Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

19-SGD-0047

SEP 26 2019

Dr. Laura C. Buelow, Project Manager
Superfund and Emergency Management Division
Site Cleanup Section 4
U.S. Environmental Protection Agency
825 Jadwin Avenue, Suite 210
Richland, Washington 99352

Dear Dr. Buelow:

PROPOSED PLAN FOR REMEDIATION OF THE 100-BC-1, 100-BC-2, AND 100-BC-5 OPERABLE UNITS, DOE/RL-2016-43, REVISION 0

This letter transmits the Proposed Plan for Remediation of the 100-BC-1, 100-BC-2, and 100-BC-5 Operable Units, DOE/RL-2016-43, Revision 0 to the U.S. Environmental Protection Agency (EPA) in compliance with Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) Action Plan Section 9.2. The Proposed Plan evaluates remedial alternatives and proposes a remedy for the 100-BC-1, 100-BC-2, and 100-BC-5 Operable Units under the Comprehensive Environmental Response, Compensation, and Liability Act.

The Remedial Investigation/Feasibility Study (RI/FS) for the 100-BC-1, 100-BC-2, and 100-BC-5 Operable Units, DOE/RL-2010-96, Revision 0 was submitted to EPA for review on June 27, 2019, by letter 19-SGD-0032 REISSUE.

The RI/FS for 100-BC-1, 100-BC-2, and 100-BC-5 Operable Units, DOE/RL-2010-96, Draft A, and Proposed Plan for Remediation of the 100-BC-1, 100-BC-2, and 100-BC-5 Operable Units, DOE/RL-2016-43, Draft A were submitted to EPA for review on December 13, 2016, by letter 17-AMRP-0052, in compliance with Tri-Party Agreement Milestone M-015-79.

The U.S. Department of Energy Richland Operations Office (RL) has worked closely with EPA to incorporate comments and revise the document. Several updates to the Proposed Plan were also provided in a collaborative effort to resolve EPA's comments. The attached document incorporates resolution of these comments and considered Hanford Advisory Board advice and the Tribal Nation's input. Transmittal of this document partially satisfies Tri-Party Agreement Interim Milestone M-015-00 "Complete the RI/FS (or RCRA Facility Investigation/Corrective Measures Study) process for all non-tank farm operable units except for canyon/associated past practice waste site Operable Units covered in M-85-00" by June 30, 2026.

RL is issuing this Proposed Plan for the formal public comment process currently planned for October 7, 2019, through November 6, 2019. Please provide written comments within 30 days of receipt of this letter.

If you have any questions please contact me, or your staff may contact Mike Cline of my staff, on (509) 376-6070.

Sincerely,

William F. Hamel, Assistant Manager
for the River and Plateau

SGD:ETG

Attachment

cc w/attach:
J. Bell, NPT
R. Buck, Wanapum
L. Contreras, YN
D. R. Einan, EPA (USB)
K. A. Elsethagen, Ecology
M. Johnson, CTUIR
S. Leckband, HAB
N. M. Menard, Ecology
K. Niles, ODOE
S. N. Schleif, Ecology
A. K. Smith, Ecology
Administrative Record (100-BC-1, 100-BC-2, 100-BC-5)
Environmental Portal

cc w/o attach:
S. G. Austin, CHPRC
S. L. Brasher, MSA
S. W. Davis, MSA
M. H. Doornbos, CHPRC
W. R. Faught, CHPRC
L. K. O'Mara, CHPRC

DOE/RL-2016-43
Revision 0

PROPOSED PLAN FOR REMEDIATION OF THE 100-BC-1, 100-BC-2, AND 100-BC-5 OPERABLE UNITS

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

U.S. DEPARTMENT OF ENERGY | Richland Operations Office

P.O. Box 550
Richland, Washington 99352

Approved for Public Release;
Further Dissemination Unlimited

DOE/RL-2016-43
Revision 0

PROPOSED PLAN FOR REMEDIATION OF THE 100-BC-1, 100-BC-2, AND 100-BC-5 OPERABLE UNITS

Date Published
August 2019

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

U.S. DEPARTMENT OF ENERGY | Richland Operations Office
P.O. Box 550
Richland, Washington 99352

APPROVED
By Janis D. Aardal at 7:35 am, Aug 27, 2019

Release Approval | Date

Approved for Public Release;
Further Dissemination Unlimited

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

Proposed Plan for Remediation of the 100-BC-1, 100-BC-2, and 100-BC-5 Operable Units

DOE/RL-2016-43, Rev. 0

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

Public Comment Period
October 7 through
November 6, 2019

How You Can Participate:

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

Comment on this Proposed Plan by mail or email on or before November 6, 2019.

Paula Call, U.S. Department of Energy, Richland Operations Office
P.O. Box 550, H5-20
Richland, WA 99352
Email: 100BCAreaPP@rl.gov

See page 47 for more information about public involvement and contact information.

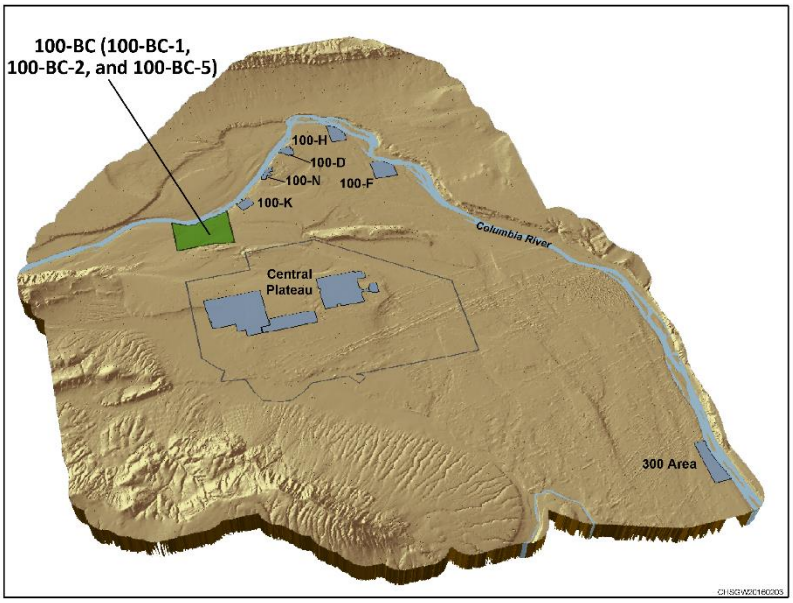

Figure 1. 100-BC Location Within the Hanford Site[1]

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Introduction

The U.S. Department of Energy (DOE) and U.S. Environmental Protection Agency (EPA) invite the Tribal Nations and the public to comment on this ***Comprehensive Environmental Response, Compensation, and Liability Act of 1980*** ***(CERCLA) Proposed Plan***[2] for cleanup of contaminated soil in two source ***operable units (OUs)*** (100-BC-1 and 100-BC-2) and contaminated ***groundwater*** in one OU (100-BC-5) in the 100 Area of the Hanford Site located near Richland, Washington. These three OUs are the only OUs associated with the former operational area for the B and C Reactors and are referred to collectively as 100-BC (Figure 1). DOE has completed its investigation of ***waste sites***, most of which have already been addressed in previous cleanup actions, and the groundwater through the ***remedial investigation (RI)/feasibility study (FS)*** process. The RI/FS concluded that some waste sites and some contaminants in

[1] "B" represents B Reactor area; "C" represents C Reactor area. The three operable units identified as 100-BC-1, 100-BC-2, and 100-BC-5 are collectively referred to as 100-BC.

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

the groundwater require ***remedial action*** due to unacceptable risk to human health and the environment. This Proposed Plan addresses the contamination at 112 waste sites in the two source OUs (100-BC-1 and 100-BC-2), as well as the contaminated groundwater in the 100-BC-5 OU.

DOE is issuing this Proposed Plan to seek input from the Tribal Nations and the public on the cleanup alternatives considered and on the ***preferred alternative*** proposed for implementation. This Proposed Plan presents a summary of the evaluation of several remedial alternatives and identifies a preferred alternative. The alternatives were developed to address contamination at the 100-BC-1 and 100-BC-2 Source OUs and the 100-BC-5 Groundwater OU. Remedial alternatives that were evaluated include the following (some waste sites have more than one remedial action, so site subtotals do not sum to 112):

- Alternative 1 – ***No Action***
- Alternative 2 – ***Institutional Controls (ICs)*** for 30 Waste Sites, ***Removal, Treatment, and Disposal (RTD)*** for One Waste Site and No Action for 82 Waste Sites; and ***Monitored Natural Attenuation (MNA)*** with ICs for Groundwater
- Alternative 3 – ICs for 30 Waste Sites, RTD for One Waste Site, and No Action for 82 Waste Sites; and ***Pump and Treat (P&T)*** and MNA with ICs for Groundwater
- Alternative 4 – ICs for 29 Waste Sites, RTD for Five Waste Sites, and No Action for 82 Waste Sites; and P&T and MNA with ICs for Groundwater
- Alternative 5 – ICs for 30 Waste Sites, RTD for One Waste Site, and No Action for 82 Waste Sites; and Hexavalent Chromium (Cr(VI)) Source Treatment with P&T, and MNA with ICs for Groundwater
- Alternative 6 – ICs for 29 Waste Sites, RTD for Five Waste Sites, and No Action for 82 Waste Sites; and Cr(VI) Source Treatment with P&T, and MNA with ICs for Groundwater

Tribal Nations and Public Involvement

Input from the Tribal Nations and the public on this Proposed Plan and the supporting analysis and information in the ***Administrative Record*** will be considered in selecting the final remedy. A ***Record of Decision (ROD)*** will be prepared by EPA. In accordance with CERCLA, the ROD will be issued by DOE and EPA, or by EPA if EPA and DOE cannot agree. Comments will be accepted during the comment period (see sidebar on left side of page 1). For additional information regarding how to participate, see the "Community Participation" section of this Proposed Plan.

This Proposed Plan summarizes information that can be found in greater detail in DOE/RL-2010-96, *Remedial Investigation/Feasibility Study for the 100-BC-1, 100-BC-2, and 100-BC-5 Operable Units* (hereinafter called the 100-BC RI/FS report). The 100-BC RI/FS report was used to evaluate alternatives and develop the preferred alternative and can be accessed online and at the various information repositories identified in the "Community Participation" section of this Proposed Plan. This document and supporting information that forms the basis for the proposed remedial actions for each OU are contained in the Administrative Record. The Administrative Record and index for 100-BC is available at https://pdw.hanford.gov/document/AR-02863.

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

Agencies' Role

DOE is the lead agency and the party responsible for conducting the selected remedy. DOE is issuing this Proposed Plan as part of the public participation requirements under Section 117(a) of CERCLA (commonly known as "Superfund") and the ***Code of Federal Regulations***, 40 CFR 300, "***National Oil and Hazardous Substances Pollution Contingency Plan***" (commonly known as the "National Contingency Plan," or NCP) (40 CFR 300.430(f)(2) "Remedial Investigation/Feasibility Study and Selection of Remedy"). CERCLA establishes the broad federal authority for conducting cleanup at Superfund sites, and the NCP includes the procedures and expectations for cleanup.

EPA and the Washington State Department of Ecology (Ecology) provide regulatory oversight of the Hanford Site cleanup. EPA is the lead regulatory agency for 100-BC, and Ecology is the non-lead regulatory agency per the *Hanford Federal Facility Agreement and Consent Order* (***Tri-Party Agreement***) (Ecology et al., 1989a) and the support agency. DOE prepared this proposed plan in conjunction with EPA.

Preferred Alternative

Based on the results of the detailed and comparative evaluation of alternatives, the preferred alternative is Alternative 2: ICs, RTD, and No Action for waste sites; and MNA with ICs for groundwater. ICs would be used for 30 waste sites until radioactive contamination decays to levels protective of ***unlimited use/unrestricted exposure*** (UU/UE). RTD would be used to remove contaminated soil from 1 waste site. No action would be taken at 82 waste sites. MNA with ICs would be used to monitor groundwater contaminants and restrict groundwater use until ***preliminary remediation goals (PRGs)*** are met.

The preferred alternative meets the statutory requirements under CERCLA and the NCP (40 CFR 300) to select remedies that are protective of human health and the environment and comply with ***applicable or relevant and appropriate requirements (ARARs)***, are cost effective, and use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. Alternative 2 is the preferred alternative because it is protective, meets ARARs, and provides the best balance of tradeoffs with regard to the criteria specified in Section 300.430 of the NCP. In addition to the preferred alternative, the other alternatives that were evaluated are described in the "Summary of Remedial Alternatives" section of this Proposed Plan. Each alternative includes a combination of actions, all of which are explained briefly in this Proposed Plan and more fully in the 100-BC RI/FS report (DOE/RL-2010-96).

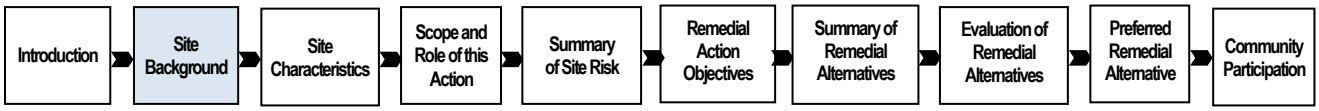
Proposed Plan Organization

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

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

- **Evaluation of Remedial Alternatives**: Provides comparison of the options using CERCLA criteria.
- **Preferred Remedial Alternative**: Provides rationale for selecting the preferred alternative and affirmation that it is expected to fulfill statutory and regulatory requirements.
- **Community Participation**: Provides information on how the Tribal Nations and the public can provide input to the remedy selection process.

From this point forward, the following graphic is included before each new section to indicate where the section fits within this Proposed Plan:



Site Background

The Hanford Site is a 1,502 km^2 (580 mi^2), federally owned property located within the semiarid, shrub-steppe Pasco Basin of the Columbia Plateau in south-central Washington State. In 2000, a Presidential Proclamation (65 FR 114, "Establishment of the Hanford Reach National Monument"), under authority of the *American Antiquities Act of 1906*, set aside about half of the Hanford Site for preservation as the Hanford Reach National Monument (HRNM), including lands in the River Corridor within about 0.4 km (0.25 mi) of the Columbia River (Figure 2). Historical nuclear material production and processing at the Hanford Site released contamination to the environment, resulting in areas of contaminated soil and groundwater that pose a risk to human health and the environment. To facilitate cleanup, the Hanford Site has been divided into the River Corridor and the Central Plateau. The area of the Hanford Site that borders the Columbia River is referred to as the River Corridor (Figure 2), which spans approximately 567 km^2 (219 mi^2), and has been divided into six geographic areas. These six areas were selected to define manageable portions of the River Corridor that align with historical operations (e.g., uranium fuel rod preparation at the 300 Area or reactor operations at the 100-BC Area). For River Corridor cleanup decisions, the 100-BC Area includes the 100-BC-1, 100-BC-2, and 100-BC-5 OUs. The 100-BC-5 OU comprises groundwater contaminated from the 100-BC-1 and 100-BC-2 OUs.

The 100-BC Area (Figure 2) encompasses approximately 11.5 km^2 (4.5 mi^2) and includes two deactivated nuclear reactors and support facilities that operated from 1944 through 1969. The B and C Reactors were built to irradiate uranium fuel rods from which plutonium and other special nuclear materials were extracted. The B Reactor was the first full-scale plutonium production reactor in the world and has since been converted to a museum that hosts more than 10,000 public visitors annually. Figure 3 shows the B Reactor during operations, and Figure 4 shows the C Reactor during operations. The reactors and processes associated with operations 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. Sodium dichromate was added to reduce corrosion. Leaks of sodium dichromate concentrate, considered a ***principal threat waste***, from pipelines and spills resulted in Cr(VI) contamination in soils and in groundwater. Contaminated waste generated from reactor operations contained ***radionuclides***, hazardous chemicals, or both.

