wells. Because plume sources have been remediated, declining concentrations are expected to continue through natural attenuation. However, due to the size and multiple past sources of the plume, concentrations in some wells are variable. The wells with variable or increasing trends above 45 mg/L are all located in central 100-F Area. The nitrate concentrations in aquifer tubes are less than 45 mg/L.

Concentrations of strontium-90 in groundwater above the 8 pCi/L DWS are present in an area of 16 ha (40 ac) based on 2013 data (Figure 1-4). The maximum concentration of strontium-90 measured in 2013 was 180 pCi/L (DOE/RL-2014-32). Sources of strontium-90 included the 116-F-14 Retention Basin and the 116-F-2 Trench, located in northeastern 100-F. The main groundwater plume is in eastern 100-F Area near these former sources. A smaller plume is present in central 100-F Area

The area of groundwater with TCE concentrations greater than the 4.0 µg/L 2007 MTCA (WAC 173-340) level is approximately 105 ha (259 ac) based on 2013 data. TCE concentrations exceed the MTCA (WAC 173-340) level of 4 µg/L in several wells in southwestern 100-F, and sporadically in wells in central 100-F. The maximum concentration of TCE measured in 2013 was 15 µg/L (DOE/RL-2014-32). Three wells in southwestern 100-F and a single well in central 100-F exceed the DWS. It is probable that the plume extends farther south; however, there are no wells in this area from which to draw conclusions.

TCE below the MTCA (WAC 173-340) groundwater CUL of 4 µg/L was previously measured approximately 2 km (1.2 mi) south of 100-F, suggesting that a plume extends southward at concentrations below the DWS. However, TCE was not detected at this location during the 2013 sampling.

Groundwater beneath 100-IU-2/IU-6 is contaminated with tritium and iodine-129 (Figure 1-5), but the sources of those contaminants are in the 200 Areas; remediation of these contaminant sources will be addressed in 200 Area CERCLA documents. Because wells on the Hanford Site are monitored at different periods and frequencies, the plumes in Figure 1-5 are based on annual average concentrations.

[1] Nitrate may be expressed as nitrate-nitrogen (NO_3-N) or as nitrate (NO_3). The DWS for NO_3-N is 10,000 µg/L, and the mathematical equivalent value for NO_3 is 45,000 µg/L.

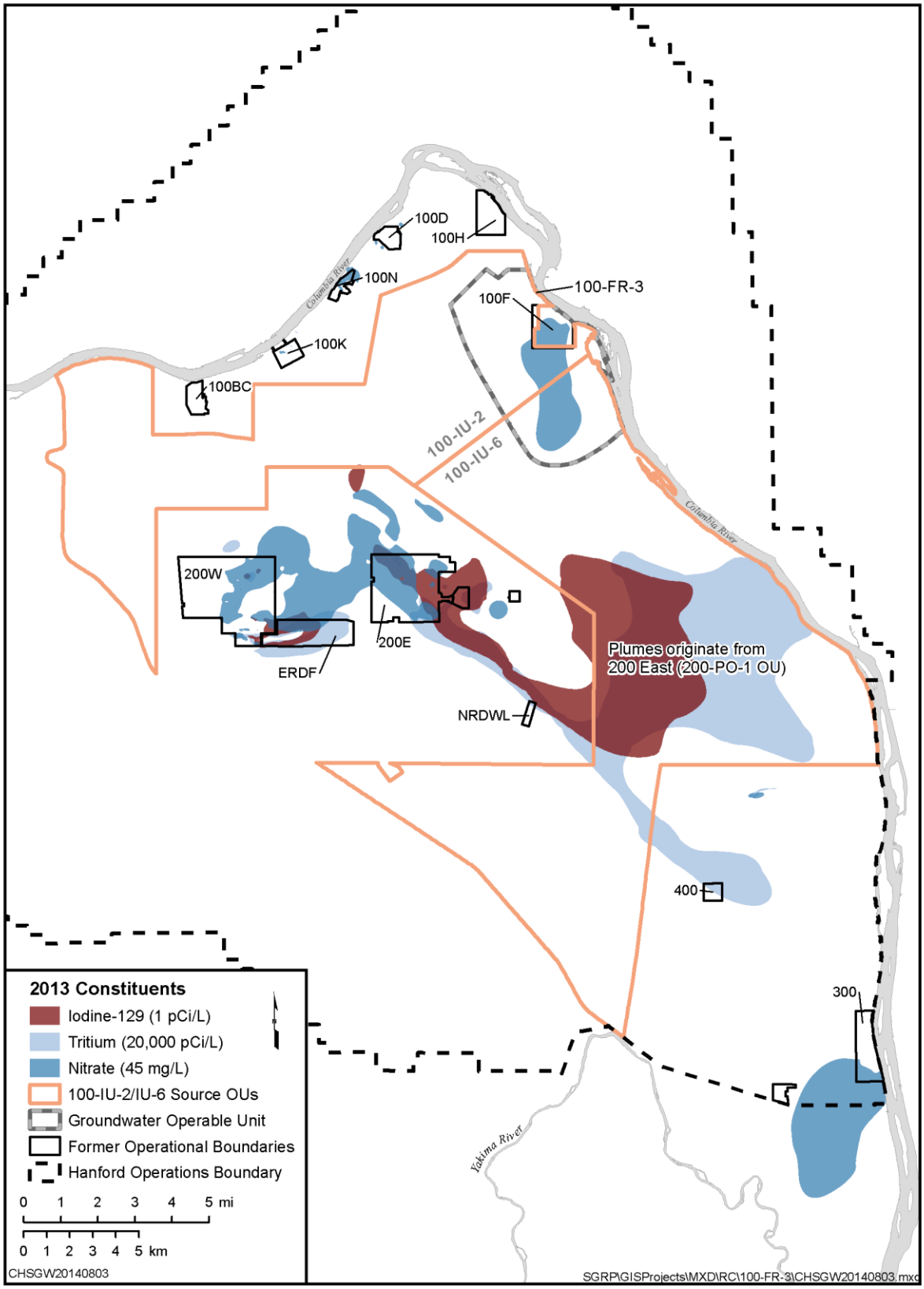

Figure 1-5. Groundwater Contaminant Plumes beneath the 100-IU-2 and 100-IU-6 Operable Units

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2 Basis for Remedial Action

The risk assessment in the 100-F/IU RI/FS report (DOE/RL-2010-98) included cleanups in vadose zone material conducted as part of the interim actions were effective in reducing human health risks to within EPA's target risk range. 100-IU-2 and 100-IU-6 OU waste sites that have not been remediated were determined to pose an unacceptable risk to HHE from direct exposure. Based on the results of the 100-FR-3 OU groundwater risk evaluation, concentrations of Cr(VI), nitrate, strontium-90, and TCE are present at levels in the groundwater that provide a basis for RA.

The risk assessment also reported that groundwater contamination beneath the 100-IU-2 and 100-IU-6 OUs exceeds action levels in some areas; however, the groundwater contaminants originate from the 200-BP-5 or 200-PO-1 OUs. Because groundwater contaminants underlying 100-IU-2 and 100-IU-6 OUs are addressed by other OUs, a groundwater risk assessment for these OUs was not included in the 100 F/IU RI/FS report (DOE/RL-2010-98).

The 100-F/IU ROD (EPA and DOE, 2014) stated that the selected response actions are necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances, pollutants or contaminants into the environment. Such a release or the threat of release may present an imminent and substantial endangerment to public health, welfare or the environment.

2.1 Selected Remedy

An overview of the basis for the selected RA for each OU is summarized in the following paragraphs as presented in the 100-F/IU ROD (EPA and DOE, 2014). The details of the designs and any refinements are described in the Soil and Groundwater Addenda.

The selected remedies presented in the 100-F/IU ROD (EPA and DOE, 2014) may be modified and refined as a result of remedial design (RD) and monitoring results. Any changes to the remedies described in the 100-F/IU ROD (EPA and DOE, 2014) will be documented using a technical memorandum in the administrative record, Change Notices to the RDR/RAWP, an Explanation of Significant Differences (ESD), or a ROD amendment, as appropriate.

2.1.1 RTD of Waste Sites for 100-IU-2 and 100-IU-6 OUs

Contaminated soil, structures, debris, and pipelines with concentrations above the CULs will be removed from 100-IU-2 and 100-IU-6 waste sites, treated as necessary to meet disposal facility requirements, and disposed at ERDF. The remediated sites will be backfilled, recontoured, and planted with native vegetation.

2.1.2 Institutional Controls

ICs are used to protect the integrity of a response action and/or minimize exposure to contamination in soil and groundwater until such contamination is at levels that allow for UU/UE. ICs are mechanisms to control uses of land, facilities, and environmental media in order 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.

2.1.2.1 Institutional Controls Common Elements for 100-F/IU

ICs are required before, during, and after the active phase of RA implementation where ICs are needed to protect HHE. ICs are used to control access to residual contamination in soil and groundwater above standards for UU/UE. DOE shall be responsible for implementing, maintaining, reporting on and

enforcing ICs. Although DOE may later transfer these procedural responsibilities to another party by contract, property transfer agreement or through other means, DOE shall retain ultimate responsibility for remedy integrity and ICs. In the event that land is transferred out of federal ownership, deed restrictions (proprietary controls such as easements and covenants) are required that are legally enforceable against subsequent property owners.

The current implementation, maintenance and periodic inspection requirements for ICs at the Hanford Site are described in approved work plans and the Sitewide IC Plan (DOE/RL-2001-41), that was prepared by DOE and approved by EPA and the Washington State Department of Ecology (Ecology) in 2002. No later than 180 days after the ROD is signed, DOE shall update the Sitewide IC Plan (DOE/RL-2001-41) to include the ICs required by this ROD and specify the implementation and maintenance actions that will be taken, including periodic inspections. The revised Sitewide IC Plan (DOE/RL-2001-41) shall be submitted to EPA and Ecology for review and approval as a TPA (Ecology et al., 1989) primary document. DOE shall comply with the Sitewide IC Plan (DOE/RL-2001-41), as updated and approved by EPA and Ecology.

The following IC performance objectives are required to be met as part of this RA. Land-use controls will be maintained until CULs are achieved, and the concentrations of hazardous substances are at such levels to allow for UU/UE; EPA authorizes the removal of restrictions. ICs to be implemented by DOE to support achievement of the RAOs include the following:

- In the event that land is transferred out of federal ownership, deed restrictions (proprietary controls such as easements and covenants) are required that are legally enforceable against subsequent property owners.
- In the event of any unauthorized access (e.g. trespassing), DOE shall report such incidents to the Benton County Sheriff's Office for investigation and evaluation of possible prosecution.
- Activities that would disrupt or lessen the performance of any component of the remedies are prohibited.
- Signage and access control to waste sites with contamination above CULs will be provided.
- Maintain the integrity of any current or future remedial or monitoring system such as monitoring wells.
- Prohibit the development and use of property for residential housing, elementary and secondary schools, child care facilities and playgrounds until CULs are met.
- DOE shall employ and maintain an excavation permit program for protection of human health against unacceptable exposure, and protection of environmental and cultural resources.
- DOE shall report on the effectiveness of ICs for all OUs that are the subject of this ROD in an annual report, or on an alternative reporting frequency specified by the LRA. Such reporting may be for OUs individually or may be part of the Sitewide IC plan (DOE/RL-2001-41).

Measures that are necessary to ensure continuation of ICs shall be taken before any lease or transfer of any land subject to ICs. DOE will provide notice to Ecology and EPA at least 6 months before any transfer or sale of land subject to ICs so that the LRA can be involved in discussions to ensure that appropriate provisions are included in the transfer terms or conveyance documents to maintain effective ICs. If it is not possible for DOE to notify Ecology and EPA at least 6 months before any transfer or sale, DOE will notify Ecology and EPA as soon as possible, but no later than 60 days before the transfer or

sale of any property subject to ICs. In addition to the land transfer notice and discussion provisions, DOE further agrees to provide Ecology and EPA with similar notice, within the same timeframes, as to federal-to-federal transfer of property. DOE shall provide a copy of the executed deed or transfer assembly to Ecology and EPA. DOE shall notify EPA and Ecology immediately upon discovery of any activity inconsistent with the specific ICs.

2.1.2.2 Institutional Controls Unique Elements for 100-FR-1 and 100-FR-2 OU

The following IC performance objectives are required to be met as part of this RA for 100-FR-1 and 100-FR-2 OUs. Land-use controls will be maintained until CULs are achieved and the concentrations of hazardous substances allow for UU/UE, and EPA authorizes the removal of restrictions. The following ICs are to be implemented by DOE to support achievement of the RAOs:

- Exposure to contamination deeper than 4.6 m (15 ft) bgs is not anticipated. Where contamination at depth exceeds the CULs attained for the waste site, ICs are required to ensure future activities do not bring this contamination to the surface or otherwise result in exposure to contaminant concentrations that exceed the CULs that were attained at the waste site. A total of 15 100-FR-1 and 100-FR-2 OU waste sites require drilling and excavation ICs for specified time periods due to radionuclide contamination exceeding human health direct contact CULs. The waste sites are presented in Table 2-1. The expected year that ICs can be removed is indicated after the site number.

- Prohibit irrigation over or near waste site 116-F-14 (100-FR-1) that represents an unacceptable surface water protection risk.

The ICs for these sites are implemented through the Sitewide IC Plan (DOE/RL-2001-41). The IC boundaries for the 100-FR-1 and 100-FR-2 OUs are presented in Figure 2-1.

The IC boundaries for 100-IU-2 and 100-IU-6 RTD sites are presented in Figure 2-2.

2.1.2.3 Institutional Controls Unique Elements for 100-FR-3 OU Groundwater

The following IC performance objectives are required to be met as part of this RA for the 100-FR-3 OU. Land-use controls will be maintained until CULs are achieved, and the concentrations of hazardous substances are at such levels to allow for UU/UE; EPA authorizes the removal of restrictions. DOE will implement the following ICs to support achievement of RAOs:

- DOE shall employ and maintain an excavation permit program limiting 100-FR-3 OU groundwater access and use to research purposes and for monitoring and treatment in areas where groundwater is above CULs (Figure 2-3).

- Prevent access or use of the groundwater for drinking water purposes until CULs are met.

These ICs are implemented though the Sitewide IC Plan (DOE/RL-2001-41). The IC boundary for the 100-FR-3 OU is shown in Figure 2-3.

2.1.3 MNA of Groundwater for 100-FR-3 OU

MNA will be used in the 100-FR-3 OU to reduce groundwater COCs to concentrations less than the CULs. Overall plume behavior is controlled by a combination of the source strength (flux of contaminants into the groundwater) and the rate and capacity of attenuation in the groundwater. Without a continuing source, the net plume response will be to diminish over time. The primary natural attenuation processes for COCs present in the 100-FR-3 OU include biodegradation and abiotic degradation, radioactive decay, dispersion, volatilization, and sorption.

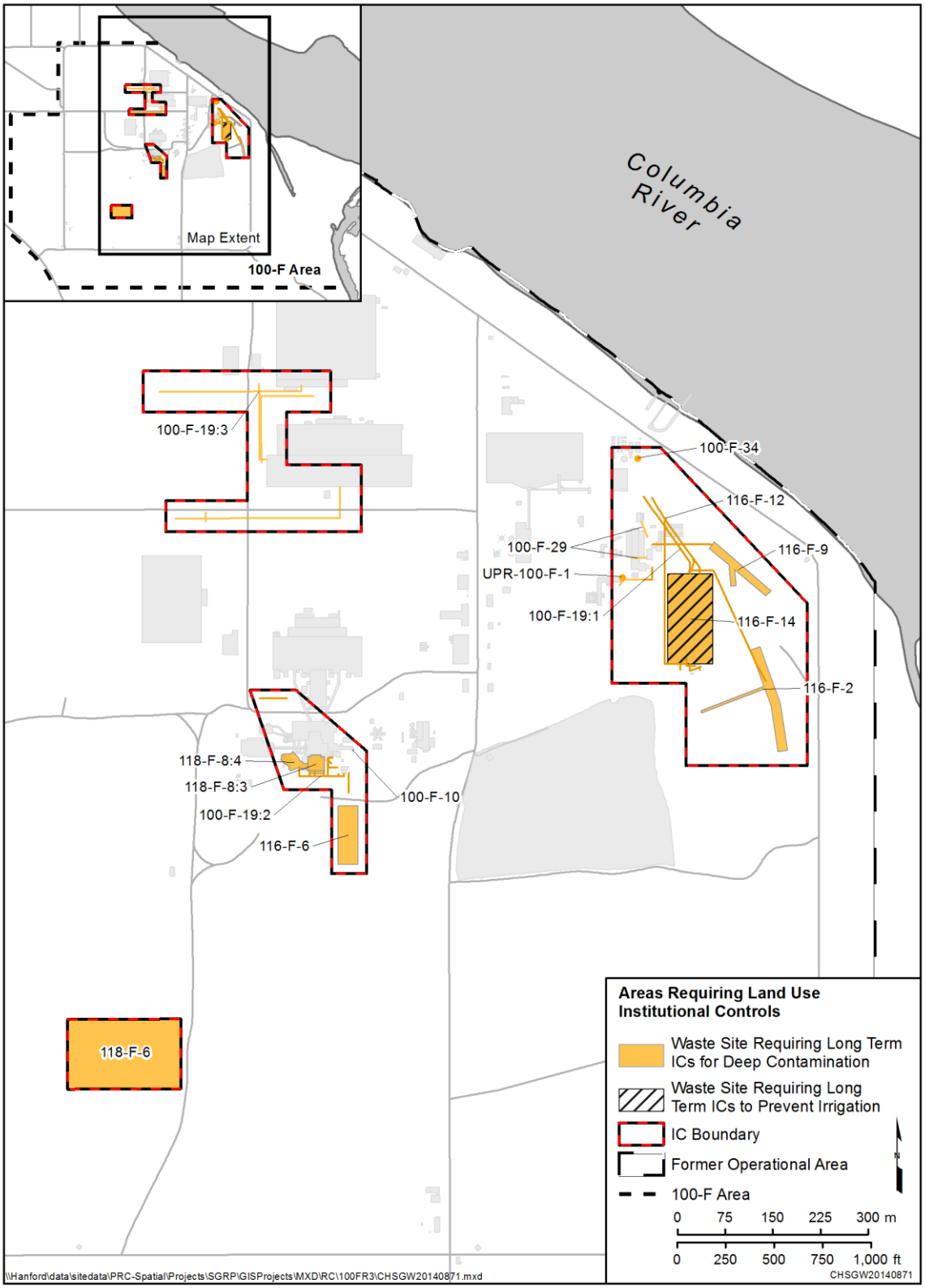

Figure 2-1. 100-FR-1 and 100-FR-2 Operable Unit Institutional Control Boundaries

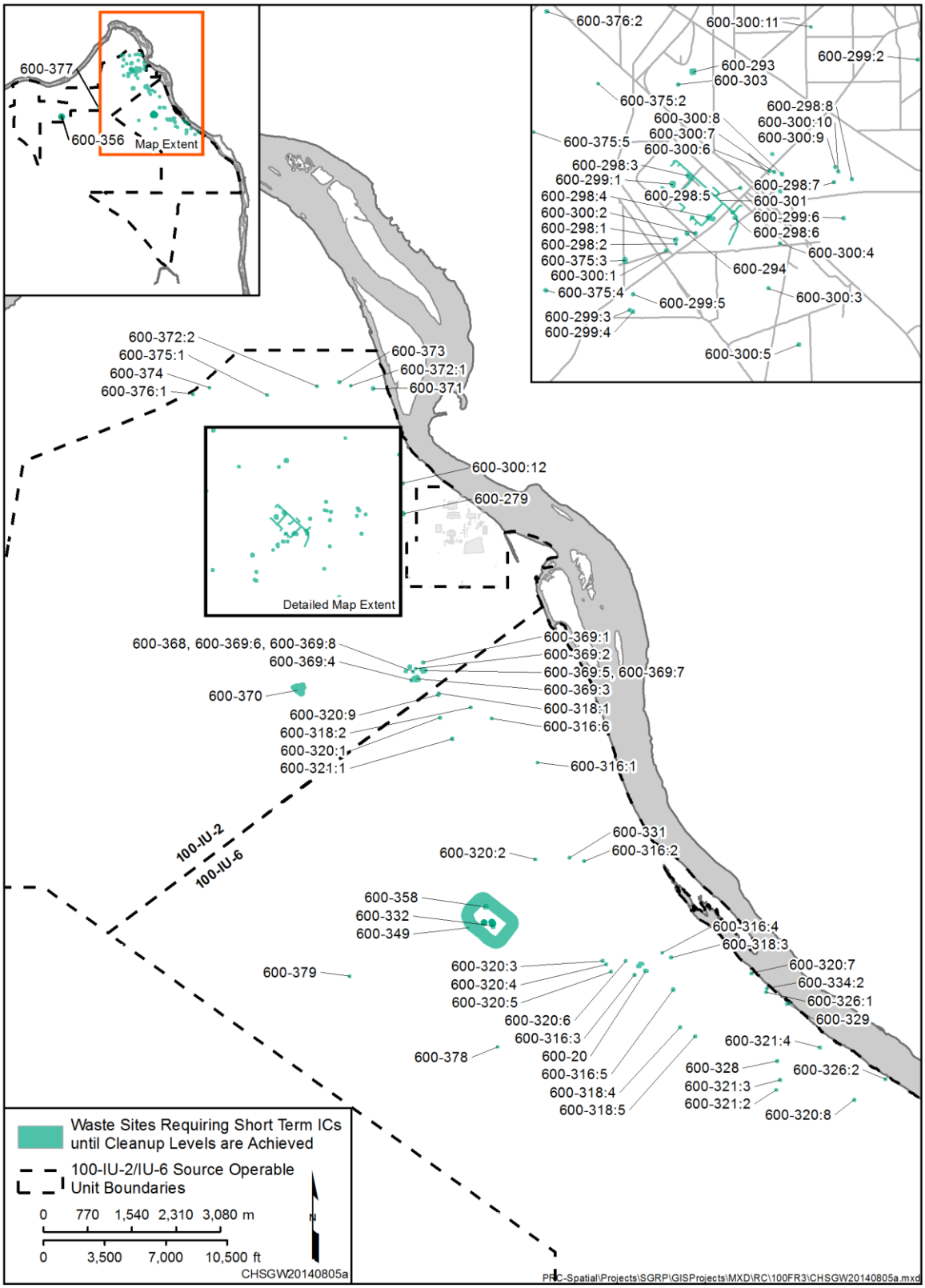

Figure 2-2. 100-IU-2 and 100-IU-6 Operable Unit Institutional Controls Boundaries

Table 2-1. Institutional Controls at Remediated 100-FR-1 and 100-FR-2 Operable Unit 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 cleanup 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.

bgs = below ground surface

The required performance monitoring component includes installation of new monitoring wells, periodic sampling, laboratory analysis, and data evaluation needed to assess and confirm 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.

Performance monitoring for 100-FR-3 groundwater OU was developed using the data quality objective (DQO) process to assess the responses of the groundwater plumes to the remedy over time. Performance monitoring is integrated into the 100-FR-3 Groundwater Sampling and Analysis Plan (Groundwater SAP), which is an appendix to the Groundwater Addendum. Sampling will be sufficient to document changes in contaminant plumes for all groundwater COCs. As part of monitoring the lateral extent of plumes, groundwater will be monitored in the near vicinity of the Columbia River to ensure that the lateral extent of the plumes are defined. Monitoring will continue until COCs have attained the CULs and are expected to continue to meet CULs and EPA approves termination of the monitoring. Considered in the evaluation are processes that can affect concentrations such as river fluctuations, waste site activities, and land use activities. Groundwater monitoring will be performed to evaluate the effectiveness of the selected 100-FR-3 OU remedy to achieve CULs and will include the groundwater COCs (Cr(VI), nitrate, TCE, and strontium-90).