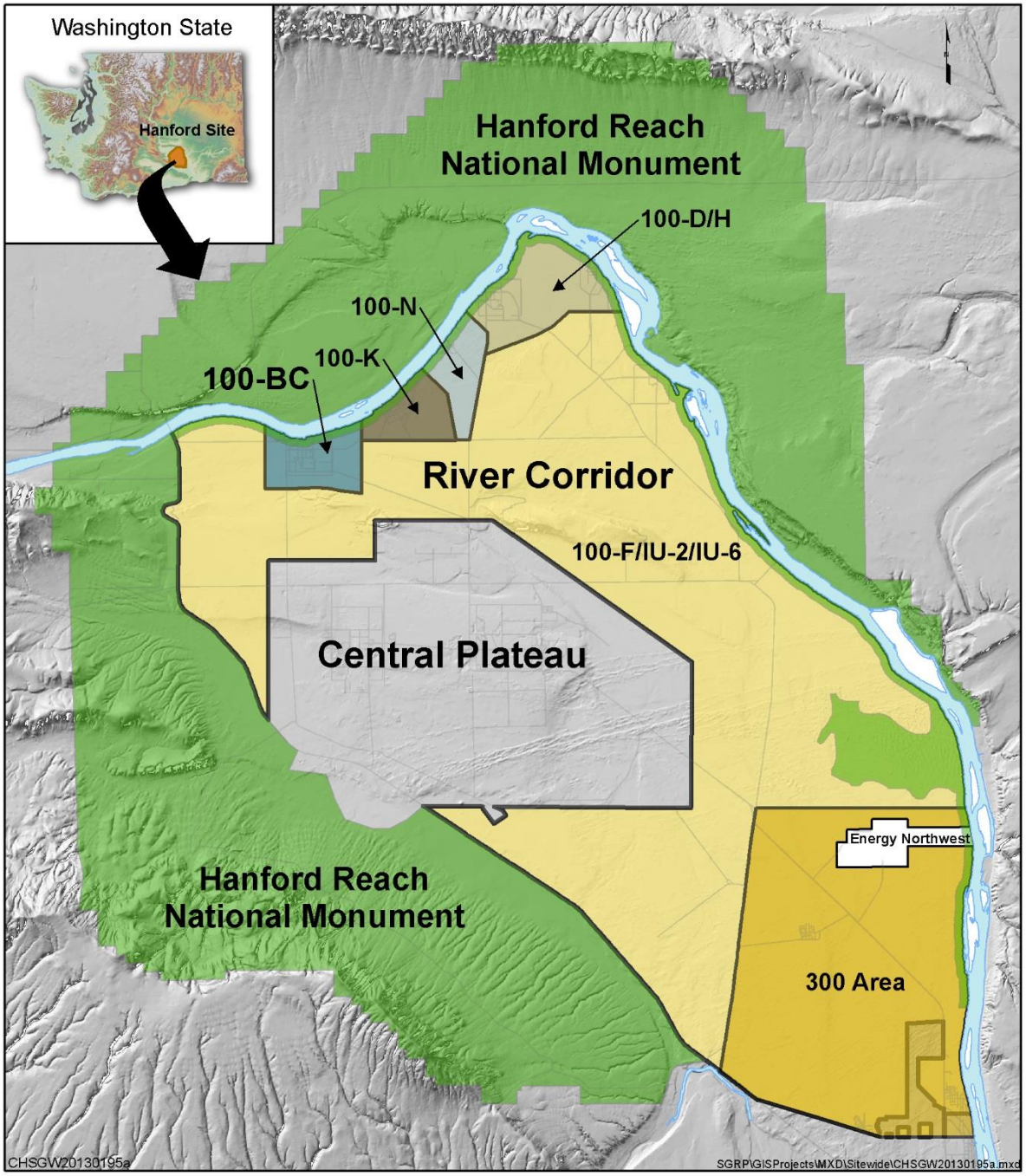


Figure 2. Hanford Site River Corridor

Figure 3. Aerial View of the B Reactor (1944)

Figure 4. Aerial View of the C Reactor (1952)

Previous Cleanup Actions and Decisions

Of the 117 facilities used to support the B and C Reactor operations, 104 have been demolished or removed under separate decisions not addressed in this Proposed Plan. Reactor operation facilities (retention basins, the C Reactor stack, office and storage buildings, maintenance shops, process plants, electric substations, storage tanks, and pump stations) comprise most of the demolished or removed facilities. The remaining active facilities include the river pump house (181B), reservoir and pump house (182B), and valve pits that continue to provide water supply to the 200 Areas, as well as an emergency siren and secondary electrical substations associated with the remaining facilities. The B Reactor building is considered an active facility because it is a museum. The four remaining inactive facilities include the C Reactor building that is within a safe storage enclosure and three facility components associated with the B Reactor museum. These remaining facilities are not part of the 100-BC OUs and so are not addressed by this Proposed Plan. B Reactor has been listed on the National Register of Historic Places since 1992, and DOE declared that the B Reactor Building would be preserved as a museum as part of the 64 FR 61615, "Record of Decision: Hanford Comprehensive Land-Use Plan Environmental Impact Statement (HCP EIS)." It was named a National Historic Landmark in 2008 and was included as part of the Manhattan Project National Historical Park established in 2015.

In addition to the 104 structures demolished or removed under CERCLA removal or other authority, interim remedial action has also been taken to address a number of contaminated waste sites. Waste site remedial action began in 1995 under EPA/ROD/R10-95/126, *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*, which consisted of RTD, followed by backfill and revegetation. Specifically, contaminated material was excavated and transported to the ***Environmental Restoration Disposal Facility (ERDF)***, located in the Hanford Site 200 Areas. The contaminated materials were treated as necessary to meet applicable land disposal restrictions and were disposed at ERDF. Subsequent ***interim action*** RODs, interim action ROD amendments, and ***explanations of significant differences (ESDs)*** identified additional waste sites or changes to interim remedial actions. The waste site decisions include the following:

- **1995** – EPA/ROD/R10-95/126, *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*
- **1997** – EPA/AMD/R10-97/044, *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*
- **1999** – EPA/ROD/R10-99/039, *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington (100 Area Remaining Sites)*
- **2000** – EPA/ROD/R10-00/121, *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*
- **2004** – EPA et al., 2004, *Explanation of Significant Differences for the 100 Area Remaining Sites Interim Remedial Action Record of Decision*
- **2007** – EPA et al., 2007, *Explanation of Significant Difference for the Interim 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 (100 Area Burial Grounds) October 2007*
- **2009** – EPA et al., 2009, *Explanation of Significant Differences for the 100 Area Remaining Sites Interim Remedial Action Record of Decision: Hanford Site, Benton County, Washington*

As of July 2015, RTD under the interim action RODs is complete and ICs have been implemented. The interim action RODs required RTD of waste site structural elements (e.g., pipelines and concrete basins) and soil contaminated above interim action cleanup levels. These cleanup levels were based on protection of groundwater and the Columbia River and protection of human health from direct contact to shallow soil (to 4.6 m [15 ft] below ground surface [bgs]). RTD was completed at 82 waste sites, and 2.86 million metric tons (3.15 million U.S. tons) of contaminated material were removed from 100-BC. Figure 5 through Figure 7 show the progression of waste site remediation at 100-BC (1999 to 2012). An additional 27 waste sites were investigated and did not require RTD to meet interim action cleanup levels. Institutional controls were implemented where necessary to prevent inadvertent exposure to contaminated material located deeper than 4.6 m (15 ft) bgs and to prohibit irrigation at one waste site where residual tritium soil contamination posed a potential threat to groundwater.

Figure 5. 100-BC Waste Site Remediation (B Reactor in Foreground, June 1999)

Figure 6. 100-BC Waste Site Remediation (C Reactor in Foreground, October 2003)

Figure 7. 100-BC Waste Site Remediation (C Reactor at Right in Foreground, January 2012)

Investigations

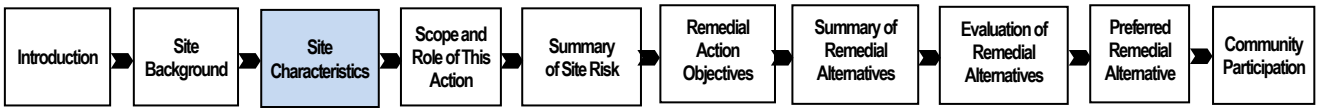
In 2010, DOE prepared DOE/RL-2008-46-ADD3, *Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan, Addendum 3: 100-BC-1, 100-BC-2, and 100-BC-5 Operable Units*, which summarized the current knowledge of contamination and identified additional data needs to support final remedial decisions. The initial RI fieldwork consisting of both soil and groundwater sampling was completed in 2011. In 2012, additional groundwater data needs were identified, and the 100-BC RI/FS work plan (DOE/RL-2008-46-ADD3) was revised to include an additional 2-year field study. The additional RI fieldwork was performed from 2013 to 2015. At the conclusion of the additional fieldwork, the data needs identified for the RI were met, and the results were documented in the 100-BC RI/FS report (DOE/RL-2010-96).

Previous Public Participation

DOE, EPA, and Ecology (also known as the ***Tri-Party Agreement Agencies***) have conducted formal and informal public involvement during the previous interim remedial action decision processes for cleanup in the 100-BC-1 and 100-BC-2 OUs, as well as for deactivation and decommissioning of buildings in 100-BC conducted pursuant to CERCLA removal authority. Public comment was sought and considered before selecting and amending all 100-BC interim remedial actions. The historical input and advice from all parties, including the Tribal Nations, the state of Oregon, and the Hanford Advisory Board relative to these OUs, were reviewed in the development of this Proposed Plan. The Hanford Advisory Board is a federally chartered advisory board composed of representatives of diverse stakeholders concerned with Hanford Site cleanup.

Previous Tribal Nations Participation

The Hanford Site is located on land ceded to the United States under separate treaties with the Confederated Tribes and Bands of the Yakama Nation and the Confederated Tribes of the Umatilla Indian Reservation. The Nez Perce Tribe also secured rights at what is now the Hanford Site in a separate treaty. DOE consults with these Tribal Nations and the Wanapum Band of Indians, who were historical residents on Hanford lands. DOE and EPA invited the Tribal Nations to formal consultation on the proposed River Corridor cleanup actions, including this one. The Tribal Nations were provided a draft of the RI/FS report and input received was considered in finalization of the RI/FS report and development of this Proposed Plan.



Site Characteristics

This section presents information on 100-BC surface features, current and anticipated future land and groundwater uses, the nature and extent of waste site soil contamination, and groundwater contaminant plumes.

Site Features and Land and Groundwater Use

Exposure to contamination in 100-BC is currently controlled by DOE site controls (restricted access via signage, fencing, and security checkpoints) to prevent unacceptable exposure to humans. Risk to site workers and public visitors to the B Reactor museum is managed through health and safety programs.

The principal structures include the B and C Reactors, 181B river pump house, 182B reservoir and pump house, parts of the export water system infrastructure, and roads. The B Reactor is a museum within the Manhattan Project National Historical Park and provides public tours. The C Reactor remains in ***interim safe storage***.

The 100-BC Area is being used for waste management, environmental monitoring, waste site remediation, and conservation and restoration activities. The segment of the Columbia River adjacent to 100-BC, which is part of

the HRNM, is used for a variety of recreational activities. The land use in the HRNM includes preservation and conservation. A portion of the land is being managed by the National Park Service, including the B Reactor, and is used for public tours.

The raw water supply for the 100 and 200 Areas is provided from the Columbia River through a series of pump houses, reservoirs, and pipelines. This water distribution system is known as the export water system. A part of this system, including the 181B river pump house and 182B reservoir and pump house, is located in 100-BC. No water supply wells are located in 100-BC and groundwater is extracted only for monitoring.

Many communities downstream of the Hanford Site draw water from the Columbia River for all or part of their domestic water supply. The city of Richland water intake is the closest to the Hanford Site. The city of Richland filters and treats water from the river and routinely monitors it prior to its distribution to ensure that the water meets federal ***drinking water standards (DWSs)*** (maximum contaminant levels), as required by the *Safe Drinking Water Act*.

Physical Features Impacting Remedy Selection

The 100-BC Area topography is relatively flat inland from the Columbia River, with ground surface elevations[3] declining from 150 m (490 ft) at the southern border to 130 m (430 ft) in the north. Along the northern border, the riverbank slopes steeply to the river shoreline, where the elevation is 122 m (400 ft). The 100-BC Area has been disturbed and graded extensively since reactor construction began in 1943 and through recent waste site remediation activities.

The ***vadose zone*** at the 100-BC Area comprises up to 30 m (98 ft) of unconsolidated gravel and sand of the Hanford formation. The unconfined aquifer ranges from a saturated thickness of 32 m (105 ft) near the river in the northern 100-BC Area to 50 m (164 ft) in the western portion of 100-BC. The low-permeability Ringold Formation upper mud unit forms a continuous base of the aquifer at 100-BC. This unit forms an ***aquitard*** that restricts groundwater flow to deeper geologic units beneath 100-BC.

Groundwater flow direction is generally north toward the Columbia River, but changes direction in response to high river stage. This interaction with the river also affects contaminant concentrations and transport rates.

Waste Site Contamination

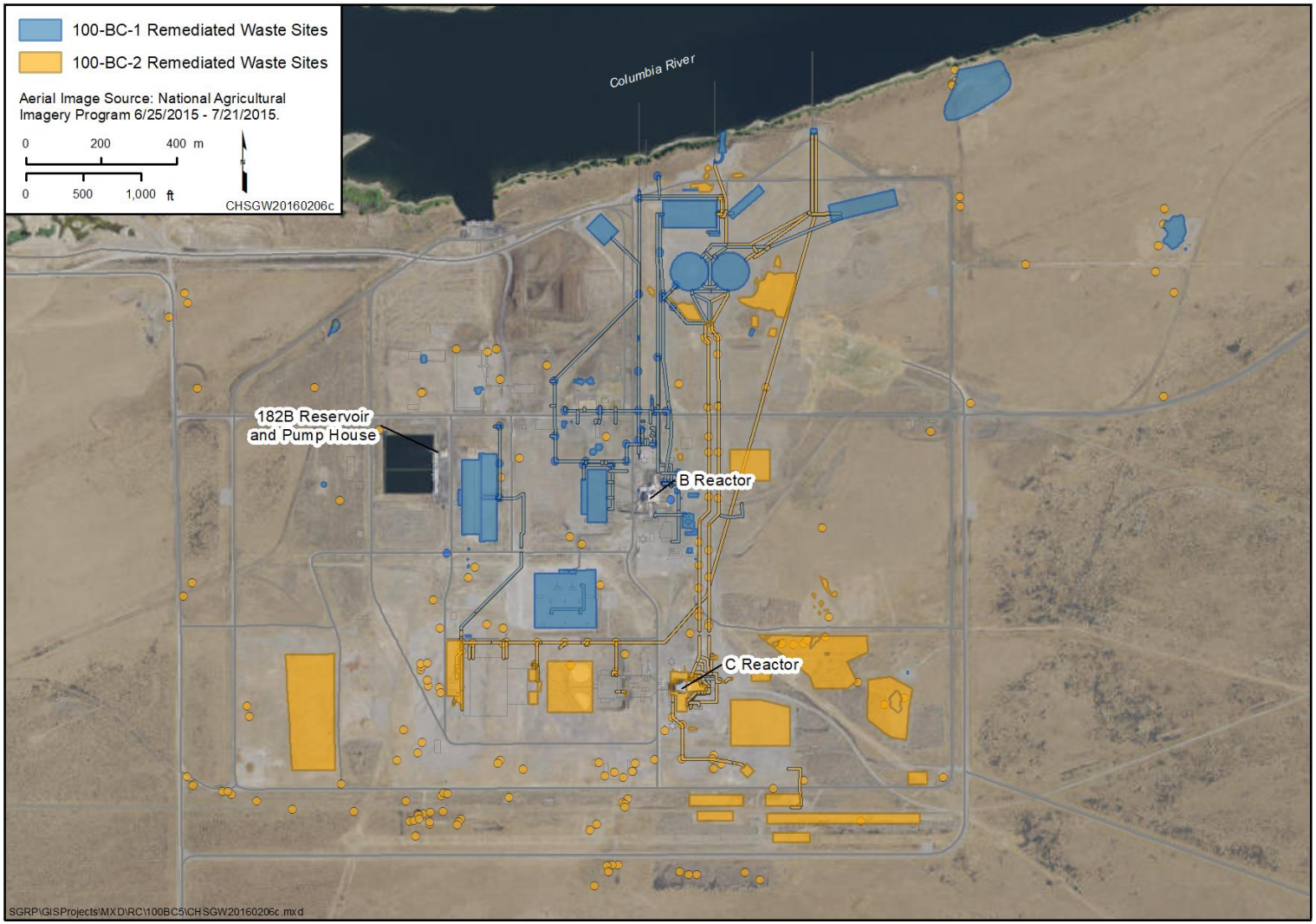
Liquid waste from reactor and support facility operations was conveyed by sewer pipelines to basins, cribs, trenches, and ponds. The largest volume of waste was cooling water discharges from the reactors and system leaks and liquid disposal that resulted in soil contamination. Solid waste from reactor and support facility operations was disposed in unlined burial grounds and burn pits, also resulting in contamination of underlying soil. Soil contaminants included radionuclides, metals, and organic chemicals. The key contaminants that drove waste site cleanup under the interim action RODs included cesium-137, strontium-90, and Cr(VI). Higher mobility contaminants such as Cr(VI), tritium, and strontium-90 migrated through the vadose zone to groundwater at some sites. At the most contaminated sites, contaminants were present at concentrations three to four orders of magnitude higher than interim action cleanup levels.

Hexavalent Chromium

Cr(VI) is sometimes referred to as "hex chrome" or "chrome six" in vernacular usage and is commonly represented by the molecular formula Cr(VI) or Cr^{+6}. In the 100-BC RI/FS report and this Proposed Plan, Cr(VI) is typically used. Cr(VI) is more toxic than trivalent chromium (Cr(III)), which is commonly present naturally in the environment.

The waste site RTD required under the interim action RODs has been completed, and ICs have been implemented as needed to address residual contamination in soil deeper than 4.6 m (15 ft) bgs. Figure 8 shows the locations of the waste sites at 100-BC that have been remediated.

[3] Elevations are provided in reference to NAVD88, *North American Vertical Datum of 1988*.



Note: The 100-BC-1 OU generally addresses liquid effluent waste sites and sites associated with the B Reactor operations area. The 100-BC-2 OU generally addresses solid waste burial grounds and sites associated with the C Reactor operations area. Tables 1-10 and 1-11 in DOE/RL-2010-96, *Remedial Investigation/Feasibility Study for the 100-BC-1, 100-BC-2, and 100-BC-5 Operable Units*, list the OU designations for waste sites.