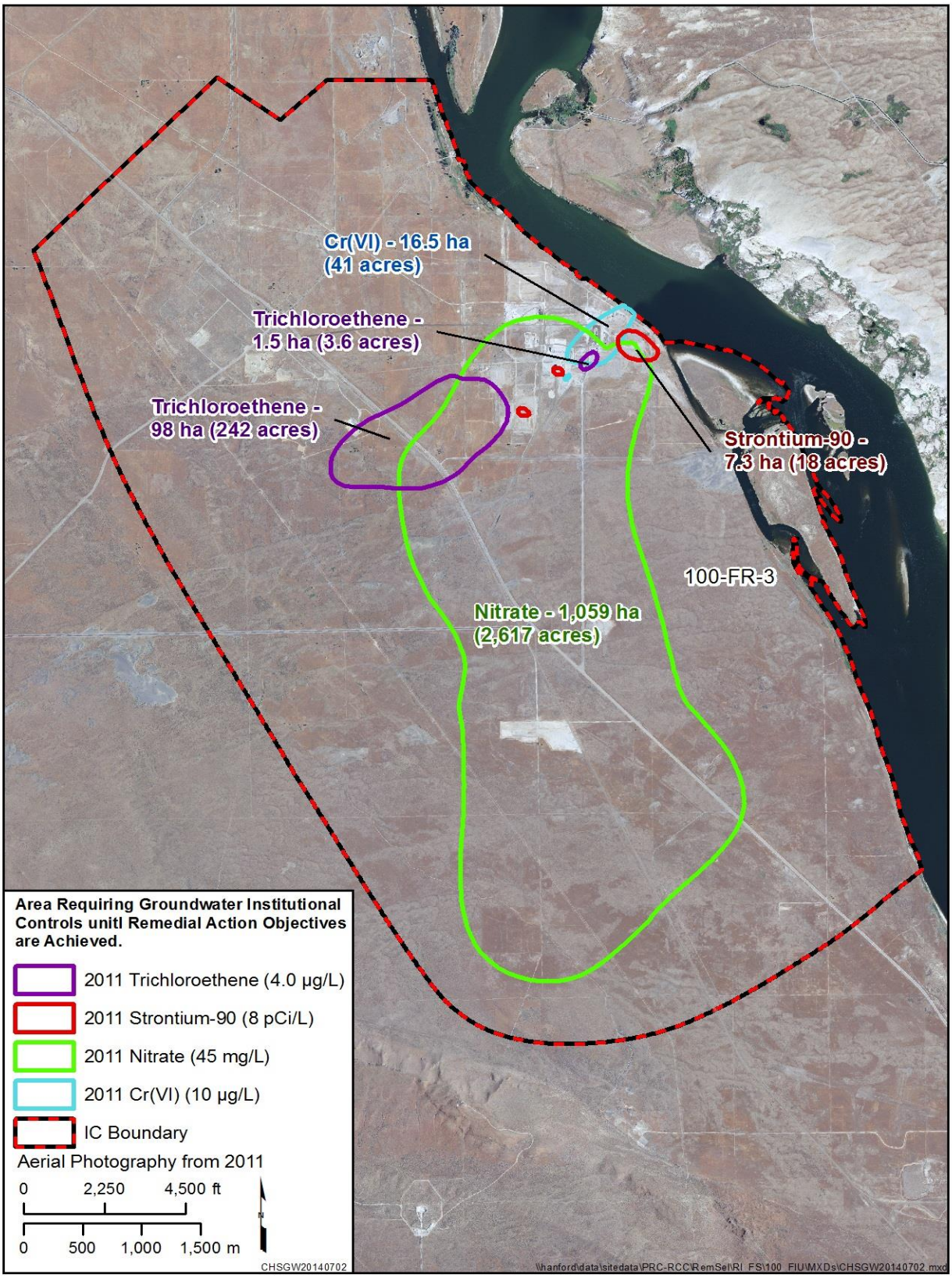

Figure 2-3. 100-FR-3 Operable Unit Institutional Controls Boundary

2.2 Remedial Action Objectives

RAOs describe what the RA 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.

RAOs identified in the 100-F/IU ROD (EPA and DOE, 2014) are summarized in Table 2-2, and referenced to the sections of the Integrated RDR/RAWP, Soil Addendum, or Groundwater Addendum that describe the actions that address each RAO. 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.

These RAOs address the risks identified in the 100-F/IU RI/FS report (DOE/RL-2010-98), are protective of HHE, and are compatible with the RAOs in the previous interim RODs for these OUs.

2.3 Cleanup Levels

CULs for 100-F/IU were selected in the 100-F/IU ROD (EPA and DOE, 2014). Soil CULs for the 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 OUs were developed based on direct human contact (Table 2-3) as well as groundwater and surface water protection (Table 2-4). These CULs apply to soil and debris. Groundwater CULs for the 100-FR-3 OU are based on site-specific data, current federal DWSs, state water quality standards and risk-based concentrations that are more stringent than the DWS for TCE using an MTCA (WAC 173-340) calculation method plus EPA-approved toxicity information (Table 2-5).

Table 2-2. Remedial Action Objectives

RAO	Integrated RDR/RAWP	Soil Addendum	Groundwater Addendum
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.	Sections 2.1.2.1, 2.1.2.3, and 2.1.3		Sections 3 and 4
RAO 2. Prevent unacceptable risk to human health and ecological receptors from groundwater discharges to surface water containing contaminant concentrations above federal and state standards and risk-based thresholds.	Sections 2.1.1, 2.1.2.1, 2.1.2.2, and 2.1.3		Sections 3 and 4
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.	Sections 2.1.1, 2.1.2.1, and 2.1.2.2	Sections 3 and 4	
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.	Sections 2.1.1, 2.1.2.1, and 2.1.2.2	Sections 3 and 4	

Table 2-2. Remedial Action Objectives

RAO	Integrated RDR/RAWP	Soil Addendum	Groundwater Addendum
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 excess lifetime cancer risk 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.	Sections 2.1.1, 2.1.2.1, and 2.1.2.2	Sections 3 and 4	
RAO 6. Manage direct exposure to contaminated soils deeper than 4.6 m (15 ft) to prevent an unacceptable risk to human health and the environment.	Sections 2.1.2.1 and 2.1.2.2	Sections 3 and 4	
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 timeframe that is reasonable given the particular circumstances of the site.	Sections 2.1.2.1, 2.1.2.3, and 2.1.3		Sections 3 and 4

Table 2-3. 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 Operable Units Soil Cleanup Levels for Protection of Human Health

Contaminant of Concern	Units	Cleanup Level (≤4.6 m [15 ft] bgs)	Basis for Cleanup Level
Radionuclides			
Cesium-137	pCi/g	4.4	Direct contact residential scenario
Cobalt-60	pCi/g	1.4	Residential interim remedial action cleanup level
Europium-152	pCi/g	3.3	Residential interim remedial action cleanup level
Europium-154	pCi/g	3.0	Residential interim remedial action cleanup level
Nickel-63	pCi/g	608	Direct contact residential scenario
Strontium-90	pCi/g	2.3	Direct contact residential scenario
Chemicals			
Arsenic	mg/kg	20	MTCA Method A
Hexavalent Chromium	mg/kg	240	MTCA Method B
Lead	mg/kg	250	MTCA Method A
Mercury	mg/kg	24	MTCA Method B
Nitrate	mg/kg	568,000	MTCA Method B

Table 2-3. 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 Operable Units Soil Cleanup Levels for Protection of Human Health

Contaminant of Concern	Units	Cleanup Level (≤4.6 m [15 ft] bgs)	Basis for Cleanup Level
Aroclor 1254	mg/kg	0.50	MTCA Method B
Aroclor 1260	mg/kg	0.50	MTCA Method B
Benzo(a)pyrene	mg/kg	0.14	MTCA Method B
TPH–Diesel Range	mg/kg	2,000	MTCA Method A
TPH–Motor Oil (High Boiling)	mg/kg	2,000	MTCA Method A

bgs = below ground surface
MTCA = "Model Toxics Control Act—Cleanup" (WAC 173-340)

Table 2-4. 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 Operable Units Soil Cleanup Levels for Protection of Groundwater and Surface Water

Contaminant of Concern	100-FR-1 and 100-FR-2	100-IU-2	100-IU-6
Radionuclides			
Cesium-137	—[a]	—[a]	—[a]
Cobalt-60	—[a]	—[a]	—[a]
Europium-152	—[a]	—[a]	—[a]
Europium-154	—[a]	—[a]	—[a]
Nickel-63	—[a]	—[a]	—[a]
Strontium-90	24,600[b]	64,200[b]	104,000[b]
Chemicals			
Arsenic	—[a]	—[a]	—[a]
Hexavalent Chromium	2.0	2.0	2.0
Lead	—[a]	—[a]	—[a]
Mercury	—[a]	—[a]	—[a]
Nitrate	1,790	6,360	11,300
Aroclor 1254	—[a]	—[a]	—[a]
Aroclor 1260	—[a]	—[a]	—[a]
Benzo(a)pyrene	—[a]	—[a]	—[a]
TPH–Diesel Range	2,000[c]	2,000[c]	2,000[c]
TPH–Motor Oil (High Boiling)	2,000[c]	2,000[c]	2,000[c]

Table 2-4. 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 Operable Units Soil Cleanup Levels for Protection of Groundwater and Surface Water

Contaminant of Concern	100-FR-1 and 100-FR-2	100-IU-2	100-IU-6

Note: 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 2-3) and groundwater and surface water protection (Table 2-4). 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 assumed 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).

a. 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.

b. 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.

c. 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 A*dministrative Code*

Table 2-5. 100-FR-3 Operable Unit Groundwater Cleanup Levels

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

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 DWS for NO_3-N is 10,000 µg/L, and the mathematical equivalent value for nitrate (NO3) is 45,000 µg/L.

DWS = drinking water standard

2.4 Applicable or Relevant and Appropriate Requirement Compliance

Applicable or relevant and appropriate requirements (ARARs) are determined based on analysis of which requirements are applicable or relevant and appropriate to the distinctive set of circumstances and actions at a specific site. The NCP (40 CFR 300, Appendix B) requires that ARARs be attained or appropriately waived during implementation and at completion of the RA. No ARAR waivers are authorized as part of the ROD for 100-F/IU. Appendix A presents a summary of federal and state ARARs that are selected in the 100-F/IU ROD (EPA and DOE, 2014).

3 Remedial Design Approach

This chapter is intended to provide general RD information and a description of RA activities necessary to support implementation of the selected remedy. As described in Chapter 1 (Figure 1-2), design details specific to waste site remedies (RTD) are described in the Soil Addendum. Design details for MNA and performance monitoring are presented in the Groundwater Addendum. IC implementation for soil and groundwater is described in Section 2.1.2 and also discussed in the Soil Addendum and Groundwater Addendum.

3.1 Design Basis

Contaminant fate and transport modeling and results of the risk assessment, as documented in the 100-F/IU RI/FS report (DOE/RL-2010-98), were used to identify areas needing remediation and for the design basis of the groundwater and soil RAs. The design basis of specific soil and groundwater remedies is described in detail in the addenda.

3.2 Conceptual Design Summary

Conceptual design approaches for 100-F/IU remedies are presented in the Soil and Groundwater Addenda. A high level summary of remedy conceptual designs is presented in the following subsections.

3.2.1 RTD

The RTD remedy component includes removal (by excavation) of contaminated soil and structures, as necessary, to meet soil CULs; treatment, as necessary, to meet disposal criteria; and disposal at ERDF. The sites are then backfilled and recontoured, followed by revegetation. No additional post-ROD field investigations are anticipated to support the RTD remedy. Actions to complete RTD are discussed further in the Soil Addendum.

3.2.2 MNA of Groundwater

The MNA remedy includes performance monitoring to determine the progress and effectiveness of natural attenuation to meet CULs. Performance monitoring consists of remediation monitoring followed by attainment monitoring. Performance monitoring will include analyses for the COCs (nitrate, Cr(VI), TCE, and strontium-90) in the respective plume areas. Analysis for TCE degradation products (vinyl chloride and *cis*-1,2-dichloroethene) will be performed in the TCE plume areas. Due to analytical uncertainties identified in the 100-F/IU RI/FS report (DOE/RL-2010-98), sampling and analysis will be conducted for antimony, cadmium, and cobalt at selected locations. Field parameters (specific conductance, pH, dissolved oxygen, turbidity, and temperature) will also be reported with the analytical data. To refine understanding of the hydraulic gradients, an automated water level network will be utilized for at least the first 5 years of monitoring.

No additional post-ROD field investigations will be implemented to support the design of MNA. A performance monitoring plan was developed to assess the responses of COC plumes to the remedy over time. Performance monitoring is described in the Groundwater Addendum and the Groundwater SAP. The Groundwater SAP identifies the groundwater monitoring locations, parameters, and frequency to support the MNA remedy. Monitoring will continue until COCs have attained the CULs, and are expected to continue to meet CULs, and EPA approves termination of the monitoring. Estimated durations of MNA are based on the model-estimated timeframe for each COC to achieve its CUL as described in the 100-F/IU RI/FS report (DOE/RL-2010-98). The estimated timeframes for each COC were determined in 2011 and are presented in Table 3-1.

Table 3-1. Estimated Timeframe for Groundwater Cleanup Levels to be Attained through Monitored Natural Attenuation

COC	CUL	Estimated Years to Attain CUL[a]
Hexavalent Chromium	10 µg/L[b]	35
Hexavalent Chromium	48 µg/L[b]	20
Nitrate	45,000 µg/L	80
Trichloroethene	4 µg/L	50
Strontium-90	8 pCi/L	150

a. The remedial action timeframe estimates were determined in 2011 and 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*. Some areas of the COC plume will achieve the CUL earlier than the estimate for the entire plume.
b. The cleanup levels for hexavalent chromium are 48 µg/L in the upland groundwater and 10 µg/L where groundwater discharges to surface water.

COC = contaminant of concern

CUL = cleanup level

Performance monitoring includes installation of new wells to monitor plume sizes and update the rates of attenuation that are occurring to reflect post-source remediation conditions. Locations for the new wells were determined using a phased approach based on available sampling and analysis results. The first phase of new wells was identified through a DQO process and includes 8 locations. The second phase of new wells, if needed, will be determined using data collected from both new and existing wells in the monitoring network.

3.3 Design Approach

Methods and sampling designs summarized in Section 3.2 of this Integrated RDR/RAWP and corresponding addenda represent the overall design and implementation approach that will be followed. The design and planning for completion of RAs at the 100-IU-2 and 100-IU-6 OUs are described in the Soil Addendum. Details of the RD for performance monitoring of the MNA remedy are provided in the Groundwater Addendum. Refinements to the monitoring design may be made after sampling results for the first phase of new wells are evaluated, as described in the Groundwater Addendum.

The Integrated RDR/RAWP, Soil Addendum, and Groundwater Addendum serve as the RDR. The Integrated RDR/RAWP and addenda will be submitted to EPA for review as a primary document in accordance with the TPA (Ecology et al., 1989a), Section 9.2.1.

4 Remedial Action Management and Approach

This chapter describes the work elements and management approach associated with implementation of the selected remedies that are common to all of 100-F/IU. The Soil and Groundwater Addenda include the elements that are specific to each.

4.1 Project Team

The term "project team" includes the individuals working to accomplish the RA. Accordingly, the project team includes the DOE-RL 100-F/IU project manager, the LRA, and the remediation contractors. Figure 4-1 shows the RDR/RA Project Organization. The roles and responsibilities for these team members are discussed in the addenda. The overall project team common to both remediation contractors is briefly discussed in the following paragraphs:

- **Lead Agency (U.S. Department of Energy)** – DOE is the lead agency under CERCLA (delegated by Executive Order 12580, *Superfund Implementation*), the primary authority under Section 104, "Response Authorities," and Section 121, "Cleanup Standards," to conduct removal and RAs at DOE facilities. DOE is responsible for RAs throughout the Hanford Site and, as such, has assigned remedial project managers to each main area and task involved with remediation activities. The lead agency is responsible for managing the assigned activities, which include scope, budget, schedule, quality, personnel, communication, risk/safety, contracts, and regulatory interface, and works under EPA oversight in accordance with CERCLA Section 120, "Federal Facilities," as implemented through the TPA (Ecology et al, 1989a). DOE obtains Congressional funding for these activities.

- **Lead Regulatory Agency (U.S. Environmental Protection Agency)** – EPA is the LRA for CERCLA remediation activities at the 100-F/IU OUs, as described in the TPA (Ecology et al., 1989a). The LRA is responsible for overseeing activities to verify that applicable regulatory requirements are met. LRA approval will be required on all TPA (Ecology et al., 1989a) primary documents (for example, this Integrated RDR/RAWP and addenda).

Remediation Contractors:

- The waste site remediation contractor will implement the RDR/RAWP for RTD and associated ICs at 100-IU-2 and 100-IU-6 waste sites. The RDR/RAWP elements specific to the RA management and approach are provided in the Soil Addendum.

- The groundwater remediation contractor will implement the RDR/RAWP activities associated with MNA. The RDR/RAWP elements specific to the RA management and approach are provided in the Groundwater Addendum.

- The Hanford Site administration contractor will implement the activities associated with long-term ICs restricting drilling and excavation and prohibiting irrigation at identified 100-FR-1 and 100-FR-2 OU waste sites and ICs restricting access to groundwater within the 100-FR-3 boundary identified in the 100-F/IU ROD (EPA and DOE, 2014). The site administration contractor reports directly to DOE.

- Contractors for Operations, Waste Management, Field Construction, Radiological Control, Engineering, Quality Assurance (QA), Health and Safety, Environmental Compliance, and Sample Management may be used for both soil and groundwater work and would report to the Remediation Contractors.

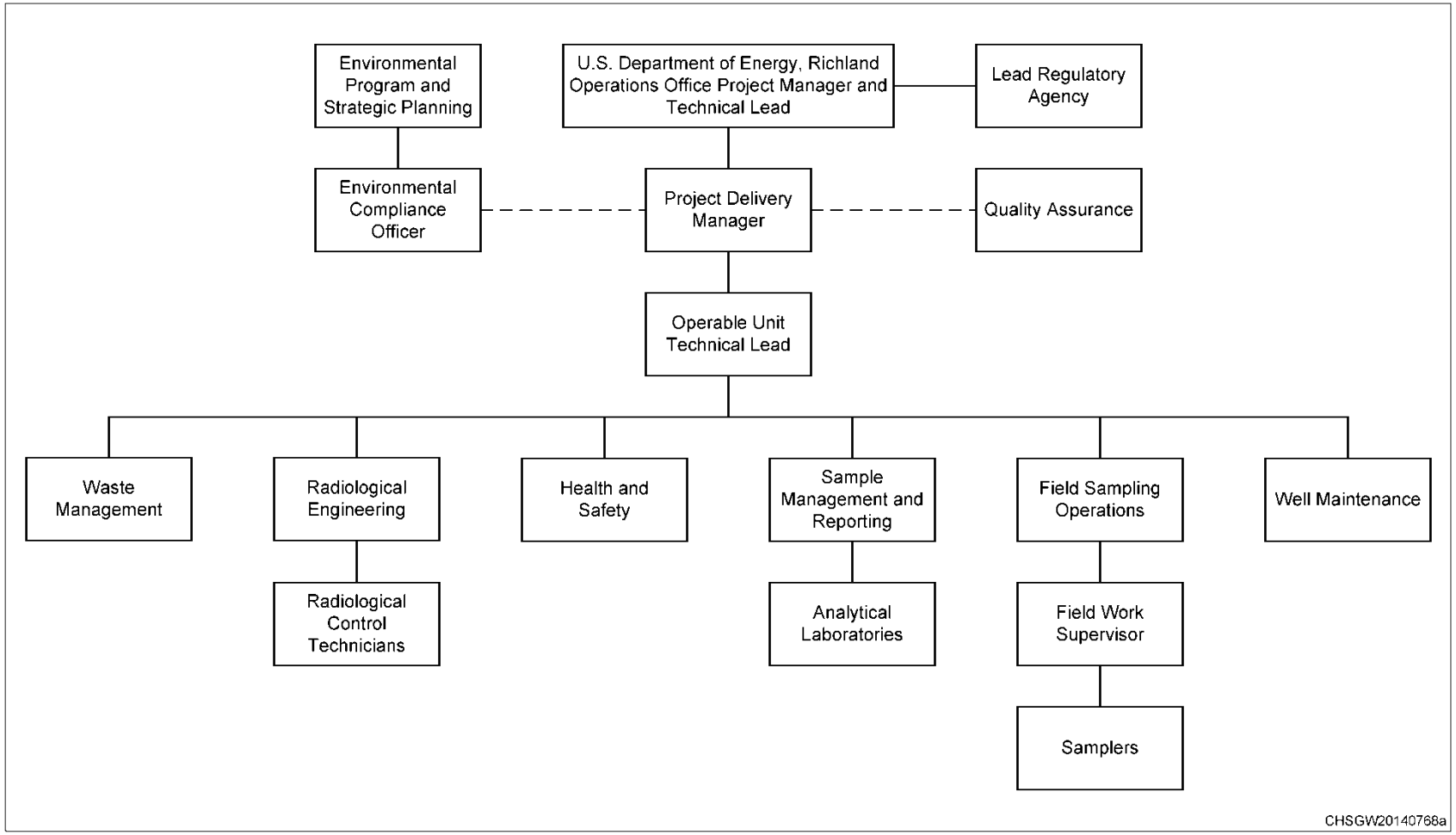

Figure 4-1. Remedial Design/Remedial Action Project Organization

4.2 Change Management

Three types of changes in the RAs could affect compliance with the requirements in the 100-F/IU ROD (EPA and DOE, 2014):

- A nonsignificant or minor change does not impact the remedy identified in the 100-F/IU ROD (EPA and DOE, 2014). An example of a nonsignificant change may include modifications to the RA schedule that do not impact an agreed-upon milestone. Minor changes should be documented in the appropriate post-decision project file (for example, through interoffice memoranda or in logbooks), project manager's meeting minutes, or Unit Manager's Meeting minutes.
- A significant change is defined as a change that significantly modifies the scope, performance, or component cost for the remedy as presented in the 100-F/IU ROD (EPA and DOE, 2014). All significant changes will be addressed in an ESD.
- A fundamental change does not meet the requirements set forth in the 100-F/IU ROD (EPA and DOE, 2014) or incorporates remedial activities that are not defined in the scope of the ROD. Should this situation arise, the ROD must be amended.

Determining the significance of the change is the responsibility of DOE and the LRA. The remediation or environmental manager is responsible for tracking all changes and obtaining appropriate reviews by contractor staff. The remediation or environmental manager will discuss the change with DOE, and DOE will then discuss the type of change that is necessary with the LRA. Appropriate documentation will follow, in accordance with the requirements for that type of change.

4.3 Remedial Action Work Tasks

RA work tasks include procurement and construction, operational approach, and data use and interpretation. RA activities that are specific to the soil or groundwater RA are described in the Soil and Groundwater Addenda, respectively.