Figure 8. Waste Sites Remediated under Interim Action RODs in the 100-BC-1 and 100-BC-2 OUs

The following two waste sites at 100-BC were not remediated as part of interim actions and contain contamination:

- The 100-B-34 waste site consists of three segments of pipeline not removed under interim action due to overlying active utilities. The two eastern pipe segments are associated with a previously remediated radiological sewer, and the third western segment is associated with a previously remediated sodium dichromate transfer line. Residual radionuclide contamination is present within the eastern pipeline segments and is potentially present in underlying soil. However, actual concentrations cannot be determined without removal of the pipeline segments. Residual Cr(VI) contamination is present within the western pipeline segment and is potentially present in underlying soil. Grout was pumped into the western pipe segment to push out concentrated sodium dichromate liquid for collection and disposal. The grouting was not intended to provide long-term stabilization of residual Cr(VI).

- The 118-B-8:4 waste site consists of contaminated soil around the former B Reactor fuel storage basin. The basin has been drained and is managed as part of the B Reactor museum, and the basin structure is not part of the 100-BC-1 or 100-BC-2 OUs and is not addressed by this Proposed Plan. Radiological soil contamination is present below 3.8 m (12.5 ft) bgs at the site, including cesium-137, europium-152, and strontium-90 concentrations up to 316, 28.4, and 13.9 ***picocuries*** per gram (pCi/g), respectively (including consideration of radioactive decay to 2019).

Based on the risk assessment, five waste sites at 100-BC that were previously remediated by RTD under interim actions contained residual contamination that warrants further final action consideration (radionuclide concentrations include adjustment for radioactive decay to 2019):

- The 116-B-5 waste site was a shallow crib that received effluent from tritium separation processes. The crib and surrounding soil were removed by interim action remediation up to 5 m (16 ft) bgs. Low concentrations of europium-152 (2.1 pCi/g) and tritium (182 pCi/g) are present in shallow soil at the site beyond the extent of previous remediation and above levels protective of human health considering cumulative risk.

- The 116-B-6A waste site was a shallow crib that received effluent from decontamination of reactor hardware and equipment. The 116-B-16 waste site was a collocated shallow underground tank used for temporary holding of decontamination water. The crib, tank, and surrounding soil were removed by interim action remediation up to 4.6 m (15 ft) bgs. Low concentrations of cesium-137 (4.1 pCi/g) and strontium-90 (2.1 pCi/g) are present in shallow soil at the sites beyond the extent of previous remediation and above levels protective of human health considering cumulative risk.

- The 116-C-1 waste site was a large unlined trench used for disposal of approximately 700 million L (184 million gal) of contaminated reactor cooling water. Contaminated soil was removed by interim action remediation up to 5 m (16 ft) bgs. Residual strontium-90 contamination below the depth of previous remediation (up to 52 pCi/g) exceeds the level protective of groundwater under an irrigation land-use scenario.

- The 118-B-1 waste site was a large unlined burial ground used for disposal of hardware and other solid wastes from the reactors and support facilities. Debris and contaminated soil were removed by interim action remediation up to 10 m (33 ft) bgs. Low concentrations of strontium-90 (3.3 pCi/g) above levels protective of human health are present in shallow soil beyond the extent of previous remediation at a portion of the site. Residual tritium contamination (119 pCi/g) exceeding the level protective of groundwater under an irrigation land-use scenario is also present in deep soil beneath the depth of previous remediation. Higher tritium concentrations (up to 20,700 pCi/g) are also present in limited areas of the site beneath the depth of previous remediation.

Groundwater Contamination

Groundwater contaminants at levels that currently exceed federal or state DWSs in the 100-BC-5 OU include Cr(VI), strontium-90, and trichloroethene (TCE). Prior to 2013, tritium concentrations exceeded the 20,000 picocuries per liter (pCi/L) DWS but have subsequently declined and remain less than the DWS. Most of the waste sites in the 100-BC-1 and 100-BC-2 OUs that were the source of groundwater contaminants were remediated under the interim action to levels protective of groundwater and the river. Natural processes including dilution, dispersion, radioactive decay, sorption, and abiotic/biotic degradation are causing residual contaminant concentrations to decline in groundwater. The locations of the groundwater contaminant plumes within the 100-BC-5 OU are shown in Figure 9 and Figure 10.

Cr(VI). Concentrations of Cr(VI) in groundwater above the 48 µg/L ***Model Toxics Control Act—Cleanup (MTCA)*** (WAC 173-340) Method B groundwater cleanup level are present in a plume beneath the northeastern portion of 100-BC within a 0.04 km^2 (0.02 mi^2) area in the upper part of the unconfined aquifer (Figure 9). There is no federal DWS for Cr(VI); however, total chromium concentrations are all less than the 100 µg/L federal DWS for total chromium. In 2017, the maximum groundwater concentration of Cr(VI) was 50 µg/L. DOE also used the 10 µg/L Washington State surface water quality standard as a conservative screening level for groundwater to assess the potential for Cr(VI)-contaminated groundwater to reach the river at concentrations greater than the surface water quality standard. Concentrations of Cr(VI) exceed this 10 µg/L standard over an area of approximately 1.3 km^2 (0.5 mi^2) in the upper portion of the aquifer (Figure 10). Cr(VI)-contaminated groundwater that exceeds 10 µg/L occurs separately in the upper and lower portion of the aquifer. Pore water monitoring at the river bed adjacent to the plumes showed Cr(VI) concentrations up to 36 µg/L from 2013 to 2017, with concentrations fluctuating with seasonal river level changes.

Strontium-90. Concentrations of strontium-90 in groundwater above the 8 pCi/L DWS are present in a plume beneath the northeastern portion of 100-BC within a 0.5 km^2 (0.2 mi^2) area in the upper part of the unconfined aquifer (Figure 9). In 2017, the maximum groundwater concentration of strontium-90 was 43.6 pCi/L. While above the DWS, the maximum concentration is less than the lowest risk-based concentrations for riparian animals (278 pCi/L) and for aquatic life (53,900 pCi/L) (DOE-STD-1153-2002, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota*).

Tritium. Concentrations of tritium in groundwater have historically exceeded the 20,000 pCi/L DWS, but have declined below the standard since 2013 from radioactive decay and dispersion. Tritium concentrations continue to decline. Measured and forecasted concentrations are below the lowest risk-based concentration for aquatic or riparian animals, which is 265,000,000 pCi/L for riparian animals (DOE-STD-1153-2002).

Trichloroethene. TCE was detected above the 4 µg/L MTCA (WAC 173-340) cleanup level for drinking water use in one inland monitoring well in 2016 and 2017 (Figure 9). TCE has not been detected above the cleanup level in other 100-BC monitoring locations. Where detected, it is located primarily in the lower part of the unconfined aquifer. Concentrations are below the lowest ecological effect level of 47 µg/L (ES/ER/TM-96/R2, *Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: 1996 Revision)*.

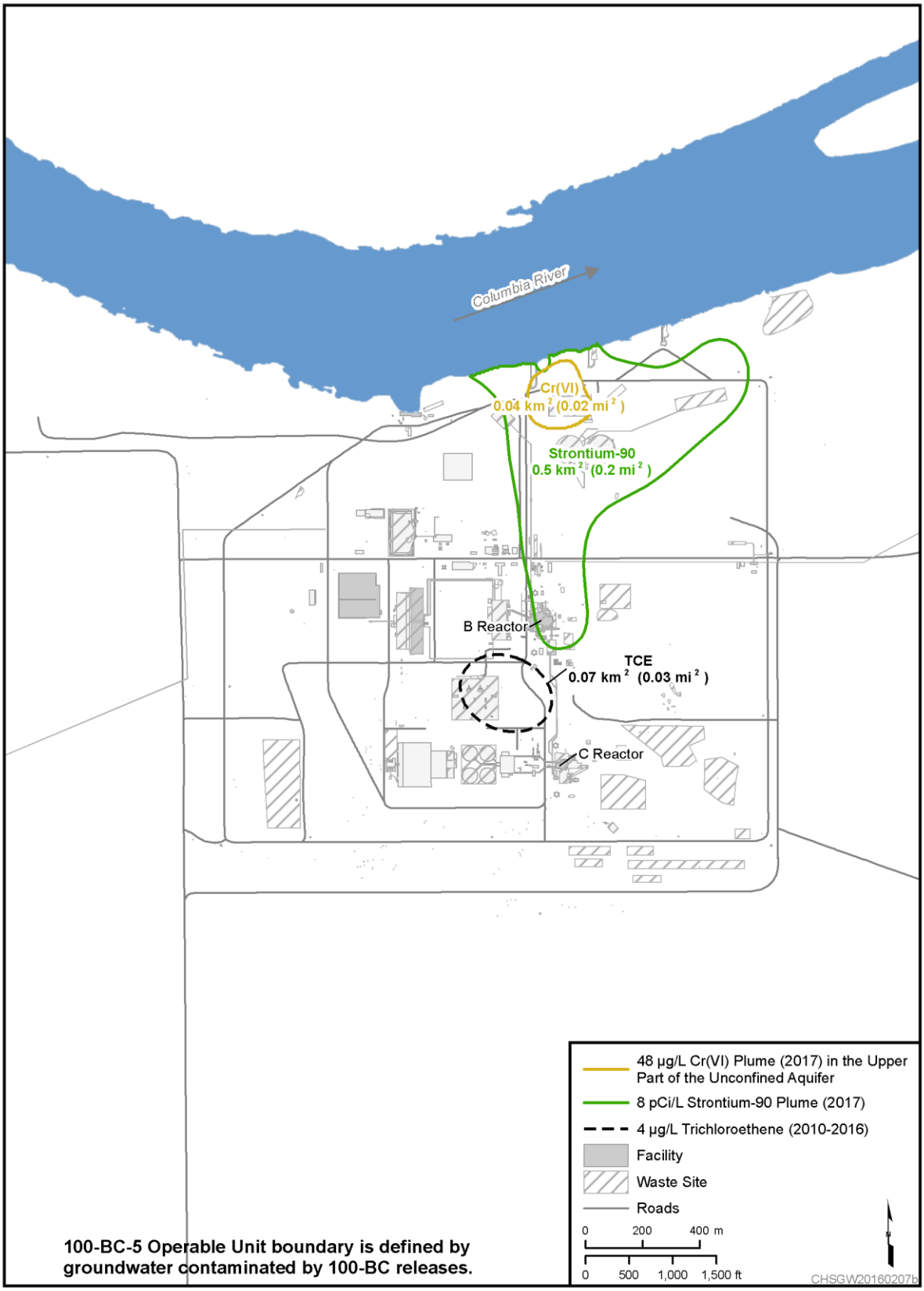


Figure 9. Strontium-90, Cr(VI), and TCE Plumes Exceeding Federal or State DWSs

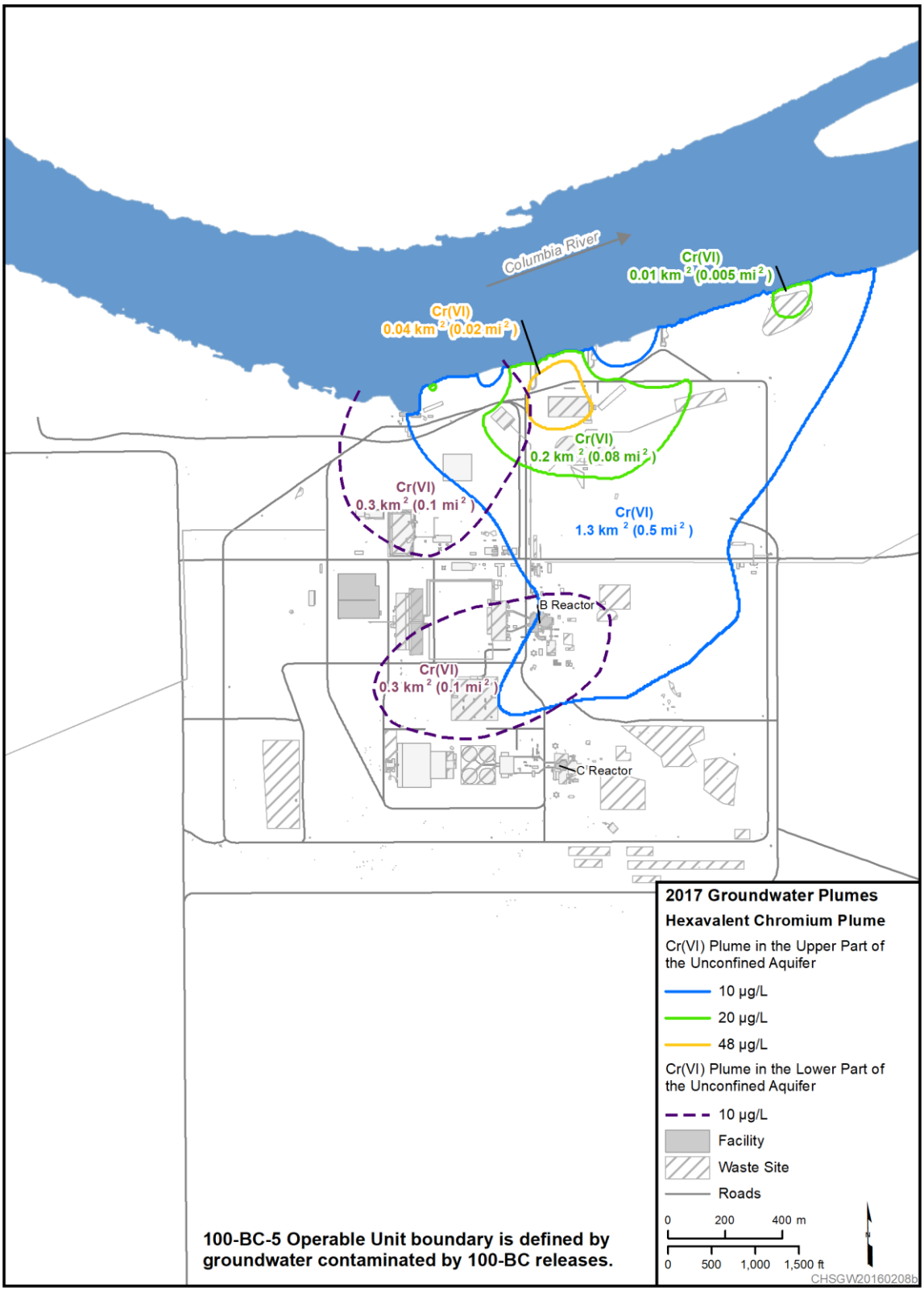
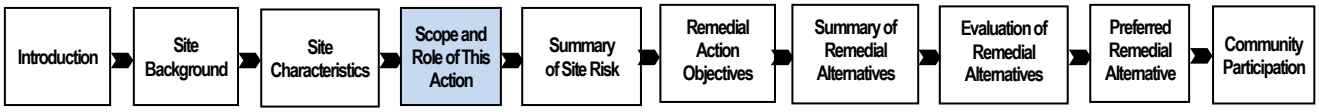


Figure 10. Cr(VI) Plumes Exceeding the 10 µg/L State Surface Water Quality Standard

Principal Threat Wastes

Principal threat wastes are those source materials at concentrations considered highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to public health or the environment should exposure occur. Contaminated groundwater is generally not considered to be source material.

Principal threat wastes associated with 100-BC such as fuel fragments, concentrated liquid sodium dichromate, and highly Cr(VI)-contaminated soil and debris have been removed through earlier cleanup actions. Residual waste site contamination consists of low levels in shallow soil and in short pipeline segments and low mobility radiological contamination in deeper soil. No waste sites remain in the source OUs with contaminant concentrations that would constitute principal threat waste.



Scope and Role of This Action

This Proposed Plan addresses releases in the following OUs:

- 100-BC-1 Source OU
- 100-BC-2 Source OU
- 100-BC-5 Groundwater OU

These are the only OUs associated with the former B and C Reactor operational area. The roles of the 100-BC-1, 100-BC-2, and 100-BC-5 OUs in the scope of the Hanford Site cleanup strategy are presented in the following discussion.

Hanford Site Overall Cleanup Strategy

This Proposed Plan is part of a cleanup strategy to complete remediation of the Hanford Site. The River Corridor and the Central Plateau (Figure 2) are the two main geographic areas for cleanup work on the Hanford Site. The 100-BC-1, 100-BC-2, and 100-BC-5 OUs are located in the 100-BC Area, part of the River Corridor, which includes the former reactor operations and fuel fabrication areas adjacent to the Columbia River. The OUs associated with other areas in the River Corridor are being addressed by separate ROD processes. The objective of the cleanup strategy is to ensure that cleanup actions address all threats to human health and the environment in accordance with regulatory requirements.

The intent of the Hanford Site cleanup strategy is to shrink the site's waste management footprint to that of the Central Plateau for long-term waste management. The strategy includes remediation of waste sites and restoration of groundwater that (1) is protective of human health and the environment, including the Columbia River; (2) restores groundwater to beneficial use wherever practicable; and (3) supports reasonably anticipated future uses.

Summary of Site Risks

A baseline risk assessment, as required under the NCP (40 CFR 300) to characterize current and potential threats to human health and the environment and to provide information that can be used in the development and evaluation of remedial alternatives, is presented in the 100-BC RI/FS report (DOE/RL-2010-96). Prior to the 100-BC RI/FS report, the River Corridor Baseline Risk Assessment (DOE/RL-2007-21, *River Corridor Baseline Risk Assessment, Volume I: Ecological Risk Assessment* and *River Corridor Baseline Risk Assessment*; *Volume II: Human Health Risk Assessment*; hereinafter called the RCBRA) and the Columbia River Component (DOE/RL-2010-117, *Columbia River Component Risk Assessment, Volume I: Screening-Level Ecological Risk Assessment*; and *Columbia River Component Risk Assessment*; *Volume II: Baseline Human Health Risk Assessment*; hereinafter called the CRC) were conducted to characterize current and potential future risks to human health and the environment that may be posed by contamination in the River Corridor, including the OUs discussed in this Proposed Plan. The results of the RCBRA and the CRC are summarized in the 100-BC RI/FS report.