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5 Environmental Management and Controls

This chapter describes environmental management and controls associated with implementation of the 100-F/IU remedies.

5.1 Air Emissions

The requirements for environmental management and controls of radiological and nonradiological air emissions is described in the following sections.

5.1.1 Radiological Air Emissions

The remedial activities will be evaluated on a waste site-specific basis with respect to determining the potential-to-emit radionuclides from any point source or diffuse/fugitive source. Any radiological air emissions associated with RTD at waste sites for the 100-IU-2 and 100-IU-6 OUs will be managed with treatment conducted, as necessary, in advance or during removal to control worker exposure and minimize airborne releases. Additional information regarding evaluation and management of radiological emissions from waste site RA is presented in the Soil Addendum. Air monitoring requirements for waste site RTD are also described further in the Soil Addendum.

Radiological air emissions associated with MNA of groundwater are not anticipated.

5.1.2 Nonradiological Air Emissions

To demonstrate compliance with the ARARs of WAC 173-400, “General Regulations for Air Pollution Sources,” and WAC 173-460, “Controls for New Sources of Toxic Air Pollutants,” fixatives and dust suppression methods will be used.

Nonradiological air emissions associated with MNA of groundwater are not anticipated.

5.2 Reporting Requirements for Nonroutine Releases

40 CFR 302, “Designation, Reportable Quantities, and Notification,” requires immediate notification to the National Response Center upon discovery of a release of a hazardous substance into the environment in excess of a reportable quantity in a 24-hour period. 40 CFR 355, “Emergency Planning and Notification,” requires immediate notification to the community emergency coordinator for the local emergency planning committee and to the State Emergency Response Commission for a release of a reportable quantity of an extremely hazardous substance or a CERCLA hazardous substance in a 24-hour period, except for releases exempted from reporting under 40 CFR 355.31, “What Types of Releases are Exempt from the Emergency Release Notification Requirements of this Subpart?” The Hanford Site has comprehensive policies and procedures in place to report nonroutine releases to the environment. These procedures will be followed at the 100-F/IU OUs.

5.3 Waste Management

Waste management requirements for project waste streams, waste characterization, designation and disposal, waste generation management, management of waste containers, final disposal/storage, waste disposal records, waste transportation, waste treatment, and waste minimization and recycling are included in the 100-F/IU Soil Addendum and Groundwater Addendum.

5.4 Cultural/Ecological Resources

Protection of cultural resources is addressed, in part, during the ARAR identification process based on CERCLA and NCP (40 CFR 300) guidance. The lead and non-lead agencies identify ARARs for RA at a

CERCLA site (NCP, 40 CFR 300.400(g), "General"). ARARs identified in the 100-F/IU ROD (EPA and DOE, 2014) for the RAs are provided in Appendix A of this Integrated RDR/RAWP. As identified in Appendix A, the following ARARs protect ecological, cultural, historic, and Native American sites and artifacts (resources) for work within 100-IU-2/-IU-6:

- *National Historic Preservation Act of 1966* (Public Law 89-665, as amended, 16 USC 470, et seq.). "Protection of Historic Properties" (36 CFR 800)*:* Cultural and historic sites have been identified within 100-IU-2 and 100-IU-6. Additional reviews will be done at RA areas where existing reviews are not sufficient. For any discoveries, appropriate actions will be taken to meet standards.

- *Protection and Enhancement of the Cultural Environment* (Executive Order 11593). "National Historic Landmarks Program" (36 CFR 65): Cultural and historic sites have been identified within 100-IU-2 and 100-IU-6. RAs shall comply with this standard.

- *Native American Graves Protection and Repatriation Act of 1990* (Public Law 101-601, as amended, 25 USC 3001, et seq.); "Native American Graves Protection and Repatriation Regulations" (43 CFR 10).
  "Native American Graves Protection and Repatriation Regulations" (43 CFR 10): Native American archaeological, cultural, and historic sites have been identified within 100-IU-2 and 100-IU-6, and Native American remains and associated objects have the potential to be present. RAs will be conducted to identify, protect, and provide for appropriate disposition of covered human remains, objects, and items. Native American Tribal consultation will be conducted in the event of discovery.

- *Archeological and Historic Preservation Act of 1974* (Public Law 93-291, as amended; 16 USC 469a-1 through 469a-2(d)).
  "Applicant Requirements" 16 USC 469a-1 through 469a-2(d): Archaeological and historic sites have been identified within 100-IU-2 and 100-IU-6. In the event that RAs may cause irreparable loss to significant scientific, prehistoric, or archeological data, the data will be preserved.

- *Migratory Bird Treaty Act of 1918*; 50 CFR 10, "Wildlife and Fisheries," "General Provisions;" and 50 CFR 21, "Wildlife and Fisheries," "Migratory Bird Permits": RAs within 100-IU-2 and 100-IU-6 will require mitigation measures to deter nesting by migratory birds on, around, or within RA sites and methods to identify and protect occupied bird nests in a manner that complies with requirements.

- *Bald and Golden Eagle Protection Act of 1940*; 50 CFR 22, "Wildlife and Fisheries," "Eagle Permits": Bald eagles nest, feed, and overwinter along the shores of the Columbia River. RAs within 100-IU-2 and 100-IU-6 will be performed in a way to protect bald eagle habitat.

The following ARAR is applicable for work within the 100-FR-3 OU:

- *Endangered Species Act of 1973*: 100-FR-3 OU groundwater discharges into the Hanford Reach of the Columbia River, which contains endangered Upper Columbia River spring-run Chinook salmon and steelhead. 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 listed as a threatened species but is not considered a resident species and is rarely observed in the Hanford Reach. RAs will be managed to avoid jeopardy and/or adverse effects to a listed species or critical habitat.

Prior to disturbing the earth (e.g., drilling, surface grubbing, and excavating), DOE-RL will initiate discussion with the affected parties (as prescribed by the *National Historic Preservation Act of 1966*), and an analysis of cultural and ecological resource impacts will be undertaken. This will include an assessment of the resources present and a qualitative comparison to the risk posed by the contaminants present in

the OU. A mitigation action plan is prepared to minimize project impacts to cultural and natural resources that are identified during the survey.

A cultural resources review is part of work planning activities, and the project will involve cultural resources staff early in the planning stage to address potential concerns and consider the effects that the planned project activities could have.

5.5 Safety and Health Program

A health and safety plan (HASP) addresses routine job site hazards and physical hazards and specifies general controls and requirements for work activities. Access and work activities are controlled in accordance with approved work packages, as required by established internal work requirements and processes. The HASP includes the requirements for hazardous waste operations and/or construction activities, as specified in 29 CFR 1910.120, "Occupational Safety and Health Standards," "Hazardous Waste Operations and Emergency Response." Depending on the specific hazards present, one or more HASPs could be written for this RA. As part of work package development, a job or activity hazards analysis will be written to identify the hazards associated with specific tasks in addition to the HASP.

In addition to the HASP, in accordance with contractor-level procedures and programs, radiological work permits (RWPs) will be prepared, as needed, for work in areas with potential radiological hazards. The RWP extends the Radiological Protection Program to the specific work site or operation. All personnel assigned to the project and all work site visitors shall strictly adhere to the provisions identified in the HASP and RWP. Before work and before each activity begins, a pre-job briefing will be held with the involved workers. This briefing will include reviews of the hazards that could be encountered and the associated requirements. Throughout an activity, daily briefings could also be held, as well as special briefings before major evolutions.

5.6 Emergency Response

During construction and operations, emergency response for project activities will be covered by the project-specific HASP, and related health and safety procedures and work instructions. The HASP, health and safety procedures, and work instructions contain primary emergency response actions for site personnel, area alarms, implementation of the emergency action plan, and emergency equipment at each task site, as well as emergency coordinators, emergency response procedures, and spill containment. A copy of the HASP will be kept in the construction field office. When emergencies arise that are beyond the limitations of the project-specific HASP, DOE-0223, *Emergency Plan Implementing Procedures*, will govern project staff response, as specified in the HASP.

5.7 Quality Assurance Program

Overall QA for the RDR/RAWP will be planned and implemented in accordance with 10 CFR 830, "Nuclear Safety Management," Subpart A, "Quality Assurance Requirements;" EPA/240/B-01/003, *EPA Requirements for Quality Assurance Project Plans* (EPA QA/R-5); EPA/240/R-02/009, *Guidance for Quality Assurance Project Plans* (EPA QA/G-5); and EPA/240/B-05/001, *Guidance on Quality Assurance for Environmental Technology Design, Construction, and Operation* (EPA QA/G-11). QA activities will use a graded approach based on the potential impact to the environment, safety, health, reliability, and continuity of operations. QA for the Soil and Groundwater remedy implementation is discussed in the applicable SAPs and will comply with the following requirements:

- DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Document* (HASQARD)
- DOE O 414.1D, *Quality Assurance*

The SAPs prepared to support the 100-F/IU RA contain a QA project plan, which establishes the quality requirements for environmental data collection, including planning, implementation, and assessment of sampling, field measurements, and laboratory analysis.

6 Remedial Action Completion

This chapter describes how the effectiveness of the remedies will be evaluated for RA completion. Performance standards were established for 100-FR-3 OU groundwater and 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 OU waste sites. Performance standards for groundwater are CULs that are based on the DWSs for strontium-90 and nitrate, state surface water quality standards for Cr(VI), and risk-based standards that are more stringent than DWSs for TCE. Performance standards selected for 100-F/IU soil, structures, and debris within the top 4.6 m (15 ft) bgs are protective of residential use. CULs for soil at all depths are based on protection of groundwater and surface water. Additional details for remedy completion are provided in the 100-F/IU Soil and Groundwater Addenda.

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7 Cost and Schedule

This chapter discusses the cost and schedule associated with implementation of the 100-F/IU remedies.

7.1 Cost Summary

Cost estimates for the 100-F/IU RDR/RAWP are reported in ECE-100FR314-00007, *Environmental Cost Estimate for 100 F/IU RD/RAWP*.

Cost estimates for remediation of remaining 100-IU-2/IU-6 waste sites were prepared as part of the 100-F/IU RI/FS report (DOE/RL-2010-98) and subsequently carried forward into the 100-F/IU ROD (EPA and DOE, 2014). The estimates for RTD and ICs were prepared with an accuracy of -30 percent to +50 percent to support evaluation of remedial alternatives and selection of a remedy. Cost estimates are updated based on design work. In accordance with CERCLA requirements, an ESD will be pursued by the Tri-Parties if remediation costs change significantly from those identified in the 100-F/IU ROD (EPA and DOE, 2014).

The estimated cost for RTD of remaining 100-IU-2/IU-6 waste sites was $9.6 million.

ICs for the 100-FR-1 and 100-FR-2 OUs restrict excavation at 15 waste sites and prohibit irrigation at 1 waste site until CULs are achieved. ICs for the 100-FR-3 OU include a prohibition on groundwater use except for monitoring, remediation, or research purposes as authorized in EPA-approved documents. ICs will be maintained until CULs are achieved. The cost for 150 years of ICs is estimated at $26.2 million.

The estimated costs for MNA and performance monitoring are $18.1 million. This estimate was prepared with an accuracy of –20 percent to +30 percent to support RA implementation.

7.2 Schedule

The schedule for implementation of 100-F/IU remedies is presented in the respective 100-F/IU Soil and Groundwater Addenda. RTD at 100-IU-2 and 100-IU-6 waste sites is planned to be completed in 3 to 5 years.

Implementation of the 100-FR-3 OU performance monitoring will begin after approval of the RDR/RAWP. Installation of new phase 1 monitoring wells is anticipated to be initiated immediately following RDR/RAWP approval. Phase 1 well installation is anticipated to be completed within 6 months of initiation.

The duration of the MNA performance monitoring period is based on the model-estimated timeframe for each COC to achieve its CUL as described in the 100-F/IU RI/FS report (DOE/RL-2010-98). The estimated attenuation timeframes were determined in 2011 and are rounded up to account for model uncertainties. The following timeframes are estimated for each COC:

- Cr(VI) = 35 years based on 10 µg/L CUL
- Trichloroethene = 50 years
- Nitrate = 80 years
- Strontium-90 = 150 years

Five years of attainment monitoring will be performed at each well once CULs for each COC are achieved, as described in the Groundwater Addendum. The 5-year attainment monitoring period is not included in the timeframe estimates.

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8 References

10 CFR 830, "Nuclear Safety Management," Subpart A, "Quality Assurance Requirements," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title10-vol4/xml/CFR-2010-title10-vol4-part830-subpartA.xml.

29 CFR 1910.120, "Occupational Safety and Health Standards," "Hazardous Waste Operations and Emergency Response," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title29-vol5/xml/CFR-2010-title29-vol5-sec1910-120.xml.

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36 CFR 800, "Protection of Historic Properties," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title36-vol3/xml/CFR-2010-title36-vol3-part800.xml.

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300.400, "General."

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40 CFR 355, "Emergency Planning and Notification," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title40-vol27/xml/CFR-2010-title40-vol27-part355.xml.

355.31, "What Types of Releases are Exempt from the Emergency Release Notification Requirements of this Subpart?"

43 CFR 10, "Native American Graves Protection and Repatriation Regulations," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title43-vol1/xml/CFR-2010-title43-vol1-part10.xml.

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Appendix A

Applicable or Relevant and Appropriate Requirements

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A1 Introduction

A list of applicable or relevant and appropriate requirements (ARARs) are identified in the 100-F/IU ROD (EPA and DOE, 2014). Only the substantive requirements of listed ARARs are included. The application column of Table A-1 identifies if the ARARs apply to the selected remedy for 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and/or 100-IU-6.

Table A-1. Applicable or Relevant and Appropriate Requirements

Regulatory Citation	Description of Regulatory Requirement	Rationale for Including	Application
Groundwater			
***Safe Drinking Water Act of 1974* (Public Law 93-523, as amended; 42 USC 300f, et seq.); "National Primary Drinking Water Regulations" (40 CFR 141)**			
"Maximum Contaminant Levels for Organic Contaminants" (40 CFR 141.61) "Maximum Contaminant Level Goals for Organic Contaminants" (40 CFR 141.50(b))	Establishes MCLs and nonzero MCLGs for drinking water. The standards/goals are designed to protect human health from adverse effects of organic contaminants in the drinking water.	These levels regulate the concentrations of contaminants in public drinking water supplies and are considered relevant and appropriate for groundwater and for surface water used potentially for drinking water. Although 100-FR-3 groundwater is not currently used for drinking water, it is a potential drinking water source and discharges into the Columbia River, which is used for drinking water.	100-FR-3. To be met through MNA and source control measures.
"Maximum Contaminant Levels for Inorganic Contaminants" (40 CFR 141.62) "Maximum Contaminant Level Goals for Inorganic Contaminants" (40 CFR 141.51(b))	Establishes MCLs and nonzero MCLGs for drinking water. The standards/goals are designed to protect human health from adverse effects of inorganic contaminants in the drinking water.	These levels regulate the concentrations of contaminants in public drinking water supplies and are considered relevant and appropriate for groundwater and for surface water used potentially for drinking water. Although 100-FR-3 groundwater is not currently used for drinking water, it is a potential drinking water source and discharges into the Columbia River, which is used for drinking water.	100-FR-3. To be met through MNA and source control measures.
"Maximum Contaminant Levels for Radionuclides" (40 CFR 141.66)	Establishes MCLs for drinking water. The standards are designed to protect human health from the adverse effects of radionuclides in the drinking water.	These levels regulate the concentrations of contaminants in public drinking water supplies and are considered relevant and appropriate for groundwater and for surface water used potentially for drinking water. Although 100-FR-3 groundwater is not currently used for drinking water, it is a potential drinking water source and discharges into the Columbia River, which is used for drinking water.	100-FR-3. To be met through MNA and source control measures.

Table A-1. Applicable or Relevant and Appropriate Requirements

Regulatory Citation	Description of Regulatory Requirement	Rationale for Including	Application
"Hazardous Waste Cleanup—Model Toxics Control Act" (RCW 70.105D, as amended); "Model Toxics Control Act—Cleanup" (WAC 173-340)			
"Potable Groundwater Defined" (WAC 173-340-720(2)) "Method B Cleanup Levels for Potable Ground Water" (WAC 173-340-720(4)(b)(i-iii)(A)&(B)) "Adjustments to Cleanup Levels" (WAC 173-340-720(7)) "Points of Compliance" (WAC 173-340-720(8)) "Compliance Monitoring" (WAC 173-340-720(9)(b-f))	Groundwater shall be classified as potable unless exclusion criteria are met. These groundwater cleanup requirements are ARARs where they are more stringent than federal MCL ARARs. Adjustments to CULs are made in accordance with WAC 173-340-720(7). Points of compliance are established throughout 100-FR-3. Groundwater sample analysis shall be conducted on unfiltered samples unless a filtered sample is shown to be more representative.	Groundwater in 100-FR-3 contains contaminants that require remediation. It is not currently used for drinking water but is a potential drinking water source. Groundwater discharges into the Columbia River, which is used for drinking water.	100-FR-3. The groundwater cleanup levels for chemicals are calculated using Method B equations (720-1 and 720-2) for noncarcinogens and carcinogens, respectively. The selected remedy will comply with the standards using MNA and source control measures, with the 100-FR-3 points of compliance being throughout the 100-FR-3 aquifer.
"Water Well Construction" (RCW 18.104, as amended); "Minimum Standards for Construction and Maintenance of Wells" (WAC 173-160)			
"How Shall Each Water Well Be Planned and Constructed?" (WAC 173-160-161)	Identifies well planning and construction requirements. Water wells must not be a conduit for contamination and be constructed to yield the necessary quantity of water.	Wells are used to monitor groundwater.	100-FR-3. The selected remedy will comply by constructing water wells that meet these standards.
"What Are the Requirements for Preserving the Natural Barriers to Ground Water Movement Between Aquifers?" (WAC 173-160-181)	Identifies the requirements for preserving natural barriers to groundwater movement between aquifers.	Wells are used to monitor groundwater.	100-FR-3. The selected remedy will comply by constructing water wells that meet these standards.
"What Are the Minimum Standards for Resource Protection Wells and Geotechnical Soil Borings?" (WAC 173-160-400)	Identifies the minimum standards for resource protection wells and geotechnical soil borings.	Wells are used to monitor groundwater.	100-FR-3. The selected remedy will comply by building wells that meet these standards.
"What Are the General Construction Requirements for Resource Protection Wells?" (WAC 173-160-420)	Identifies the general construction requirements for resource protection wells.	Wells are used to monitor groundwater.	100-FR-3. The selected remedy will comply by building wells that meet these standards.
"What Are the Minimum Casing Standards?" (WAC 173-160-430)	Identifies the minimum casing standards.	Wells are used to monitor groundwater.	100-FR-3. The selected remedy will comply by building wells that meet these standards.

Table A-1. Applicable or Relevant and Appropriate Requirements

Regulatory Citation	Description of Regulatory Requirement	Rationale for Including	Application
"What Are the Equipment Cleaning Standards?" (WAC 173-160-440)	Identifies the equipment cleaning standards for construction and maintenance of wells.	Wells are used to monitor groundwater.	100-FR-3. The selected remedy will comply by building wells that meet these standards.
"What Are the Well Sealing Requirements?" (WAC 173-160-450)	Identifies the well sealing requirements for resource protection wells.	Wells are used to monitor groundwater.	100-FR-3. The selected remedy will comply by building wells that meet these standards.
"What Is the Decommissioning Process for Resource Protection Wells?" (WAC 173-160-460)	Identifies the decommissioning process for resource protection wells.	Wells are used to monitor groundwater.	100-FR-3. The selected remedy will comply by decommissioning wells and borings to meet these standards.
Surface Water			
***Federal Water Pollution Control Act* (also known as *Clean Water Act of 1972* [Public Law 107-303, as amended; 33 USC 1251, et seq.]), Section 303c; "Water Quality Standards" (40 CFR 131)**			
"Toxics Criteria for Those States Not Complying with Clean Water Act" (40 CFR 131.36(b)(1) as applied to Washington, 40 CFR 131.36(d)(14))	Establishes numeric water quality criteria for priority toxic pollutants for the protection of human health and aquatic organisms which supersede criteria adopted by the state, except where the state criteria are more stringent than the federal criteria.	Groundwater from 100-FR-3 that discharges into the Columbia River contains priority toxic pollutants that require remediation to meet toxics criteria standards.	100-FR-3. These standards apply where groundwater discharges to the river. The selected remedy will comply through MNA, infiltration control and source control measures.
"Water Pollution Control" (RCW 90.48, as amended); "Water Quality Standards for Surface Waters of the State of Washington" (WAC 173-201A)			
"Toxic Substances" (WAC 173-201A-240(3))	Establishes chemical water quality standards for surface waters of the State of Washington for protection of aquatic life.	Groundwater in 100-FR-3 contains contaminants that require remediation and discharges into the Columbia River.	100-FR-3. These standards apply where groundwater discharges to the river. The selected remedy will comply through MNA control and source control measures
"Toxic Substances" (WAC 173-201A-240(6))	Establishes water quality standards for surface waters of the State of Washington. Risk-based criteria for carcinogenic substances shall be selected such that the upper-bound excess cancer risk is less than 1×10^{-6} for individual contaminants.	Contaminated groundwater that requires remediation to protect drinking water uses discharges to the Columbia River. Surface water is not contaminated by 100-FR-3 discharges in excess of this standard.	100-FR-3. Columbia River surface waters of the State currently comply with this standard for discharges from 100-FR-3. The selected remedy will further reduce 100-FR-3 discharges and comply with this standard.

Table A-1. Applicable or Relevant and Appropriate Requirements

Regulatory Citation	Description of Regulatory Requirement	Rationale for Including	Application
Soil and Vadose Zone			
"Hazardous Waste Cleanup—Model Toxics Control Act" (RCW 70.105D, as amended); "Model Toxics Control Act—Cleanup" (WAC 173-340)			
"Unrestricted Land Use Soil Cleanup Standards" (WAC 173-340-740(3)) "Unrestricted Land Use Soil Cleanup Standards, Adjustments to Cleanup Levels" (WAC 173-340-740(5)) "Unrestricted Land Use Soil Cleanup Standards, Point of Compliance" (WAC 173-340-740(6)) "Unrestricted Land Use Soil Cleanup Standards, Compliance Monitoring" (WAC 173-340-740(7))	Requires that soil cleanup levels result in no significant adverse effects on terrestrial ecological receptors. Requires human health protection from both groundwater contaminated due to leaching and direct soil contact. Total excess cancer risk may not exceed 1×10^{-5} or a noncancer hazard index of 1 for chemical contaminants. Soil points of compliance are throughout the site. Soil cleanup levels apply to the less than 2 mm size fraction of dry samples, or also larger-size fractions if they could be crushed.	Soil in 100-IU-2 and 100-IU-6 contains contaminants that require remediation to meet Method B soil cleanup levels calculated based on an unrestricted land use.	100-IU-2 and 100-IU-6. The selected remedy will comply through RTD of contaminants that exceed the standards. Table 5 includes soil cleanup levels to protect direct exposure that meet the risk and hazard requirements. Table 6 includes soil cleanup levels for the protection of groundwater and surface water due to leaching from soil contamination.
"Deriving Soil Concentrations for Groundwater Protection" (WAC 173-340-747(3) through (8))	Establishes soil concentrations that will not cause contamination of groundwater at levels that exceed the groundwater cleanup levels established under "Groundwater Cleanup Standards" (WAC 173-340-720).	Soil in 100-IU-2 and 100-IU-6 contains contaminants that require remediation to ensure protection of groundwater. Although 100-FR-3 groundwater is not currently used for drinking water, it is a potential drinking water source Groundwater discharges into the Columbia River, which is used for drinking water.	100-IU-2 and 100-IU-6. The selected remedy will comply through RTD of contaminants that exceed the standards. Table 6 includes soil cleanup levels to protect groundwater and surface water due to leaching from soil contamination.
Air			
"Washington Clean Air Act" (RCW 70.94, as amended); "General Regulations for Air Pollution Sources" (WAC 173-400)			
"General Standards for Maximum Emissions" (WAC 173-400-040)	All sources and emission units are required to meet the general emission standards unless a specific source standard is available. General standards apply to visible emissions, particulate fallout, fugitive emissions, odors, emissions detrimental to health and property, sulfur dioxide, and fugitive dust.	Soil remedial action at 100-IU-2 and 100-IU-6 provides the potential for emissions subject to these standards because selected remedial action could result in emissions of regulated hazardous air pollutants.	100-IU-2 and 100-IU-6. Remedial actions that have the potential to release hazardous air emissions will meet standards.