Baseline Risk Assessment

The baseline risk assessment identifies and characterizes the actual and potential risks a site poses to human health or the environment if no action were taken at the site. It provides the basis for taking a response action under CERCLA.

The risk assessment for waste sites in the RI/FS relied on a comprehensive review of all available data for each waste site, including field data, radiological surveys, process history, analogous site information, personal interviews, engineering drawings and as-builts, and any other information identified during the development of the RI/FS. Post-interim remediation sampling results, including cleanup verification documentation, were included in the risk assessment. The 100-BC RI/FS report presented the determination that either:

- These waste sites had no remaining contaminants at concentrations greater than established standards that define acceptable levels of exposure, which are also the PRGs (Table 6 and Table 7 at the end of this Proposed Plan); therefore, no further remedial action is necessary.

or

- There are contaminant concentrations above risk-based thresholds defined in the baseline risk assessment that identify acceptable levels of exposure and/or above concentrations protective of groundwater and surface water, thus providing a basis for action.

Land- and Groundwater-Use Assumptions

Land use in the River Corridor is currently controlled by DOE, with the U.S. Fish and Wildlife Service (USFWS) managing most of the HRNM. DOE and the USFWS manage this federally owned land to protect natural and cultural resources while cleanup activities are being conducted. Such management is consistent with DOE/EIS-0222F, *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement*; DOE/EIS-0222-SA-01, *Supplement Analysis, Hanford Comprehensive Land-Use Plan Environmental Impact Statement*; and DOE/EIS-0222-SA-02, *Supplement Analysis of the Hanford Comprehensive Land-Use Plan Environmental Impact Statement*, for the Hanford Site. This joint management also reflects the requirements of the USFWS management plan (USFWS, 2008, *Hanford Reach National Monument: Final Comprehensive Conservation Plan and Environmental Impact Statement; Adams, Benton, Grant and Franklin Counties, Washington*) for the HRNM. Both DOE and the USFWS expect that this joint management of the Hanford Site will continue for many years into the future and that the property will remain under federal ownership.

In June 2000, the HRNM was established within the boundaries of the Hanford Site (Figure 2). The Presidential Proclamation that established the HRNM (65 FR 114) mandates preservation of the natural and cultural resources within the HRNM and specifically included the possibility of adding lands to the HRNM as they are remediated.

DOE's reasonably anticipated future use of the 100-BC-1 and 100-BC-2 OUs is conservation and preservation. EPA and Ecology believe that other uses, including residential use, are reasonably anticipated future land use for these areas. In the preferred alternative, DOE and EPA have proposed residential-based PRGs. The proposed residential PRGs also allow for conservation and preservation uses and minimize the need for ICs and long-term monitoring.

The NCP establishes an expectation to "return useable ground waters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site" (40 CFR 300.430(a)(1)(iii)(F)). The Tri-Party Agreement Agencies' goal for Hanford Site groundwater is to return groundwater to its beneficial use as a potential future drinking water source.

Groundwater from the 100-BC-5 OU is currently contaminated above DWSs. Groundwater was evaluated in the risk evaluation, assuming potential future use for drinking water and other domestic activities. Contaminant concentrations were also compared to federal ***ambient water quality criteria*** and state surface water quality standards because groundwater discharges to the Columbia River via riverbank seeps and upwelling through the river bottom.

Contaminant Fate and Transport Modeling

Fate and transport modeling was performed to simulate and predict the movement of contaminants in soil and groundwater, and is described in the 100-BC RI/FS report (DOE/RL-2010-96). Contaminant transport in soil was modeled to determine residual concentrations protective of groundwater and surface water. The modeling results were used to identify waste sites where remedial action may be necessary to protect future groundwater and surface water quality. In addition, contaminant transport in groundwater was modeled to predict timeframes to achieve cleanup for the purpose of comparing the remedial alternatives.

Risk Assessment

For purposes of assessing current and future potential risk, various human exposure scenarios were evaluated in the RCBRA (DOE/RL-2007-21, Volume II), the CRC (DOE/RL-2010-117, Volume II), and the baseline human health risk assessment in the 100-BC RI/FS report. These exposure scenarios were evaluated to reflect a range of land uses, including the residential scenario, which is described below.

Excess lifetime cancer risks (ELCRs) and noncancer hazard quotients and ***hazard index*** values were calculated based on ***exposure point concentrations (EPCs)*** for the 100-B/C RI/FS report. ***Contaminants of potential concern (COPCs)*** were identified when the ELCR and/or noncancer hazard quotients were greater than the acceptable risk thresholds identified in MTCA (WAC 173-340) and the NCP (40 CFR 300), or when a significant contribution to adverse human health effects was identified.

The NCP identifies cumulative ELCR below 10^{-6} as acceptable risk (NCP; 40 CFR 300). Risks between10^{-4} to 10^{-6} are generally referred to as an "acceptable risk range." Risks above 10^{-4} are considered unacceptable. However, for nonradionuclide contaminants, MTCA states that cancer risks resulting from a single hazardous substance cannot exceed 1×10^{-6} and cancer risks from multiple hazardous substances cannot exceed 1×10^{-5} for unrestricted land use. MTCA is not applicable to radionuclide contaminants.

For noncarcinogenic effects, EPA policy and MTCA define the acceptable target hazard index as ≤1. The hazard index may exceed 1 even if all of the individual hazard quotients are <1. In this case, the chemicals may be

segregated by similar mechanisms of toxicity and toxicological effects. Separate hazard index values may then be derived based on mechanism and effect.

Residential Scenario. For assessing cancer risks and noncancer hazards from exposure to chemicals in the top 4.6 m (15 ft) of soil, MTCA (WAC 173-340-740, "Unrestricted Land Use Soil Cleanup Standards") Method B levels were used. The MTCA Method B methods used for this assessment are consistent with CERCLA risk assessment methods. MTCA Method B considers direct contact exposure of a child through incidental soil ingestion. It also considers the inhalation pathway based on exposure to adults and children from inhalation of vapors and dust in ambient air. Calculations of these MTCA cleanup standards (identified as the soil PRGs) are described in the 100-BC RI/FS report (DOE/RL-2010-96).

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

Human Health Soil Risks. The interim remediated waste sites in the 100-BC source OUs were evaluated in the risk assessment presented in the 100-BC RI/FS report. Six waste sites (100-B-34 [eastern segments], 116-B-5, 116-B-6A, 116-B-16, 118-B-1, and 118-B-8:4) had radionuclide concentrations above residential-based risk thresholds for radionuclides in the shallow soil (up to 4.6 m [15 ft] bgs). Additionally, the residual Cr(VI) at the western segment of 100-B-34 is considered an ongoing risk for direct contact and possible indefinite threat to groundwater. No other exceedances of acceptable ELCR, hazard quotient, or hazard index values were identified for these sites or for any of the other 100-BC waste sites.

Twenty-nine waste sites (100-B-5, 100-B-8:1, 100-B-8:2, 100-B-14:1, 100-B-21:4, 100-B-34, 100-C-6:1, 100-C-6:2, 100-C-6:3, 100-C-6:4, 116-B-1, 116-B-2, 116-B-3, 116-B-4, 116-B-6A, 116-B-11, 116-B-14, 116-B-16, 116-C-1, 116-C-2A, 116-C-2B, 116-C-2C, 116-C-3, 116-C-5, 118-B-1, 118-B-8:4, 118-B-6, 118-C-1, and 118-C-3:2) in the 100-BC-1 and 100-BC-2 OUs contain residual radionuclide contamination deeper than 4.6 m (15 ft) bgs, which presents a potential risk only from inadvertent exposure through deep excavation activities. Such excavation is not reasonably anticipated as part of current or reasonably anticipated future land use. However, a risk assessment using a residential exposure scenario for radionuclides was used to identify where unacceptable exposure could occur if the contamination was brought to the surface. Each of the 29 waste sites report an ELCR $>1 \times 10^{-4}$ for deep vadose zone contamination if brought to the surface.

Groundwater Risks. Groundwater contamination risk to human health within the 100-BC-5 OU was evaluated based on calculated human health ELCRs and noncancer hazard quotients using the EPA residential drinking water exposure scenario. Individual groundwater concentration measurements were also compared to federal and state DWSs and to MTCA (WAC 173-340) Method B groundwater cleanup levels.

Cr(VI) is present within the aquifer at concentrations above the 48 µg/L MTCA cleanup level (WAC 173-340-720, "Groundwater Cleanup Standards"). There is no federal DWS for Cr(VI); however, total chromium concentrations are all less than the 100 µg/L federal DWS for total chromium. The combined strontium-90 and tritium concentrations in 100-BC-5 groundwater results in a dose equivalent of greater than the 4 mrem/yr federal DWS for beta particle and photon emitter dose to the total body or any internal organ.

Strontium-90 has been detected in 100-BC-5 groundwater at concentrations above the federal DWS of 8 pCi/L in the northeastern 100-BC-5 OU. Tritium has not been detected above the federal DWS in the 100-BC-5 OU since 2012. Due to the small rate of groundwater discharge relative to the flow rate of the river (<0.001%), groundwater discharges to the river do not represent a threat to drinking water or recreational users.

Groundwater and Surface Water Protection. Waste sites were also evaluated as potential sources for groundwater and surface water contamination. Contaminant transport in soil was modeled to determine if soil contamination could result in groundwater or surface water contamination at concentrations exceeding protective levels. The 116-C-1 waste site contains residual strontium-90 soil contamination exceeding levels protective of groundwater under an irrigation land-use scenario. The 118-B-1 waste site contains residual tritium contamination exceeding soil levels protective of groundwater under an irrigation land-use scenario. Groundwater monitoring at the 118-B-1 waste site has shown tritium levels are currently below the DWS and continue to exhibit a declining trend. No other soil contaminants or waste sites were identified that would cause an unacceptable risk to groundwater or surface water.

Ecological Risks at Upland Areas. The 100-BC RI/FS report (DOE/RL-2010-96) presented the evaluation of ecological risk from contaminants in soil within upland habitat at the 100-BC waste sites. The 100-BC RI/FS report expanded upon information first developed for the RCBRA (DOE/RL-2007-21) and other sources to identify risk-based thresholds (e.g., PRGs) and to evaluate risk to populations and communities of ecological receptors. Where soil concentrations exceeded risk-based thresholds, the context of the data and exceedance was evaluated further. Based on these evaluations, the 100-BC RI/FS report presents the conclusion that there is no ecological risk at waste sites within the 100-BC source OUs.

Ecological Risks at Riparian, Near-Shore, and Riverine Areas. The 100-BC RI/FS report used information from the RCBRA (DOE/RL-2007-21) and the CRC (DOE/RL-2010-117) (e.g., chemical data) to evaluate risk to populations and communities of ecological receptors in riparian, near-shore, and riverine habitats within and adjacent to the 100-BC OUs. The 100-BC RI/FS report presented the evaluation of contaminants present in these environments and pathways where operations within the 100-BC waste sites may have released contaminants to these environments. The evaluation included releases or potential releases of radionuclides, Cr(VI), and other inorganics and metals into the Columbia River from groundwater. The conceptual model depicting the relationships between sources and riparian or near-shore media (soil, sediment, pore water, and surface water) is presented in the 100-BC RI/FS report. The ecological risk assessment in the 100-BC RI/FS report found that there is no unacceptable current risk to aquatic organisms in the riparian, near-shore, and riverine habitats of the Columbia River adjacent to 100-BC. No ***contaminants of ecological concern*** were identified in the riparian soils above risk thresholds. However, Cr(VI) in groundwater remains above the 10 µg/L state surface water quality standard (WAC 173-201A, "Water Quality Standards for Surface Waters of the State of Washington") for protection of aquatic organisms.

Threatened or Endangered Species. The Hanford Reach of the Columbia River contains three species listed as threatened or endangered under the federal *Endangered Species Act of 1973*. These include upper Columbia River spring-run Chinook salmon, Upper Columbia River steelhead trout, and bull trout. The spring-run Chinook salmon and bull trout do not spawn in the Hanford Reach but use it as a migration corridor. Steelhead spawning has been observed in the Hanford Reach, but no steelhead redds have been observed adjacent to 100-BC or within the upwelling areas associated with the 100-BC-5 OU. Bull trout is not considered a resident species and is rarely observed in the Hanford Reach. The primary concern for aquatic biota residing in river water or the river bottom substrate is exposure to contaminants present in groundwater upwelling through the riverbed gravels, cobbles, and sand. As discussed in the 100-BC RI/FS report, contaminated groundwater from 100-BC-5 discharging to the river will have no effect on these species. Current and predicted Cr(VI) concentrations are below the relevant no-effect threshold for these species (266 µg/L) developed from Hanford Site-specific studies of salmonids.

There are two plant species listed as threatened under the federal *Endangered Species Act of 1973* that could be found on the Hanford Site. The two species, Umtanum desert buckwheat and White Bluffs bladderpod, are upland species that were listed in 2013. The habitat in the vicinity of 100-BC waste sites is not suitable to either species, and neither has been identified at 100-BC by extensive rare plant surveys (DOE/RL-96-32, *Hanford Site Biological Resources Management Plan*).

Contaminants of Concern

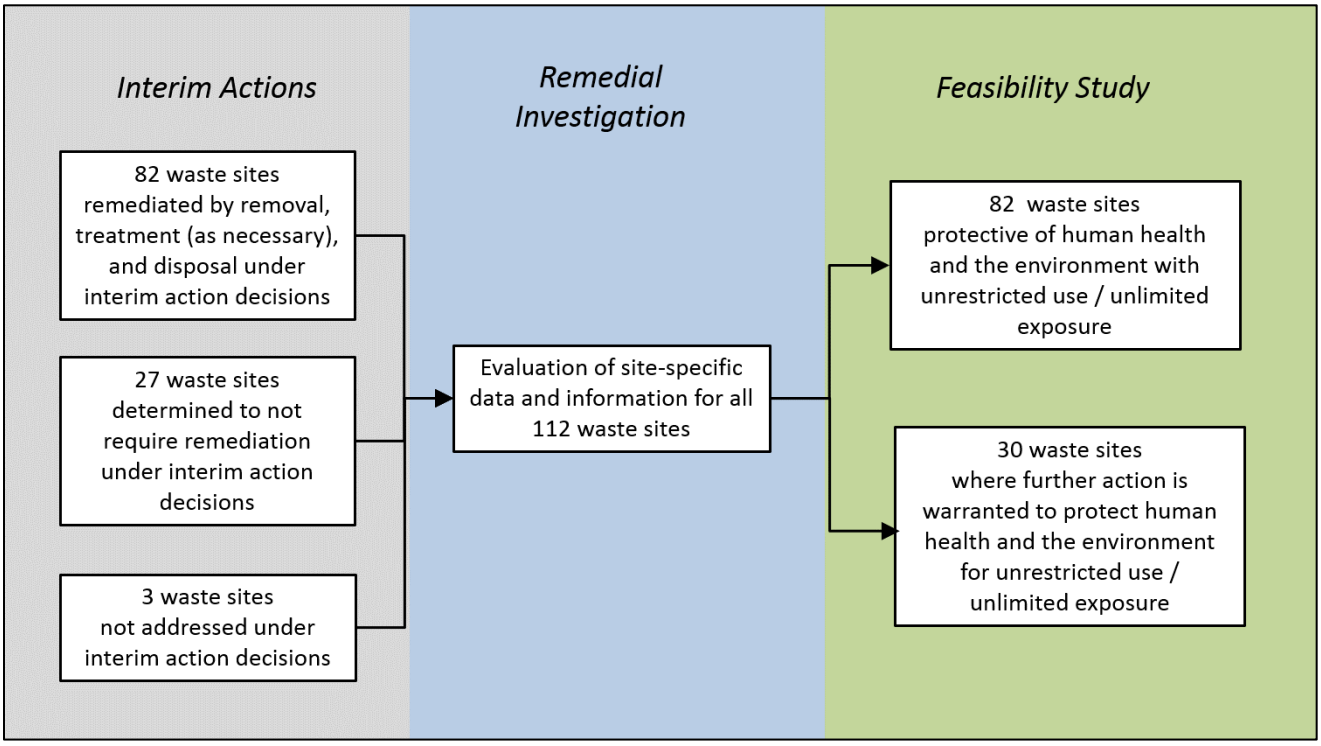
COCs are radionuclides and chemicals that pose an unacceptable threat to human health and the environment and therefore need to be addressed by a remedial action. The soil and groundwater COCs are the contaminants that exceed an acceptable risk level or a federal or state standard and are listed in Table 1. Concentrations of tritium in groundwater have been below the 20,000 pCi/L DWS since 2013. However, tritium has been identified as a groundwater COC because concentrations were greater than the DWS over the 5-year period used in the RI/FS evaluation and because contaminant transport modeling for the 118-B-1 waste site forecasts potential future DWS exceedance under an irrigation land-use scenario. Table 6, Table 7, and Table 8 (at the end of this Proposed Plan) provide the PRGs.

Table 1. 100-BC Contaminants of Concern

Soil Radionuclides	Soil Nonradionuclides	Groundwater Radionuclides	Groundwater Nonradionuclides
Carbon-14 Cesium-137 Cobalt-60 Europium-152 Europium-154 Nickel-63 Strontium-90 Tritium	Hexavalent chromium	Strontium-90 Tritium	Hexavalent chromium Trichloroethene

Conclusions

Of the 112 waste sites in the 100-BC-1 and 100-BC-2 OUs, 30 waste sites were identified where action is needed to protect human health and the environment from potential exposure to contamination (Figure 11). Remedial alternatives for these 30 sites were subsequently evaluated in the FS (100-BC RI/FS report; DOE/RL-2010-96). The 82 remaining waste sites do not have contamination exceeding levels protective of human health and the environment.

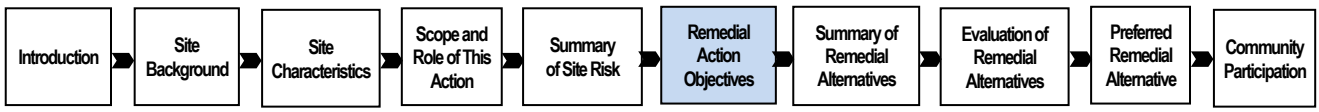


Note: The 82 waste sites remediated by RTD under interim action decisions are not the same 82 waste sites determined to be protective of human health and the environment in DOE/RL-2010-96, *Remedial Investigation/Feasibility Study for the 100-BC-1, 100-BC-2, and 100-BC-5 Operable Units*.

Figure 11. Summary of Waste Sites Addressed Under the 100-BC Proposed Plan

The risk assessment concluded that Cr(VI), strontium-90, and TCE are present in groundwater at concentrations exceeding DWSs and/or surface water protection standards; therefore, remedial action is necessary. Tritium was also identified as a groundwater COC requiring remedial action based on concentrations observed during the 5-year period used in the RI/FS evaluation and because of the possibility of residual vadose zone contamination impacting groundwater under an irrigation land-use scenario above levels protective of human health and the environment.

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



Remedial Action Objectives

The RAOs describe what a proposed remedial action is expected to accomplish. RAOs generally include information on the media, COCs, potential exposure pathways, and remediation goals. The RAOs for the

100-BC-1 and 100-BC-2 OUs are RAOs #3 through #6. The RAOs for the 100-BC-5 OU are RAOs #1, #2, and #7. The RAOs are as follows:

- **RAO #1**: Prevent unacceptable risk to human health from ingestion of and incidental exposure to groundwater containing COCs at concentrations above federal and state standards and risk-based thresholds.
- **RAO #2**: Prevent unacceptable risk to human health and ecological receptors from groundwater discharges to surface water containing COCs at concentrations above federal and state standards and risk-based thresholds.
- **RAO #3**: Prevent unacceptable risk from COCs migrating and/or leaching through soil that will result in groundwater concentrations that exceed standards and risk-based thresholds for protection of surface water and groundwater.
- **RAO #4**: Prevent unacceptable risk to human health from exposure to the upper 4.6 m (15 ft) of soil, structures, and debris contaminated with nonradiological COCs at concentrations above the MTCA unrestricted land-use standards for human health.
- **RAO #5**: Prevent unacceptable risk to human health from exposure to the upper 4.6 m (15 ft) of soil, structures, and debris contaminated with radiological COCs. Prevent exposure to radiological COCs at concentrations that result in an ELCR threshold of 1×10^{-6} to 1×10^{-4} above background for the residential exposure scenario.
- **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.
- **RAO #7**: Restore groundwater in 100-BC-5 to cleanup levels, which include DWSs, within a timeframe that is reasonable given the particular circumstances of the site.

Preliminary Remediation Goals

PRGs were developed based on the RAOs and establish acceptable protective exposure levels for COCs based on the media (soil, groundwater, or surface water) and exposure scenario (e.g., residential activities). During the FS process, PRGs were used to assess the effectiveness of the remedial alternatives in meeting RAOs. The PRGs are presented in Table 6, Table 7, and Table 8 (at the end of this Proposed Plan) and were used to evaluate all of the alternatives, except for Alternative 1. PRGs were calculated for single contaminants.

Soil PRGs for direct human contact are based on the residential scenario and were developed using standard approaches, consistent with state and federal guidance. Direct contact PRGs for nonradionuclides are based on MTCA (WAC 173-340) risk criteria of 1×10^{-6} ELCR for carcinogens and hazard index of 1 for noncarcinogenic effects. Direct contact PRGs for radionuclides were calculated based on an ELCR of 1×10^{-4}. An ELCR of 1×10^{-4} was used because the radionuclide EPCs calculated for each waste site likely overstate risk. The EPCs assume residual concentrations of radionuclides are uniformly distributed throughout the waste sites. This assumption does not consider the shielding and other risk reductive effects from fill material that is present above radionuclide contamination, as described in the 100-BC RI/FS report (DOE/RL-2010-96). The soil PRGs for groundwater and surface water protection are based on modeling as described in the 100-BC RI/FS report.

Summary of Remedial Alternatives

Remedial alternatives were developed based on the RAOs and PRGs developed for soil and groundwater and are described and evaluated in the 100-BC RI/FS report (DOE/RL-2010-96). Different technologies were evaluated and screened to develop the remedial alternatives. Technology groupings to address waste sites were combined with technology groupings to address groundwater, resulting in the alternatives shown in Table 2. Alternative 2 is the preferred alternative. Table 3 presents the 100-BC waste sites and the associated alternatives, including the alternative elements described below. Figure 12 shows the waste sites with shallow direct contact risk and/or potential to impact groundwater (100-B-34, 116-B-5, 116-B-6A, 116-B-16, 116-C-1, 118-B-1, and 118-B-8:4).

Table 2. 100-BC Remedial Alternatives

Alternative	Waste Sites	Groundwater
1	No Action for all 112 waste sites and groundwater (required by the NCP)	
2	ICs for 30 waste sites, RTD for 1 waste site, and No Action for 82 waste sites	MNA with ICs
3		P&T for Cr(VI) and MNA with ICs for strontium-90, tritium, TCE, and Cr(VI) located further inland and outside the influence of P&T operation
4	ICs for 29 waste sites, RTD for 5 waste sites, and No Action for 82 waste sites	
5	ICs for 30 waste sites, RTD for 1 waste site, and No Action for 82 waste sites	Cr(VI) Source Treatment with P&T for Cr(VI) and MNA with ICs for strontium-90, tritium, TCE, and Cr(VI) located further inland and outside the influence of P&T operation
6	ICs for 29 waste sites, RTD for 5 waste sites, and No Action for 82 waste sites	

Note: Some waste sites have more than one remedial action, so site subtotals for Alternatives 2 through 6 do not sum to 112.

Cr(VI) = hexavalent chromium
IC = institutional control
MNA = monitored natural attenuation
NCP = National Contingency Plan (40 CFR 300)
P&T = pump and treat
RTD = remove, treat, and dispose
TCE = trichloroethene

Table 3. Waste Site Alternatives

Technology/ Approach	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
No action	**82 waste sites** 100-B-1, 100-B-2, 100-B-3, 100-B-10, 100-B-11, 100-B-12, 100-B-14:2, 100-B-14:3, 100-B-14:4, 100-B-14:5, 100-B-14:6, 100-B-14:7, 100-B-15, 100-B-16, 100-B-18, 100-B-19, 100-B-20, 100-B-21:1, 100-B-21:2, 100-B-21:3, 100-B-22:1, 100-B-22:2, 100-B-23, 100-B-24, 100-B-25, 100-B-26, 100-B-27, 100-B-28, 100-B-31, 100-B-32, 100-B-33, 100-B-35:1, 100-B-35:2, 100-C-3, 100-C-7, 100-C-7:1, 100-C-9:1, 100-C-9:2, 100-C-9:3, 100-C-9:4, 116-B-10, 116-B-12, 116-B-13, 116-B-15, 116-B-6B, 116-B-7, 116-B-9, 116-C-6, 118-B-2, 118-B-3, 118-B-4, 118-B-5, 118-B-9, 118-B-10, 118-C-2, 118-C-3:3, 118-C-4, 120-B-1, 126-B-2, 126-B-3, 128-B-2, 128-B-3, 128-C-1, 132-B-1, 132-B-3, 132-B-4, 132-B-5, 132-B-6, 132-C-1, 132-C-2, 132-C-3, 1607-B1, 1607-B2:1, 1607-B2:2, 1607-B7, 1607-B8, 1607-B9, 1607-B10, 1607-B11, 600-230, 600-232, 600-233				

Table 3. Waste Site Alternatives

Technology/ Approach	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
ICs (shallow excavation restrictions)	**6 waste sites** 100-B-34[a] (eastern segments), 116-B-5, 116-B-6A, 116-B-16, 118-B-1[b] (cesium-137, strontium-90), 118-B-8:4[c] (shallow)	**6 waste sites** 100-B-34[a] (eastern segments), 116-B-5, 116-B-6A, 116-B-16, 118-B-1[b] (cesium-137, strontium-90), 118-B-8:4[c] (shallow)	**2 waste sites** 116-B-5, 118-B-1[b] (cesium-137, strontium-90)	**6 waste sites** 100-B-34[a] (eastern segments), 116-B-5, 116-B-6A, 116-B-16, 118-B-1[b] (cesium-137, strontium-90), 118-B-8:4[c] (shallow)	**2 waste sites** 116-B-5, 118-B-1[b] (cesium-137, strontium-90)
RTD to PRGs[d]	**1 waste site** 100-B-34[a] (western segment)	**1 waste site** 100-B-34[a] (western segment)	**5 waste sites** 100-B-34[a] (all segments), 116-B-6A, 116-B-16, 116-C-1, 118-B-8:4[c] (shallow)	**1 waste site** 100-B-34[a] (western segment)	**5 waste sites** 100-B-34[a] (all segments), 116-B-6A, 116-B-16, 116-C-1, 118-B-8:4[c] (shallow)
ICs (irrigation prohibition)	**2 waste sites** 116-C-1, 118-B-1[b] (deep tritium)	**2 waste sites** 116-C-1, 118-B-1[b] (deep tritium)	**1 waste site** 118-B-1[b] (deep tritium)	**2 waste sites** 116-C-1, 118-B-1[b] (deep tritium)	**1 waste site** 118-B-1[b] (deep tritium)
ICs (deep excavation restrictions)	**6 waste sites** 100-B-34[a] (eastern segments), 116-B-6A, 116-B-16, 116-C-1, 118-B-1[b] (deep tritium), 118-B-8:4[c] (deep)	**6 waste sites** 100-B-34[a] (eastern segments), 116-B-6A, 116-B-16, 116-C-1, 118-B-1[b] (deep tritium), 118-B-8:4[c] (deep)	**5 waste sites** 100-B-34[a] (eastern segments), 116-B-6A, 116-B-16, 118-B-1[b] (deep tritium), 118-B-8:4[c] (deep)	**6 waste sites** 100-B-34[a] (eastern segments), 116-B-6A, 116-B-16, 116-C-1, 118-B-1[b] (deep tritium), 118-B-8:4[c] (deep)	**5 waste sites** 100-B-34[a] (eastern segments), 116-B-6A, 116-B-16, 118-B-1[b] (deep tritium), 118-B-8:4[c] (deep)

Table 3. Waste Site Alternatives

Technology/ Approach	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
ICs (deep excavation restrictions only)	**23 waste sites** 100-B-5, 100-B-8:1, 100-B-8:2, 100-B-14:1, 100-B-21:4, 100-C-6:1, 100-C-6:2, 100-C-6:3, 100-C-6:4, 116-B-1, 116-B-2, 116-B-3, 116-B-4, 116-B-11, 116-B-14, 116-C-2A, 116-C-2B, 116-C-2C, 116-C-3, 116-C-5, 118-B-6, 118-C-1, 118-C-3:2				

Note: Alternative 1 consists of no action for all 112 waste sites. Some waste sites appear in multiple technologies/approaches, so subtotals may not sum to 112.

a. The 100-B-34 waste site comprises two pipeline segments with shallow and deep cesium-137, europium-152, and strontium-90 contamination (eastern segments) and one pipeline segment with shallow Cr(VI) contamination (western segment). The remedial approach for the eastern and western segments are determined separately for each alternative.

b. The 118-B-1 waste site contains cesium-137 and strontium-90 contamination in shallow soil at concentrations greater than the soil PRGs for direct contact, and tritium contamination in deep soil at concentrations greater than the soil PRG protective of groundwater and surface water in separate areas of the waste site.

c. The 118-B-8:4 waste site is contaminated soil around the B Reactor fuel storage basin and is located adjacent to the B Reactor museum structure. Both shallow and deep contamination are present. Removal of deep contamination (deeper than 4.6 m [15 ft] bgs) is not a viable action because it could destabilize the reactor structure. Therefore, remedial approaches for 118-B-8:4 address the shallow and deep contamination separately.

d. RTD of 100-B-34 (eastern segments), 116-B-6A, 116-B-16, and 118-B-8:4 under Alternatives 4 and 6 will remove contamination to 4.6 m (15 ft) bgs. An IC restricting excavation of soil deeper than 4.6 m (15 ft) bgs will be required at these sites after RTD is completed.

bgs = below ground surface
Cr(VI) = hexavalent chromium
IC = institutional control
PRG = preliminary remediation goal
RTD = removal, treatment, and disposal

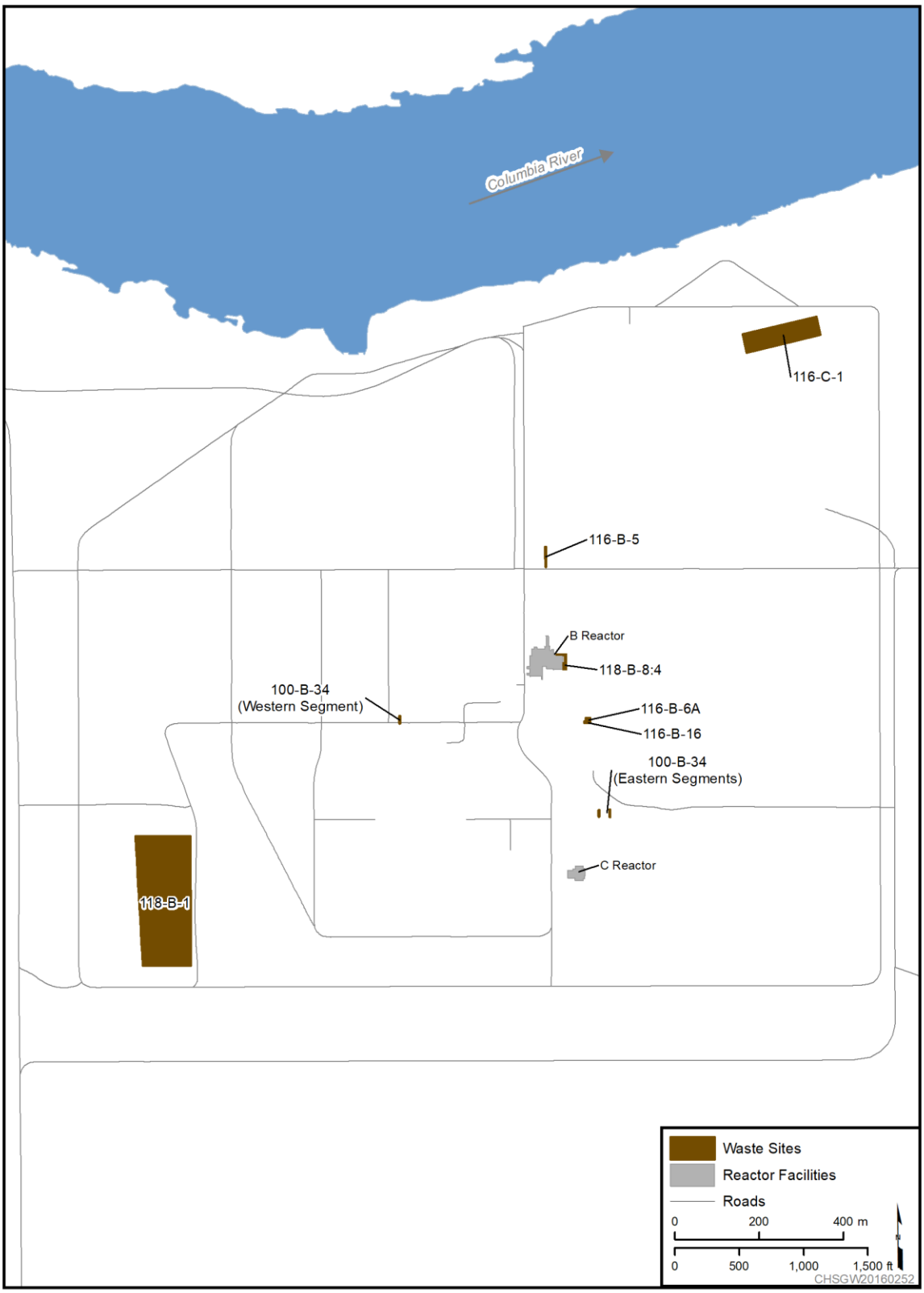


Figure 12. 100-BC Waste Sites with Shallow Direct Contact Risk and/or Potential to Impact Groundwater (Table 3)

Description of Alternatives

This section describes common elements and the distinguishing features of the six remedial action alternatives, which provide the basis for the comparative evaluation of alternatives against the CERCLA remedy selection criteria.

Alternative 1 – No Action

Consideration of a No Action alternative is a requirement of the NCP (40 CFR 300.430(e)(6)) and is included to provide a baseline for comparison against the other alternatives. Under the No Action alternative, no active remedial action would be taken to address any potential threats to human health and the environment posed by the COCs present in soil at any of the 112 waste sites and in groundwater. All existing actions, including groundwater monitoring, would cease if the No Action alternative is selected. This alternative does not meet the threshold criterion of protecting human health and the environment and therefore was not considered further.