Table A-1. Applicable or Relevant and Appropriate Requirements

Regulatory Citation	Description of Regulatory Requirement	Rationale for Including	Application
"Emission Standards for Sources Emitting Hazardous Air Pollutants" (WAC 173-400-075)	Establishes emission standards for hazardous air pollutants. Adopts, by reference, "National Emission Standards for Hazardous Air Pollutants" (NESHAP) (40 CFR 61) and appendices.	100-IU-2 and 100-IU-6 OUs contain hazardous pollutants that could become airborne.	100-IU-2 and 100-IU-6. Remedial actions will be designed and performed in compliance with the standards.
"Washington Clean Air Act" (RCW 70.94, as amended); "Controls for New Sources of Toxic Air Pollutants" (WAC 173-460)			
"Control Technology Requirements" (WAC 173-460-060) "Ambient Impact Requirement" (WAC 173-460-070) "Table of ASIL, SQER and de Minimis Emission Values" (WAC 173-460-150)	Shall not establish, operate or cause to be established or operated any new or modified toxic air pollutant source that is likely to increase TAP emissions without installing and operating BACT. Nonprocess fugitive emissions activities are exempt for the requirement to apply BACT. Requires compliance with the limits air pollutants include carcinogens and noncarcinogens listed in "Table of ASIL, SQER and de Minimis Emission Values" (WAC 173-460-150).	Hazardous contaminants detected in soil and/or 100-FR-3 groundwater include constituents that would constitute toxic air pollutants if released to the air.	100-FR-3, 100-IU-2 and 100-IU-6. Remediation activities with the potential to emit hazardous air emissions identified in this standard will comply.
"Washington Clean Air Act" (RCW 70.94, as amended); "Ambient Air Quality Standards and Emission Limits for Radionuclides" (WAC 173-480)			
"Ambient Standard" (WAC 173-480-040)	Requires that emissions of radionuclides in the air shall not cause a maximum effective dose equivalent of more than 10 mrem/year to the whole body to any member of the public. Per "Applicability" (WAC 173-480-020), the ambient standard applies to the entire state. Measurements may be made at all points up to property lines of point, area and fugitive emission sources.	Hazardous contaminants detected in soil and 100-FR-3 groundwater contains radionuclides that could be emitted to ambient air during remedial actions.	100-FR-3, 100-IU-2, and 100-IU-6. Remediation activities (e.g., RTD) that have the potential to emit radionuclides above maximum acceptable levels will be controlled to meet standards.
"General Standards for Maximum Permissible Emissions" (WAC 173-480-050(1))	At a minimum, all emission units shall make every reasonable effort to maintain radioactive materials in effluents to unrestricted areas ALARA; control equipment at sites operating under ALARA shall be defined as reasonably available control technology and as low as reasonably achievable control technology.	The potential for fugitive and diffuse emissions because of excavation and related activities will require efforts to minimize those emissions.	100-IU-2 and 100-IU-6. Remediation activities (e.g., RTD) that have the potential to emit radionuclides to residential areas will meet standards.

Table A-1. Applicable or Relevant and Appropriate Requirements

Regulatory Citation	Description of Regulatory Requirement	Rationale for Including	Application
"Emission Monitoring and Compliance Procedures" (WAC 173-480-070(2))	Compliance is determined by calculating the dose to members of the public at the point of maximum annual air concentration in an unrestricted area where any member of the public may be located.	Hazardous contaminants detected in soil in 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 include radionuclides that could be emitted to unrestricted areas during remedial actions.	100-IU-2 and 100-IU-6. Remediation activities (e.g., RTD) that have the potential to emit radionuclides to unrestricted areas will meet standards.
"Emission Standards for New and Modified Emission Units" (WAC 173-480-060)	Requires that construction, installation, or establishment of new air emission control units use best available radionuclide control technology.	Hazardous contaminants detected in soil in 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 includes radionuclides that could be emitted from air emission control units during remedial actions.	100-IU-2 and 100-IU-6. Remediation activities (e.g., RTD) that require air pollution control measures and/or equipment and have the potential to emit radionuclides to the ambient air will meet standards.
"Nuclear Energy and Radiation" (RCW 70.98, as amended); "Radiation Protection—Air Emissions" (WAC 246-247)			
"National Standards Adopted by Reference for Sources of Radionuclide Emissions" (WAC 246-247-035(1)(a)(i)) (adopts by reference, "Prohibited Activities"[40 CFR 61.05])	Identifies prohibition on any owner or operator of any stationary source subject to a national emission standard for hazardous air pollutants from constructing or operating the new or existing source in violation of any such standard.	Remedial actions in 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 have the potential to emit hazardous air pollutants.	100-IU-2 and 100-IU-6. Remedial actions that require air pollution control measures and/or equipment and have the potential to emit radionuclides to the ambient air will meet this standard.
"National Standards Adopted by Reference for Sources of Radionuclide Emissions" (WAC 246-247-035(1)(a)(i) and (ii) Adopts by reference: "General Provisions" (40 CFR 61, Subpart A) "National Emission Standards for Emissions Radionuclides Other Than Radon From Department of Energy Facilities" (40 CFR 61, Subpart H)	Requires the owner or operator of each stationary source of hazardous air pollutants subject to a national emission standard for a hazardous air pollutant to determine compliance with numerical emission limits in accordance with emission tests established in NESHAP Subpart A, "Emission Tests and Waiver of Emission Tests" (40 CFR 61.13), or as otherwise specified in an individual subpart. Compliance with design, equipment, work practice, or operational standards shall be determined as specified in the individual subpart. Also, maintain and operate the source, including associated equipment for air pollution control, in a manner consistent with good air pollution control practice for minimizing emissions.	Remedial actions in 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 have the potential to emit hazardous air pollutants.	100-IU-2 and 100-IU-6. Remedial actions involve stationary sources that provide a potential to emit regulated hazardous air pollutants (e.g., decontamination stations, or waste removal or storage activities). Associated design, equipment, work practice, and/or air emissions controls will be maintained and operated to meet these standards.

Table A-1. Applicable or Relevant and Appropriate Requirements

Regulatory Citation	Description of Regulatory Requirement	Rationale for Including	Application
"Radiation Protection, Air Emissions, General Standards" (WAC 246-247-040(3) and (4))	Requires that ALARA-based control technology Best Available Controls be used to control emissions depending on whether there is new construction or there is an existing emission unit, and whether there is a significant modification of an emission unit.	Hazardous contaminants that would be subject to radionuclide air emission standards and resultant requirements have the potential to be detected in, and emitted from, structures, components, debris, soil, and remediation equipment during remedial actions.	100-IU-2 and 100-IU-6. Remedial actions will use best available (radionuclide) control technology or as low as reasonably achievable control technology to meet this standard.
"Monitoring, Testing and Quality Assurance" (WAC 246-247-075)	Establishes the substantive monitoring, testing, and quality assurance requirements for radioactive air emissions. Emissions from nonpoint and fugitive sources of airborne radioactive material will be measured.	Hazardous contaminants that would be subject to radionuclide air emission standards and resultant requirements have the potential to be detected in and emitted from, structures, debris, soil, and remediation equipment during remedial actions.	100-IU-2 and 100-IU-6. Monitoring, testing and quality assurance requirements will be defined and followed to meet this standard.
***Clean Air Act of 1990* and amendments (42 USC 7401, et seq.); "National Emission Standard for Asbestos" (40 CFR 61, Subpart M)**			
"Applicability" (40 CFR 61.140) "Standard for Demolition and Renovation" (40 CFR 61.145)	Defines regulated ACM and regulated removal and handling requirements. Includes substantive sampling, inspection, handling, and disposal requirements for regulated sources having the potential to emit asbestos. Specifically, no visible emissions are allowed during handling, packaging, and transport of ACM.	Encountering ACM on pipelines or buried asbestos within 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 is possible during remediation activities.	100-IU-2 and 100-IU-6. Site investigation, remediation activities and associated handling, packaging, transportation and disposal of ACM will meet standards.
"Standard for Waste Disposal for Manufacturing, Fabricating, Demolition, Renovation, and Spraying Operations" (40 CFR 61.150)	Includes substantive requirements for the removal and disposal of asbestos from demolition and renovation activities.	Pipelines, other debris, and soil contain ACM.	100-IU-2 and 100-IU-6. Site remediation activities and associated handling, packaging, transportation and disposal of ACM will meet standards.

Table A-1. Applicable or Relevant and Appropriate Requirements

Regulatory Citation	Description of Regulatory Requirement	Rationale for Including	Application
Solid Wastes			
***Toxic Substances Control Act of 1976* (Public Law 107-377, as amended; 15 USC 2605, et seq.); "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions" (40 CFR 761)**			
"Applicability," "PCB Waste" (40 CFR 761.50(b)1, 2, 3, and 7) "Applicability," "Storage for Disposal" (40 CFR 761.50(c))	Establishes substantive PCB requirements for the storage and disposal of PCB wastes including liquid PCB wastes, PCB items, PCB remediation waste, PCB bulk product wastes, and PCB/radioactive wastes at concentrations greater than 50 ppm.	Remediation is expected to generate PCB and PCB/ radioactive waste.	100-IU-2 and 100-IU-6. Management and disposal of remediation waste with PCBs will meet standards.
"Disposal Requirements," "PCB Liquids" (40 CFR 761.60(a)) "Disposal Requirements," "PCB Articles" (40 CFR 761.60(b)) "Disposal Requirements," "PCB Containers" (40 CFR 761.60(c))	Establishes substantive requirements applicable to the handling and disposal of PCB liquids, PCB articles, and PCB containers.	PCB liquids, articles, and/or containers may be encountered and/or generated during the remedial actions for 100-IU-2 and 100-IU-6.	100-IU-2 and 100-IU-6. Standards will be met for PCB liquids, articles and debris handling, storage and disposal.
"PCB Remediation Waste" (40 CFR 761.61)	Provides substantive cleanup and disposal options for PCB remediation waste based on the concentration at which the PCBs are found.	PCB remediation wastes may be encountered and/or generated during the remedial actions for 100-IU-2 and 100-IU-6.	100-IU-2 and 100-IU-6. Standards will be met for PCB remediation wastes.
Solid Wastes			
"Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities" (40 CFR 264)			
"Staging Piles" (40 CFR 264.554)	Establishes the substantive requirements for staging and accumulation of remediation waste during remedial operations.	Remediation wastes may be generated and accumulated during remedial actions at 100-IU-2 and 100-IU-6.	100-IU-2 and 100-IU-6. Standards will be met for remediation waste.