Common Elements for Alternatives 2 Through 6

Common elements associated with Alternatives 2 through 6 are described below. All of these elements would comply with ARARs. All potential ARARs are identified in the 100-B/C RI/FS report (DOE/RL-2010-96) and include the following key ARARs:

- 40 CFR 141, "National Primary Drinking Water Regulations" – establishes federal DWSs applicable to surface water and groundwater, including reinjection of treated groundwater
- 40 CFR 131, "Water Quality Standards" – establishes federal surface water quality criteria
- WAC 173-201A, "Water Quality Standards for Surface Waters of the State of Washington" – establishes state water quality standards
- WAC 173-340, "Model Toxics Control Act—Cleanup" – establishes state cleanup levels for groundwater and soil
- WAC 173-303, "Dangerous Waste Regulations" – establishes requirements for designation, management, treatment, and disposal of dangerous solid waste

No Action for 82 Waste Sites. The waste site-specific risk assessment in the 100-BC RI/FS report (DOE/RL-2010-96) included a comprehensive review of all available data for each waste site, including field data, radiological surveys, process history, analogous site information, personal interviews, engineering drawings and as-builts, and any other information identified during the development of the RI/FS. Post-interim remediation sampling data, including cleanup verification documentation, were also included in the risk assessment. The 100-BC RI/FS report presented the determination that 82 waste sites did not have remaining contaminants at concentrations greater than risk-based thresholds that define acceptable levels of exposure in soil and soil concentrations protective of groundwater and surface water. The RI/FS concluded that there is no basis for action at these waste sites.

ICs for Waste Sites. ICs are nonengineered instruments such as administrative and/or legal controls to limit uses of land, facilities, and environmental media to prevent unacceptable exposure to contaminants that could pose risks above levels deemed protective. Common types of ICs include procedural restrictions for access, warning notices, permits, easements, deed notifications, leases and contracts, and restrictive covenants and easements.

Alternatives 2 through 6 would require ICs during the period before completion of the remedial action and following remedial action implementation until UU/UE is achieved. ICs would be used to restrict excavation,

prevent residential activities, and/or prohibit irrigation at specific waste sites as identified for each alternative (Table 4). These ICs would be maintained until the concentrations of hazardous substances are at such levels to allow for UU/UE and EPA authorizes the removal of restrictions. Reduction in radionuclide concentrations would occur primarily through radioactive decay, with the time required to achieve PRGs dependent on the radioactive half-lives of the contaminants. All ICs identified would be implemented through DOE/RL-2001-41, *Sitewide Institutional Controls Plan for Hanford CERCLA Response Actions and RCRA Corrective Actions*.

Exposure to contamination deeper than 4.6 m (15 ft) bgs is not anticipated. However, where contamination at depth exceeds levels protective of human health, ICs would be required to ensure that future activities do not bring this contamination to the surface or otherwise result in exposure to the contamination. ICs would be maintained until concentrations of hazardous substances are at such levels to allow for UU/UE and EPA authorizes the removal of restrictions. RTD was not considered for this deep contamination, except at the 116-C-1 waste site, because the reasonably anticipated future land use does not anticipate direct exposure below 4.6 m (15 ft). A rough-order-of-magnitude (ROM) cost evaluation estimated the cost to RTD these sites was $324 million. Deep RTD was considered for the 116-C-1 waste site to address groundwater protection as part of Alternatives 4 and 6.

Table 4. ICs at Waste Sites Under Alternatives 2 Through 6

Risk Driver	IC[a]
Waste sites that contain radiological contamination at depths deeper than 4.6 m (15 ft) bgs and present a potential risk from inadvertent exposure through deep excavation activities[b]	**Deep excavation restrictions (Alternatives 2 – 6):** 100-B-5 — 2083 100-B-14:1 — 12,110 100-B-8:1 — 2055 100-B-8:2 — 2065 100-B-21:4 — 2112 100-B-34 — 2055[c] 100-C-6:1 — 2055 100-C-6:2 — 2065 100-C-6:3 — 2065 100-C-6:4 — 2065 116-B-1 — 2112 116-B-11 — 2247 116-B-14 — 2030 116-B-2 — 2112 116-B-3 — 2075 116-B-4 — 2152 116-B-6A — 2095 116-B-16 — 2095 116-C-2A — 2228 116-C-2B — 2228 116-C-2C — 2228 116-C-3 — 2109 116-C-5 — 2137 118-B-1 —2081 118-B-6 — 2042 118-B-8:4 — 32,021 118-C-1 — 8698 118-C-3:2 — 2254 **Deep excavation restrictions (Alternatives 2, 3, and 5 only):** 116-C-1 — 2485
Waste sites with groundwater/surface water protection risk if irrigation were applied	**Prohibit irrigation (Alternatives 2 – 6):** 118-B-1 — 2051[d] **Prohibit irrigation (Alternatives 2, 3, and 5 only):** 116-C-1 — 2034[e]

Table 4. ICs at Waste Sites Under Alternatives 2 Through 6

Risk Driver	IC[a]
Waste sites with shallow (up to 4.6 m [15 ft] bgs) radiological contamination exceeding human health direct contact PRGs[c]	**Shallow excavation restrictions (Alternatives 2 – 6):** 116-B-5 — 2021 118-B-1 — 2040 **Shallow excavation restrictions (Alternatives 2, 3, and 5 only):** 100-B-34 — 2055[c] 116-B-6A — 2045 118-B-8:4 — 2203 116-B-16 — 2045

a. For each IC, the waste site is presented, followed by the year that contaminants are expected to decrease to concentrations less than PRGs.

b. These sites have contamination at depth where human exposure is not expected. ICs are applied to prevent material from being brought to the surface and to prevent other unacceptable exposure from drilling or digging.

c. The ICs at the 100-B-34 waste site would apply to the eastern segments only.

d. Tritium contamination at the 118-B-1 waste site is projected to potentially cause exceedance of the DWS until 2051 under the irrigation scenario. An IC prohibiting irrigation until 2051 would be protective of groundwater for this site.

e. Strontium-90 contamination at the 116-C-1 waste site is projected to decline below the soil PRG protective of groundwater by 2034 under an irrigation scenario. An IC prohibiting irrigation until 2034 will be protective of groundwater for this site.

bgs = below ground surface
DWS = drinking water standard
IC = institutional control
PRG = preliminary remediation goal
RTD = removal, treatment, and disposal

RTD for Waste Sites. RTD would consist of excavating contaminated soil and debris above PRGs, transporting waste to ERDF, and treating waste as necessary (e.g., by encapsulation with grout) prior to disposal. Direct contact PRGs are applicable to the upper 4.6 m (15 ft) of soil, and PRGs for the protection of groundwater and surface water are applicable throughout the depth of the vadose zone. Remediated waste sites would be backfilled with clean borrow material followed by planting and establishing native vegetation.

Under Alternatives 2 through 6, RTD would be used at the western segment of the 100-B-34 waste site. This pipeline segment contains residual Cr(VI) contamination in grout within the pipeline and possibly in underlying soil that is considered a risk for direct human contact and possible indefinite threat to leach contamination that could result in an exceedance of groundwater or surface water quality standards. RTD of this waste site would be anticipated to remove approximately 15 m^3 (20 yd^3) of contaminated material and be completed within 5 years of issuance of the remedial design/remedial action work plan. A portion of the 100-B-34 waste volume is expected to be dangerous waste. Such waste would be managed, treated, and disposed in accordance with ARARs for dangerous waste management.

Under Alternatives 4 and 6, RTD would be used for additional waste sites, as described for those alternatives below.

MNA with ICs for Groundwater. MNA would rely on natural attenuation processes, which include a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass; toxicity, mobility, or volume (TMV); or concentration of contaminants in groundwater. The primary natural attenuation processes for 100-BC groundwater COCs include dilution, dispersion, radioactive decay, sorption, and abiotic/biotic degradation. A description of MNA processes for the 100-BC-5 OU is included the 100-BC RI/FS report (DOE/RL-2010-96). MNA of groundwater would include a

monitoring component to evaluate the effectiveness of the action. This would include installation of new wells, periodic sampling, laboratory analysis, and data evaluation to assess the natural attenuation processes, rates of attenuation, and overall protectiveness.

Groundwater ICs would be used to restrict drinking water and other domestic uses of the 100-BC-5 aquifer. ICs for groundwater would be implemented until the groundwater meets PRGs for the 100-BC-5 OU (Table 8 at the end of this Proposed Plan). DOE would control well drilling through excavation permits and restrict groundwater use until the groundwater achieves levels protective of UU/UE in accordance with a remedial design/remedial action work plan approved by EPA.

Strontium-90, tritium, and TCE in groundwater would be addressed by MNA with ICs under Alternatives 2 through 6. Strontium-90 is not readily extracted from groundwater, and there are no currently available ex situ technologies that can effectively treat strontium-90 contaminated groundwater to the DWS (8 pCi/L). In situ technologies evaluated for strontium-90 groundwater contamination did not reduce remedial action timeframes and were screened out from further consideration in the 100-BC RI/FS report. Currently, tritium concentrations are below the DWS (20,000 pCi/L) and are continuing to decrease. Groundwater monitoring would be used until modeling and monitoring indicates that residual tritium no longer poses a risk to groundwater downgradient of the 118-B-1 waste site, projected to occur in 2051. TCE concentrations above the MTCA cleanup level are associated with a single well, and modeling predicts that MNA will reduce concentrations to the cleanup level within the remedial action timeframe of other groundwater contaminants.

Groundwater P&T. Under Alternatives 3 through 6, a 100-BC P&T system would be used to extract Cr(VI)-contaminated groundwater for treatment at the existing 100-KW treatment building located adjacent to 100-BC. Cr(VI) would be treated to PRGs using ex situ ion-exchange technologies, and the treated groundwater would be returned to 100-BC via an aboveground pipeline and reinjected into the 100-BC aquifer. Some strontium-90 would be co-extracted with Cr(VI), but is not expected to be removed by the treatment system. However, the modeled strontium-90 combined influent concentration to the treatment plant is below the PRG and could be reinjected. Tritium and TCE would also not be removed by the treatment system, but modeling shows that they would not be above DWSs within the system. Treated water must meet DWSs for all contaminants prior to reinjection.

The 100-KW treatment facility would be repurposed for 100-BC groundwater treatment and the treated groundwater returned to the 100-BC aquifer for reinjection. The P&T system would be designed to meet the Cr(VI) PRG for groundwater throughout the aquifer within 5 years and the Cr(VI) PRG for surface water at the shoreline within 15 years. For alternative development and evaluation, the P&T system was assumed to use a network of approximately six ***extraction wells***, four ***injection wells***, and conveyance piping to the existing 100-KW treatment building. The P&T capacity assumed for evaluation/modeling of Alternatives 3 through 6 was 1,500 L/min (400 gal/min). The actual number of wells, and their locations and pumping rates, may vary and would be determined during remedial design.

The 100-KW treatment building is located about 3.0 km (1.9 mi) east of 100-BC. The existing KW treatment system would be modified by refurbishing existing components, such as tanks and instrumentation and control hardware, and installing new, larger capacity ion-exchange systems to remove Cr(VI).

Alternative 2 – Preferred Alternative

Alternative 2 includes the elements described below.

No Action for 82 Waste Sites. Alternative 2 would use no action for the 82 waste sites that do not require action, as described above in the common elements section.

ICs for 30 Waste Sites. Alternative 2 would use ICs for 30 waste sites, as described above in the common elements section. ICs would be used to restrict excavation and prohibit irrigation at the waste sites shown in Figure 13 and listed in Table 4. ICs would be used under this alternative to prevent residential activities at six waste sites (100-B-34 [eastern segments], 116-B-5, 116-B-6A, 116-B-16, 118-B-1, and 118-B-8:4). These ICs would be maintained until decay of radioactive contamination allows for UU/UE. This is projected to occur by the year 2055, except at the 118-B-8:4 site.

Estimated capital cost: *$3.8 million*

Estimated Operations and Maintenance (O&M) cost: *$36 million*

Estimated present value (discounted): *$23 million*

Estimated time to achieve waste site cleanup (except for 118-B-8:4): *39 years for radioactive decay with ICs (shallow) and 5 years for RTD (shallow)*

Estimated time to achieve waste site cleanup (118-B-8:4): *187 years for radioactive decay with ICs (shallow)*

Estimated time to achieve groundwater PRGs: *15 years for Cr(VI), 70 years for strontium-90, and 25 years for TCE*

Estimated time to achieve Cr(VI) surface water PRG: *60 years*

The IC to prevent residential activities at the 118-B-8:4 waste site would extend until the year 2203. The 118-B-8:4 waste site is associated with soil around the former B Reactor fuel storage basin. The basin has been drained and is managed as part of the B Reactor museum. Radiological soil contamination at the 118-B-8:4 waste site is above PRGs at a depth of 3.8 to 4.1 m (12.5 to 13.4 ft) bgs, but is not above PRGs from the ground surface to 3.8 m (12.5 ft) bgs. As a result, no risk to recreational users would occur through recreational use at the B Reactor museum.

Deep excavation ICs would be used under this alternative to restrict excavation at 29 waste sites, shown in Figure 13. Table 4 identifies the 29 deep waste sites and the year when radioactive decay is projected to achieve PRGs and ICs can be removed.

Soil contamination at the 116-C-1 and 118-B-1 waste sites potentially poses a threat to leach strontium-90 and tritium, respectively, and result in an exceedance of groundwater PRGs, but only under an irrigation land-use scenario. Under Alternative 2, an IC preventing irrigation is required at the 116-C-1 and 118-B-1 waste sites until the radionuclides will have decayed below a level that could cause a potential exceedance of groundwater PRGs (2034 for 116-C-1 and 2051 for 118-B-1).

RTD for One Waste Site. Alternative 2 would use RTD for the western pipeline segment of the 100-B-34 waste site, as described above in the common elements section.

MNA with ICs for Groundwater. Alternative 2 would employ MNA for Cr(VI), strontium-90, tritium, and TCE in groundwater, as described above in the common elements section. ICs would also be implemented as described in the common elements section. Modeling shows that the Cr(VI) PRG in groundwater (48 µg/L) is estimated to be achieved in 15 years, and the surface water PRG (10 µg/L) is estimated to be achieved in 60 years. Figure 14 and Figure 15 show the simulated attenuation Cr(VI) groundwater contamination over these 60 years. It is estimated that the strontium-90 PRG in groundwater (8 pCi/L) will be achieved in 70 years and that the TCE PRG in groundwater (4 µg/L) will be achieved in 25 years.

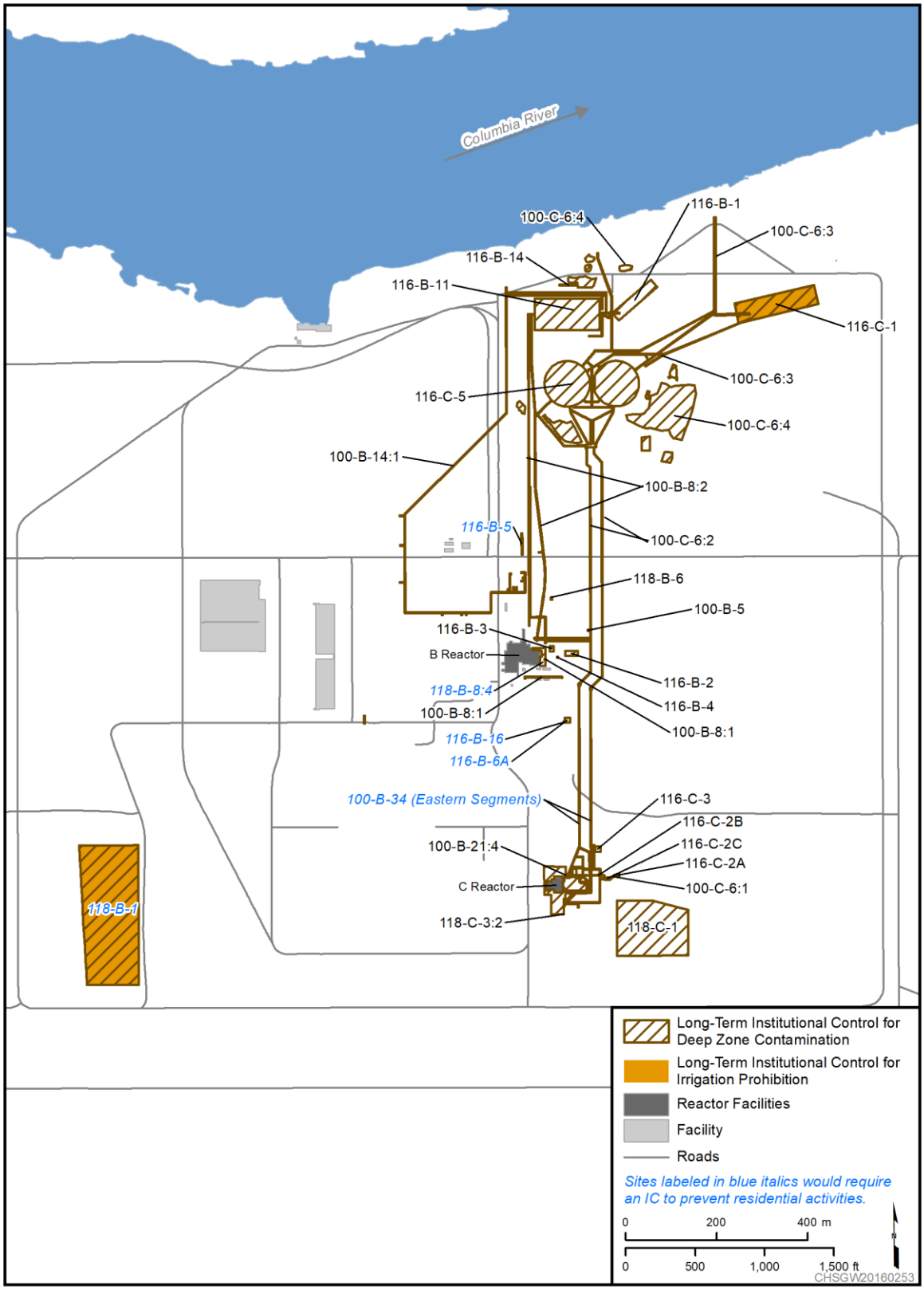


Figure 13. 100-BC Waste Sites with ICs Under Alternative 2 (the Preferred Alternative)