Table A-1. Applicable or Relevant and Appropriate Requirements

Regulatory Citation	Description of Regulatory Requirement	Rationale for Including	Application
"Hazardous Waste Management" (RCW 70.105, as amended); "Dangerous Waste Regulations" (WAC 173-303)			
"Identifying Solid Waste" (WAC 173-303-016) "Recycling Processes Involving Solid Waste" (WAC 173-303-017)	Identifies those materials that are and are not solid wastes and identifies those materials that are and are not solid wastes when recycled.	Solid wastes will be generated during 100-IU-2 and 100-IU-6 remedial actions that will be subject to solid waste and dangerous waste designation requirements.	100-IU-2 and 100-IU-6. Standards will be met for remediation activities
"Designation of Dangerous Waste" (WAC 173-303-070)	Establishes the substantive method for determining if a solid waste is a dangerous waste (or an extremely hazardous waste).	Dangerous/hazardous waste will be generated during 100-IU-2 and 100-IU-6 remedial actions.	100-IU-2 and 100-IU-6. Standards will be met for remediation (including waste treatment) activities that generate wastes.
"Requirements for Universal Waste" (WAC 173-303-077)	Identifies certain batteries, mercury-containing equipment and lamps as exempt from regulation under WAC 173-303-140 and WAC 173-303-170 through 173-303-9907 (excluding WAC 173-303-960). These wastes are subject to regulation under "Standards for Universal Waste Management" (WAC 173-303-573).	Waste sites in 100-IU-2 and 100-IU-6 contain universal wastes.	100-IU-2 and 100-IU-6. Remediation activities will meet standards for universal wastes.
"Recycled, Reclaimed, and Recovered Wastes" (WAC 173-303-120) "Recycled, Reclaimed, and Recovered Wastes" (WAC 173-303-120(3)) "Recycled, Reclaimed, and Recovered Wastes" (WAC 173-303-120(5))	Defines the requirements for the recycling of materials that are solid and dangerous waste. Specifically, "Recycled, Reclaimed, and Recovered Wastes" (WAC 173-303-120[3]) provides for the management of certain recyclable materials, including spent refrigerants, antifreeze, and lead acid batteries. "Recycled, Reclaimed, and Recovered Wastes" (WAC 173-303-120[5]) provides for the recycling of used oil.	Wastes that can be recycled, reclaimed or recovered have the potential to be generated during 100-IU-2 and 100-IU-6 remedial actions.	100-IU-2 and 100-IU-6. Recycling of wastes subject to these requirements will be done in a manner that satisfies standards.
"Land Disposal Restrictions" (WAC 173-303-140)	Establishes treatment requirements and disposal prohibitions for land disposal of dangerous waste and incorporates by and the federal "Land Disposal Restrictions" (40 CFR 268).	Remediation may generate waste subject to land disposal restrictions.	100-IU-2 and 100-IU-6. Wastes subject to these requirements will be treated as required and disposed in a manner that satisfies standards.

Table A-1. Applicable or Relevant and Appropriate Requirements

Regulatory Citation	Description of Regulatory Requirement	Rationale for Including	Application
"Requirements for Generators of Dangerous Waste" (WAC 173-303-170)	Establishes the requirements for dangerous waste generators. "Requirements for Generators of Dangerous Waste" (WAC 173-303-170[3]), which includes the substantive provisions of "Accumulating Dangerous Waste On-Site" (WAC 173-303-200) by reference.	100-IU-2 and 100-IU-6 remedial actions may generate dangerous wastes.	100-IU-2 and 100-IU-6 remediation wastes (contaminated soil, personnel protective gear, treatment chemicals) may be dangerous waste, and will be managed in accord with these requirements.
"Accumulating Dangerous Waste On-Site" (WAC 173-303-200)	Establishes the requirements for accumulating wastes onsite. "Accumulating Dangerous Waste On-Site" (WAC 173-303-200) further includes certain substantive standards from "Use and Management of Containers (WAC 173-303-630) and "Tank Systems" (WAC 173-303-640) by reference.	100-IU-2 and 100-IU-6 remedial actions may generate dangerous wastes.	100-IU-2 and 100-IU-6 remediation wastes (contaminated soil, personnel protective gear, treatment chemicals) may be dangerous waste, and accumulations of such will be in accordance with these requirements.
"Use and Management of Containers" (WAC 173-303-630)	Establishes requirements for dangerous waste facilities that store containers of dangerous waste.	Remedial actions may involve management of dangerous waste in containers that are subject to this standard.	100-IU-2 and 100-IU-6. Investigation and remedial actions that produce or manage containers of dangerous waste will be managed to meet standards.
"Corrective Action Dangerous Waste Regulation Requirements" (WAC 173-303-64620(4))	Requires corrective action to be "consistent with" specified sections of "Model Toxics Control Act—Cleanup" (WAC 173-340).	The substantive portions of this regulation establish minimum requirements for *Washington State Hazardous Waste Management Act of 1976* (RCW 70.105, as amended) corrective action.	At 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and 100-IU-6.
"Solid Waste Management—Reduction and Recycling" (RCW 70.95, as amended); "Solid Waste Handling Standards" (WAC 173-350)			
"Owner Responsibilities for Solid Waste (WAC 173-350-025) "Performance Standards" (WAC 173-350-040) "On-Site Storage, Collection and Transportation Standards" (WAC 173-350-300) "Remedial Action" (WAC 173-350-900)	Establishes minimum functional performance standards for the proper handling and disposal of solid waste, not otherwise excluded. Provides requirements for the proper handling of solid waste materials originating from residences, commercial, agricultural and industrial operations, and other sources, and identifies those functions necessary to ensure effective solid waste handling programs at both the state and local level.	Covered solid waste will be generated during implementation of remedial actions.	100-IU-2 and 100-IU-6. Remedial actions that generate covered solid waste will meet standards.

Table A-1. Applicable or Relevant and Appropriate Requirements

Regulatory Citation	Description of Regulatory Requirement	Rationale for Including	Application
Historical and Archeological Resources			
***National Historic Preservation Act of 1966* (Public Law 89-665, as amended, 16 USC 470, et seq.)**			
"Protection of Historic Properties" (36 CFR 800)	Requires federal agencies to consider the impacts of their undertaking on cultural properties through identification and evaluation. Potential project adverse effects are to be avoided or mitigated. Need to take actions as necessary to minimize harm to any National Historic Landmarks.	Cultural and historic sites have been identified within 100-IU-2 and 100-IU-6.	100-IU-2 and 100-IU-6. Historical and cultural reviews have been done to identify cultural and historic sites. Additional reviews will be done at remedial action areas where existing reviews are not sufficient. For any discoveries appropriate actions will be taken to meet standards.
***Protection and Enhancement of the Cultural Environment* (Executive Order 11593)**			
"National Historic Landmarks Program" (36 CFR 65)	These regulations set forth the criteria for establishing national significance. Requires that federal agencies shall, to the maximum extent possible, undertake such planning and actions as may be necessary to minimize harm to landmarks.	Cultural and historic sites have been identified within 100-IU-2 and 100-IU-6.	100-IU-2 and 100-IU-6. Remedial actions shall comply with this standard.
***Native American Graves Protection and Repatriation Act of 1990* (Public Law 101-601, as amended, 25 USC 3001, et seq.); "Native American Graves Protection and Repatriation Regulations" (43 CFR 10)**			
"Native American Graves Protection and Repatriation Regulations" (43 CFR 10)	Establishes federal agency responsibility for discovery, protection and appropriate disposition of human remains, associated and unassociated funerary objects, sacred objects, and items of cultural patrimony.	Native American archaeological, cultural, and historic sites have been identified within 100-IU-2 and 100-IU-6; Native American remains and associated objects have the potential to be present.	100-IU-2 and 100-IU-6. Remedial activities will be conducted to identify, protect and provide for appropriate disposition of covered human remains, objects and items. Native American Tribal consultation will be conducted in the event of discovery.
***Archeological and Historic Preservation Act of 1974* (Public Law 93-291, as amended; 16 USC 469a-1 through 469a-2(d))**			
"Applicant Requirements" 16 USC 469a-1 through 469a-2(d)	Requires that federal projects do not cause the loss of archaeological or historic data. This act mandates preservation of the data; it does not require protection of the actual waste site or facility.	Archaeological and historic sites have been identified within, 100-IU-2 and 100-IU-6.	100-IU-2 and 100-IU-6. Remediation activities will prevent irreparable loss of significant scientific, prehistoric or archeological data, the data will be preserved.

Table A-1. Applicable or Relevant and Appropriate Requirements

Regulatory Citation	Description of Regulatory Requirement	Rationale for Including	Application
Natural and Ecological Resources			
***Endangered Species Act of 1973* (Public Law 93-205, as amended; 7 USC Section 136; 16 USC 1531, et seq.)**			
Endangered Species Act of 1973, as amended 16 USC 1531–1544, specifically Sections 7 and 9(a) "Endangered and Threatened Wildlife and Plants" (50 CFR 17) (listings, prohibitions) "Interagency Cooperation—Endangered Species Act of 1973, as Amended" (50 CFR 402), "General Endangered and Threatened Marine Species" (50 CFR 222) to "Endangered Marine Anadromous Species" (50 CFR 224) "Critical Habitat for 13 Evolutionarily Significant Units (ESUs) of Salmon and Steelhead (*Oncorhynchus* spp.) in Washington, Oregon and Idaho," (50 CFR 226.212)	Prohibits actions by federal agencies that are likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of habitat critical to them. Also prohibits the taking of any endangered species.	100-FR-3 groundwater discharges into the Hanford Reach of the Columbia River, which contains the Upper Columbia River spring-run Chinook salmon and the steelhead which are endangered. 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 listed as a threatened species but is not considered a resident species and is rarely observed in the Hanford Reach.	100-FR-3. Remediation actions will be managed to avoid jeopardy and/or adversely affect a listed species or critical habitat.
***Migratory Bird Treaty Act of 1918* (16 USC 703–712; Ch. 128; July 13, 1918; 40 Stat. 755), as amended**			
Migratory Bird Treaty Act of 1918 (16 USC 703–712) "General Provisions" (50 CFR 10) "Migratory Bird Permits" (50 CFR 21)	Protects all migratory bird species and prevents "take" of protected migratory birds, their young, or their eggs." Federal agencies are required to avoid or minimize impacts to migratory bird resources, restore or enhance their habitat and prevent or abate its detrimental alteration.	Migratory birds utilize 100-IU-2 and 100-IU-6.	100-IU-2 and 100-IU-6. Remedial actions will require mitigation measures to deter nesting by migratory birds on, around or within remedial action site and methods to identify and protect occupied bird nests in a manner that complies with requirements.
"Powers and Duties," "Habitat Buffer Zone for Bald Eagles—Rules" (RCW 77.12.655); "Permanent Regulations," "Bald Eagle Protection Rules" (WAC 232-12-292)			
Bald and Golden Eagle Protection Act of 1940 (16 USC 668) "Eagle Permits" (50 CFR 22)	Protects eagle habitat to maintain eagle populations so the species is not classified as threatened, endangered, or sensitive in Washington State.	Bald eagles nest, feed, and overwinter along the shores of the Columbia River.	100-IU-2 and 100-IU-6. Remedial actions will be performed in a way to protect bald eagle habitat.

Table A-1. Applicable or Relevant and Appropriate Requirements

Regulatory Citation	Description of Regulatory Requirement	Rationale for Including	Application

ACM	=	asbestos-containing material	MCLG	=	maximum contaminant level goal
ALARA	=	as low as reasonably achievable	MNA	=	monitored natural attenuation
ARAR	=	applicable or relevant and appropriate requirement	NESHAP	=	National Emission Standards for Hazardous Air Pollutants
BACT	=	best available control technology	OU	=	operable unit
CUL	=	cleanup level	PCB	=	polychlorinated biphenyl
EPA	=	U.S. Environmental Protection Agency	RTD	=	removal, treatment (as required), and disposal
MCL	=	maximum contaminant level	TAP	=	toxic air pollutant

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