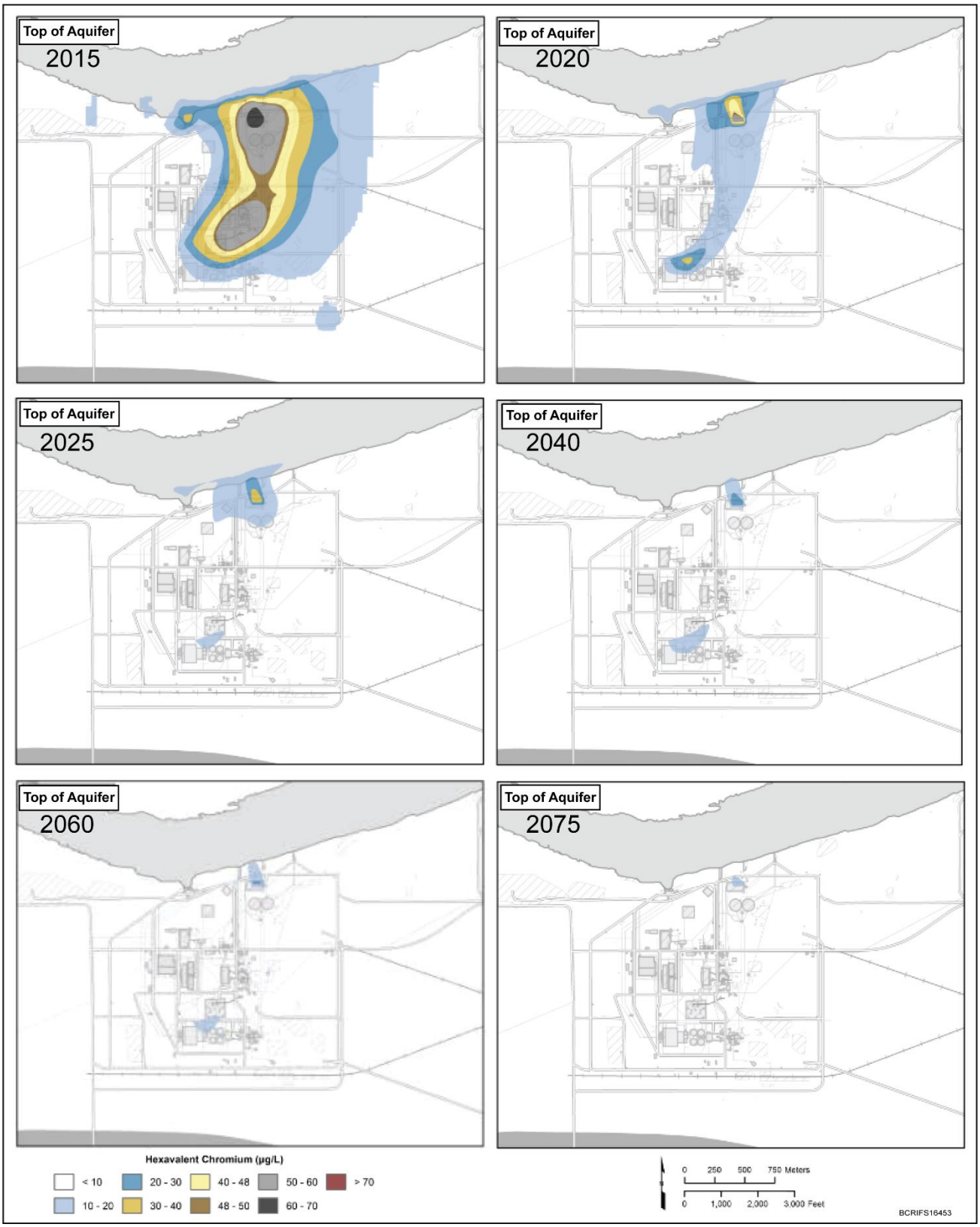


Figure 14. Simulated Attenuation of Cr(VI) Groundwater Contamination (Top of Aquifer)

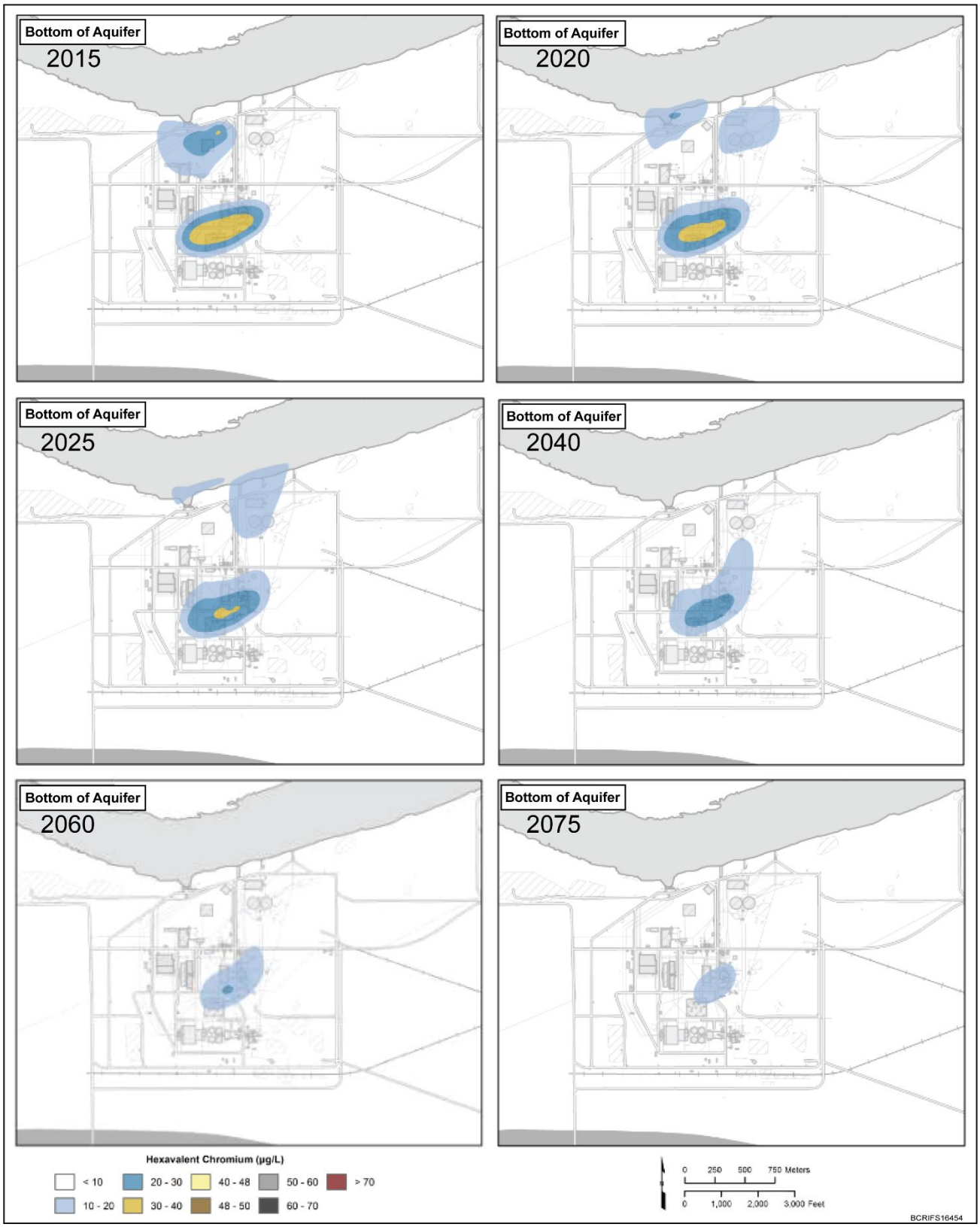


Figure 15. Simulated Attenuation of Cr(VI) Groundwater Contamination (Bottom of Aquifer)

Alternative 3

Alternative 3 would employ the same approach for waste sites as used in Alternative 2 but would utilize P&T for Cr(VI)-contaminated groundwater in addition to MNA with ICs.

No Action for 82 Waste Sites. Alternative 3 would use no action for the 82 waste sites that do not require action, as described for the common elements.

ICs for 30 Waste Sites. Alternative 3 would use ICs for waste sites as described for Alternative 2.

RTD for One Waste Site. Alternative 3 would use RTD for the western pipeline segment of the 100-B-34 waste site, as described above in the common elements section.

Groundwater P&T. Alternative 3 would use groundwater P&T for Cr(VI)-contaminated groundwater, as described for the common elements. The FS assumed that the P&T system would operate for up to 40 years, with periodic optimization as the Cr(VI) plume footprints and extraction well concentrations decline. The P&T system would be designed to meet the Cr(VI) PRG in groundwater (48 µg/L) in 5 years and the surface water PRG (10 µg/L) in 15 years. Although the surface water PRG would be achieved in 15 years, groundwater modeling results indicate that periodic P&T operation for an additional 25 years may be necessary to ensure Cr(VI) concentrations remain below 10 µg/L at the shoreline. Groundwater monitoring, which includes installation of new wells, periodic sampling, laboratory analysis, and data evaluation, would be performed to assess progress toward PRGs and overall protectiveness, and to determine if additional P&T is necessary.

MNA with ICs for Groundwater. Under Alternative 3, MNA would be used to remediate Cr(VI)-contaminated groundwater that is located further inland and outside the influence of P&T operation, as well as for strontium-90, tritium, and TCE contaminated groundwater, as described for the common elements. ICs would also be implemented as described above in the common elements section. Although some strontium-90 would be co-extracted with Cr(VI), strontium-90 is not expected to be removed by the ion-exchange systems that target Cr(VI). Modeling shows that strontium-90 is estimated to meet the PRG in groundwater (8 pCi/L) in 70 years, and TCE is estimated to meet the PRG in groundwater (4 µg/L) in 25 years.

Estimated capital cost: *$32 million*

Estimated O&M cost: *$177 million*

Estimated present value (discounted): *$160 million*

Estimated time to achieve waste site cleanup (except for 118-B-8:4): *39 years for radioactive decay with ICs (shallow) and 5 years for RTD (shallow)*

Estimated time to achieve waste site cleanup (118-B-8:4): *187 years for radioactive decay with ICs (shallow)*

Estimated time to achieve groundwater PRGs: *5 years for Cr(VI), 70 years for strontium-90, and 25 years for TCE*

Estimated time to achieve Cr(VI) surface water PRG: *15 years to achieve/40 total years of treatment to ensure standard is not exceeded*

Alternative 4

Alternative 4 would employ the same approach for groundwater used in Alternative 3 and the same approach for waste sites as Alternative 2, except that it would utilize RTD at additional waste sites.

No Action for 82 Waste Sites. Alternative 4 would use no action for the 82 waste sites that do not require action, as described for the common elements.

ICs for 29 Waste Sites. Alternative 4 would use the same ICs as described for Alternative 2 except for sites where additional RTD would be used. Following RTD, no ICs would be used at the 116-C-1 waste site and ICs preventing residential activities would not be used at the 100-B-34 (eastern segments), 116-B-6A, 116-B-16, or 118-B-8:4 waste sites.

RTD for Five Waste Sites. Alternative 4 would use RTD for the western pipeline segment of the 100-B-34 waste site, as described for the common elements. Alternative 4 would additionally use RTD for shallow contamination at the eastern pipeline segments of the 100-B-34 waste site, as well as for the 116-B-6A, 116-B-16, and 118-B-8:4 waste sites to reduce the overall timeframe to achieve waste site cleanup as compared to Alternative 2. RTD would also be employed for the 116-C-1 waste site to remove deep contamination that poses a strontium-90 leaching threat to groundwater quality. RTD of the waste sites would be completed within 5 years of issuance of the remedial design/remedial action work plan for shallow sites and 10 years for the deep site. The FS estimated 78,000 m^3 (102,00 yd^3) of contaminated material would be removed, with excavation of over 96,000 m^3 (125,00 yd^3) additional overburden and layback material.

P&T and MNA with ICs for Groundwater. Alternative 4 would use the same approach for groundwater as described in Alternative 3.

Estimated capital cost: *$92 million*

Estimated O&M cost: *$177 million*

Estimated present value (discounted): *$220 million*

Estimated time to achieve waste site cleanup: *35 years for radioactive decay with ICs and RTD (shallow) and 10 years for RTD (deep)*

Estimated time to achieve groundwater PRGs: *5 years for Cr(VI), 70 years for strontium-90, and 25 years for TCE*

Estimated time to achieve Cr(VI) surface water PRGs: *15 years to achieve/40 total years of treatment to ensure standard is not exceeded*

Alternative 5

Alternative 5 would employ the same approach for waste sites used in Alternatives 2 and 3, but would utilize Cr(VI) source treatment in addition to P&T and MNA with ICs for groundwater as in Alternative 3.

***Estimated capital cost**: $34 million*

***Estimated O&M cost:** $89 million*

***Estimated present value (discounted):** $100 million*

***Estimated time to achieve waste site cleanup (except for 118-B-8:4):** 39 years for radioactive decay with ICs (shallow) and 5 years for RTD (shallow)*

***Estimated time to achieve waste site cleanup (118-B-8:4):** 187 years for radioactive decay with ICs (shallow)*

***Estimated time to achieve groundwater PRGs:** 5 years for Cr(VI), 70 years for strontium-90, and 25 years for TCE*

***Estimated time to achieve Cr(VI) surface water PRGs:** 15 years*

No Action for 82 Waste Sites. Alternative 5 would use no action for 82 waste sites, as described above in the common elements section.

ICs for 30 Waste Sites. Alternative 5 would use the same ICs for waste sites as described for Alternative 2.

RTD for One Waste Site. Alternative 5 would use RTD for the western pipeline segment of the 100-B-34 waste site, as described for the common elements.

Cr(VI) Source Treatment with P&T. Alternative 5 would use P&T for Cr(VI)-contaminated groundwater as described above in the common elements section, supplemented with ***in situ treatment***. A chemical called calcium polysulfide (CPS) would be injected into the soil to help reduce Cr(VI) to Cr(III), which is less toxic and less mobile. This supplement to the P&T technology would be expected to reduce the time required for P&T to 15 years versus 40 years in Alternatives 3 and 4 and 60 years in Alternative 2 (the preferred alternative). The in situ reduction treatment would be performed during the first year of P&T operation.

In situ reduction for Cr(VI) would be applied to an approximate 0.5 ha (1.3 ac) area for deep Cr(VI) treatment. This area was determined based on groundwater monitoring and modeling that indicates a source of continuing groundwater contamination at the location. Waste sites in the vicinity have all been remediated. This alternative assumes that the CPS solution would be injected to depths between 9.0 and 12.5 m (30 and 41 ft) bgs using 24 temporary wells. The volume of CPS solution needed is estimated to be 57,700 L (15,000 gal). The actual number of injection points, depths, and volume of CPS required may differ from this estimate and would be determined during remedial design. Additionally, while the CPS injection would transform Cr(VI) to Cr(III), it could also mobilize other oxidation-reduction-sensitive metals such as iron and manganese, which could create new zones of potential groundwater contamination. These would be captured and treated, if necessary, by the groundwater extraction and ion-exchange treatment system described above in the common elements section. Evaluation of this alternative assumed operation of the P&T system would continue for 15 years, with periodic optimization.

MNA with ICs for Groundwater. Alternative 5 would use the same approach for MNA with ICs for groundwater as described in Alternative 3.

Alternative 6

Alternative 6 is the most aggressive remedial alternative. It would employ the same approach for waste sites used in Alternative 4 and the same approach for groundwater used in Alternative 5.

No Action for 82 Waste Sites. Alternative 6 would use no action for the 82 waste sites that do not require action, as described above in the common elements section.

ICs for 29 Waste Sites. Alternative 6 would use the same ICs for waste sites as described in Alternative 4.

RTD for Five Waste Sites. Alternative 6 would use the same approach for waste site RTD as described in Alternative 4.

Estimated capital cost: *$94 million*

Estimated O&M cost: *$88 million*

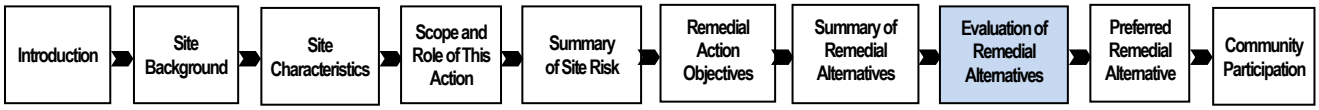
Estimated present value (discounted): *$160 million*

Estimated time to achieve waste site cleanup: *35 years for radioactive decay with ICs and RTD (shallow) and 10 years for RTD (deep)*

Estimated time to achieve groundwater PRGs: *5 years for Cr(VI), 70 years for strontium-90, and 25 years for TCE*

Estimated time to achieve Cr(VI) surface water PRGs: *15 years*

Cr(VI) Source Treatment with P&T and MNA with ICs for Groundwater. Alternative 6 would use the same approach for groundwater as described in Alternative 5.



Evaluation of Remedial Alternatives

As part of the FS, EPA and DOE evaluated each remedial alternative against the CERCLA threshold and balancing criteria set out in the NCP (40 CFR 300.430(e)(9)). Following this evaluation, EPA and DOE performed a comparative analysis to assess the overall performance of each alternative relative to the others. Figure 16 presents the nine CERCLA evaluation criteria. The nine criteria are categorized into three groups: threshold criteria, balancing criteria, and modifying criteria.

A remedial alternative must satisfy the two threshold criteria to be considered a viable alternative: (1) overall protection of human health and the environment, and (2) compliance with ARARs. The five balancing criteria allow for a comparison of major tradeoffs among the alternatives. The modifying criteria, Washington State and community acceptance, cannot be fully considered until after Tribal Nations and public comments are received on this Proposed Plan. After completion of the formal public comment period, DOE and EPA will consider the comments received before issuing a ROD. The modifying criteria are important considerations in the final evaluation of the remedial alternatives.

The following sections describe the comparative evaluation of alternatives that was used to identify the preferred alternative presented in this Proposed Plan. More detailed information on the individual and comparative analysis of alternatives is provided in the 100-BC RI/FS report (DOE/RL-2010-96).

CERCLA Evaluation Criteria

THRESHOLD CRITERIA

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

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

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

BALANCING CRITERIA

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

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

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

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

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

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

MODIFYING CRITERIA

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

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

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

Figure 16. CERCLA Evaluation Criteria

Threshold Criteria

Overall Protection of Human Health and the Environment. Alternative 1 (No Action) proposes no remediation for any of the 112 waste sites or contaminated groundwater. This alternative is not protective of human health and the environment and therefore was not carried forward in the FS for detailed and comparative evaluation for waste sites and groundwater that pose unacceptable risk to human health and the environment. However, all alternatives have a no action component for the 82 waste sites that do not have contamination exceeding levels protective of human health and the environment.

For the waste sites in the 100-BC-1 and 100-BC-2 OUs and contaminated groundwater in the 100-BC-5 OU, Alternatives 2 through 6 are protective of human health and the environment, would achieve PRGs within a reasonable timeframe, and meet this threshold criterion. Under Alternatives 2 through 6, ICs would be used to prevent exposure to contaminated soil and groundwater until PRGs are met.

Compliance with ARARs. The ARAR identification process is based on CERCLA and the NCP (40 CFR 300), with consideration of guidance. The lead and non-lead agencies identify requirements that are applicable or relevant and appropriate to the release or remedial action at a CERCLA site (NCP; 40 CFR 300.400(g)). A complete list of identified potential ARARs is provided in the 100-BC RI/FS report (DOE/RL-2010-96), and key ARARs are identified in the summary of remedial alternatives common elements section. Alternative 1 does not require action; therefore, ARARs are not implicated. Alternatives 2 through 6 would comply with ARARs.

Balancing Criteria

Long-Term Effectiveness and Permanence. The long-term effectiveness and permanence criterion evaluates (1) the magnitude of the residual risk at the conclusion of remedial activities, and (2) the adequacy and reliability of controls that may be required to manage treatment residuals or untreated waste.

Alternatives 2 through 6 provide a comparable level of long-term effectiveness and permanence. Alternatives 2, 3, and 5 take considerably longer than other alternatives to achieve RAOs at one waste site (187 years for the 118-B-8:4 waste site). These alternatives result in a similar level of residual risk from waste sites after RAOs have been met. All employ deep excavation restriction ICs for residual radionuclide contamination. ICs have been successfully implemented at the Hanford Site through DOE/RL-2001-41 and are expected to be reliable for the foreseeable future. Radioactive decay would continue to reduce residual radionuclide concentrations at the same rate across the alternatives. All of these alternatives also result in the same level of residual groundwater risk and aquifer restoration.

Reduction of Toxicity, Mobility, or Volume Through Treatment. This criterion assesses the degree to which alternatives employ recycling or treatment that reduces the TMV, including how treatment is used to treat principal threats. None of the alternatives address principal threat waste because none remains in the 100-BC OUs.

For the waste sites, Alternatives 2 through 6 would potentially use treatment to meet land disposal requirements at ERDF. The alternatives that involve more RTD have the potential for more treatment, although the waste volumes that would be treated are not expected to be significant in any of the alternatives.

For groundwater, Alternatives 2 through 6 employ MNA with ICs for strontium-90, tritium, and TCE; however, Alternatives 5 and 6 reduce TMV through treatment by using P&T in combination with Cr(VI) source treatment. Alternatives 3 and 4 use P&T but do not include a Cr(VI) source treatment component. Alternative 2 does not employ treatment for Cr(VI).

Short-Term Effectiveness. This criterion evaluates the estimated timeframe to achieve PRGs and the potential adverse effects that each alternative may pose to the community, workers, and the environment during the remedy construction and implementation phases.

For the waste sites, Alternatives 4 and 6, which use more extensive RTD, would achieve the PRGs in the shortest timeframe, with remedial action completed in 5 to 10 years of remedial action work plan approval at a majority of the waste sites and at all sites within 35 years. Under Alternatives 2, 3, and 5, which rely more on radioactive decay and ICs, PRGs would be achieved in timeframes between 5 years and 39 years, except at the 118-B-8:4 waste site, which requires an estimated 187 years before residual radionuclide concentrations decay to PRGs based on a residential scenario. However, contamination at the 118-B-8:4 waste site is located below the surface and is not accessible to a casual recreational user. ICs would be used to manage potential exposure at 29 other waste sites during the remedial action timeframe. Conditions at these waste sites are also protective of a casual recreational user. Current conditions at the remaining 82 waste sites are currently protective of UU/UE.

While the remedial action timeframes for Alternatives 4 and 6 are somewhat shorter for several waste sites and notably shorter for the 118-B-8:4 waste site, these alternatives would pose greater risks to workers and the environment. Remediation work at the Hanford Site follows health and safety plans and employs engineering controls and personal protective equipment to minimize risks to workers. Large volumes of contaminated soil that would be handled and transported to ERDF would require extensive diesel fuel use in heavy equipment (e.g., excavators and haul trucks) and would generate large amounts of carbon dioxide and other environmental pollutants.

Table 5 presents the estimated remedial action timeframes for the groundwater component of Alternatives 2 through 6. While the P&T component in Alternatives 3 through 6 achieves the Cr(VI) PRG sooner, restoration of the aquifer does not occur until the strontium-90 PRG is achieved in 70 years for Alternatives 2 through 6. Alternatives 3 and 4 provide greater protection for the community and the environment than Alternative 2 by more rapidly reducing Cr(VI) concentrations in groundwater along the 100-BC shoreline, where there is greater potential for exposure. Alternatives 5 and 6 reduce Cr(VI) concentrations in groundwater along the 100-BC shoreline more rapidly than Alternatives 2, 3, and 4. However, Alternatives 5 and 6 have the greatest potential for worker risk from chemical and physical hazards associated with CPS mixing and injection for Cr(VI) source treatment. Alternative 2, which poses the least risk to workers, poses greater risk to the community and the environment because Cr(VI) concentrations above 10 µg/L would persist along the 100-BC shoreline for an estimated 60 years to complete the MNA remedy. Alternatives 3 through 6 reduce the length of shoreline with Cr(VI) concentrations above 10 µg/L from an estimated 1,800 m (5,900 ft) to <200 m (650 ft) in 5 years, whereas Alternative 2 requires about 15 years to achieve a similar level of shoreline protection. Although the 10 µg/L state surface water quality standard (WAC 173-201A) is exceeded in the hyporheic zone, based on the findings of the ecological risk assessment presented in the 100-BC RI/FS report (DOE/RL-2010-96), no unacceptable Cr(VI) risk from 100-BC-5 OU groundwater discharges to the Columbia River was identified under current conditions.

Based on the collective waste site and groundwater evaluation, Alternatives 3 and 5 provide the highest level of short-term effectiveness. ICs for the waste sites in combination with P&T for Cr(VI) contaminated groundwater provides a high level of protection for workers, the community, and the environment from exposure during the remedial actions. Alternatives 2, 4, and 6 provide equivalent short-term protection but less than Alternatives 3 and 5. Alternative 2 would require a longer remedy implementation timeframe for Cr(VI)-contaminated groundwater and Alternatives 4 and 6 would have increased worker risk associated with deep RTD. The Cr(VI) source treatment component of Alternative 6 also has the potential to mobilize other metals and expose workers to CPS during injection operations.

Table 5. Comparison of Remedial Action Maximum Timeframe Estimates for 100-BC-5 Groundwater Operable Unit (Years)

COC	PRG	Alternative 1 – No Action	Alternative 2 – MNA with ICs	Alternatives 3 and 4 – P&T and MNA with ICs	Alternatives 5 and 6 – Cr(VI) Source Treatment with P&T, and MNA with ICs
Cr(VI)	10 µg/L[a]	60	60	40[b]	15
	48 µg/L[a]	15	15	5	5
TCE	4 µg/L	25	25	25	25
Strontium-90	8 pCi/L	70	70	70	70
Tritium	20,000 pCi/L	N/A[c]	N/A[c]	N/A[c]	N/A[c]

Note: The remedial action timeframe estimates (in years) are based on modeling as presented in DOE/RL-2010-96, *Remedial Investigation/Feasibility Study for 100-BC-1, 100-BC-2, and 100-BC-5 Operable Units*.

a. The PRGs for Cr(VI) are 10 µg/L where groundwater discharges to surface water and 48 µg/L in the upland groundwater.

b. It is estimated that the Cr(VI) PRG in groundwater (48 µg/L) will be achieved in 5 years, while the surface water PRG (10 µg/L) will be achieved in 15 years. Although the surface water PRG will be achieved in 15 years, groundwater modeling results indicate that periodic P&T operation may be necessary to address rebound of Cr(VI) concentrations for an additional 25 years.

c. Tritium has not exceeded the groundwater PRG since 2012. MNA for tritium would be performed to assure protectiveness and confirm current understanding of the nature and extent of groundwater contamination and potential risk.

COC = contaminant of concern
Cr(VI) = hexavalent chromium
IC = institutional control
MNA = monitored natural attenuation
N/A = not applicable
P&T = pump and treat
PRG = preliminary remediation goal
TCE = trichloroethene

Implementability. The criterion of implementability is used to compare the ease or difficulty of implementing the alternatives by considering technical and administrative feasibility and the availability of services and materials required to implement the alternative.

The use of ICs for 30 waste sites and MNA and a groundwater use restriction IC for contaminated groundwater for Alternative 2 is readily implementable. Alternative 2 also includes shallow RTD for one waste site that is not expected to pose technical or administrative difficulty. Necessary services and materials are readily available, including ERDF as a disposal location for RTD waste. Alternative 3 has additional implementation considerations beyond those for Alternative 2 associated with 40 years of P&T operations. Alternatives 4, 5, and 6 have additional implementation considerations beyond those for Alternative 3 because of the more extensive RTD component (Alternatives 4 and 6) and 15 years of P&T with Cr(VI) source treatment (Alternatives 5 and 6). These alternatives would require larger and long-term resource commitments and there is less experience at the Hanford Site for in situ Cr(VI) source treatment at the scale required.

Cost. Alternative 2 has the lowest cost, with a total estimated present value cost of $23 million. The four remaining alternatives have costs that are significantly higher, ranging from $100 million for Alternative 5 to $220 million for Alternative 4.

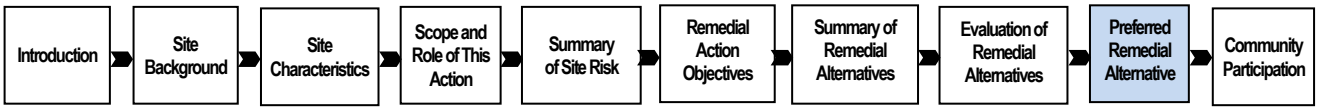
A majority of this cost differential is attributed to the groundwater component and the high annual cost of P&T operations and maintenance that will be incurred for 40 years under Alternatives 3 and 4, and 15 years under Alternatives 5 and 6. The cost for construction of the extraction wells, injection wells, piping, modification and refurbishment of the existing 100-KW treatment facility, and operation of the P&T system under Alternatives 3

through 6 is disproportionate to the level of risk reduction achieved based on the findings of the human health and ecological risk assessments in the 100-BC RI/FS report (DOE/RL-2010-96). Additionally, P&T for Cr(VI) under Alternatives 3 through 6 does not restore the aquifer to its maximum beneficial use (e.g., drinking water) any sooner than Alternative 2 because beneficial use is not restored until the strontium-90 PRG is achieved, which does not occur for 70 years under all alternatives.

Modifying Criteria

Input received to date from the Hanford Advisory Board and the Yakama Nation have been considered in the development of this Proposed Plan. However, state and community acceptance (the modifying criteria) will be fully evaluated in the ROD after considering comments from the Tribal Nations and the public on this Proposed Plan, and any state concerns will be assessed. In the final balancing of tradeoffs between alternatives upon which the final remedy selection is based, modifying and balancing criteria are both important.

Input received to date has included concerns with the use of longer term ICs for waste sites and groundwater. There were also stated preferences for active remediation, including RTD of deeper soil and P&T for Cr(VI) in groundwater.



Preferred Remedial Alternative

Alternative 2 is the preferred alternative and consists of the following components:

- No action at 82 waste sites
- ICs to prevent residential activities at six waste sites
- ICs to restrict deep excavation and drilling at 29 waste sites
- ICs to prevent irrigation at two waste sites
- RTD at one waste site
- MNA and ICs for groundwater COCs

This alternative is recommended because it achieves protection of human health and the environment; satisfies ARARs within a reasonable timeframe; and compared to the other alternatives, provides the best balance of tradeoffs under the balancing criteria.

Alternative 2 protects human health through ICs until radioactive decay reduces COC concentrations to PRGs. At the 116-C-1, 118-B-1, 116-B-5, and 116-B-6A/116-B-16 waste sites, PRGs would be achieved within 35 years (year 2051). At the 100-B-34 (eastern segments) and 118-B-8:4 waste sites, PRGs would be achieved in timeframes of 39 years (year 2055) and 187 years (year 2203), respectively. RTD is used at one waste site (100-B-34 [western segment]) to remove shallow Cr(VI) contamination. This is accomplished using standard construction practices for excavation and secure transport of materials to ERDF, treatment as necessary to meet any applicable or relevant and appropriate land disposal restrictions, and disposal of the material in ERDF, a secure environment. Conditions currently allow for UU/UE at 82 waste sites and are currently protective of the public at all waste sites, including during B Reactor Museum tours. Contamination at the 100-B-34 and 118-B-8:4 waste sites is located below the surface and is not accessible to a casual recreational user, but needs ICs until it meets PRGs based on the residential scenario. RTD activities under this alternative would be expected to have minimal impact on tours, and any controls to maintain protectiveness during tours would be addressed during planning and scheduling, including coordination with the National Park Service.

Specific waste site ICs that would be implemented under Alternative 2 include an irrigation IC at the 116-C-1 and 118-B-1 waste sites to protect groundwater; and a shallow excavation restriction IC at the 100-B-34 (eastern segments), 118-B-1, 118-B-8:4, 116-B-5, 116-B-6A, and 116-B-16 waste sites (Table 4). Exposure to deep contamination (below 4.6 m [15 ft] bgs) is not reasonably foreseeable as part of the future land use, but a deep excavation restriction IC will also be implemented at the 29 waste sites with deep radionuclide contamination above PRGs. The excavation restriction ICs meet RAOs #4, #5, and #6 for preventing unacceptable risk to human health, while the irrigation IC meets RAO #3 by preventing migration and/or leaching of residual contaminants to groundwater and surface water. Table 3 lists the waste sites in the 100-BC-1 and 100-BC-2 OUs and identifies how each would be specifically addressed under the preferred alternative.

Alternative 2 achieves PRGs for groundwater through MNA and meets RAOs #1, #2, and #7. Implementation of Alternative 2 includes groundwater monitoring (installation of new wells, periodic sampling, laboratory analysis, and data evaluation) to assess the natural attenuation processes, rates of attenuation, and overall protectiveness. Under Alternative 2, human health is protected by restricting groundwater use through ICs until PRGs are met. Groundwater PRGs for drinking water use for Cr(VI) (48 µg/L), TCE (4 µg/L), and strontium-90 (8 pCi/L) will be achieved in approximately 15, 25, and 70 years, respectively. The surface water PRG for Cr(VI) (10 µg/L) will be achieved in approximately 60 years. Although Cr(VI) concentrations in river gravel pore water exceed the surface water PRG, there is no unacceptable ecological risk.

Groundwater with strontium-90 concentrations above the 8 pCi/L PRG that upwells through the river bottom does not pose a threat to recreational users because there is limited potential for direct contact and, if present, concentrations are rapidly reduced upon mixing with the overlying surface water. Groundwater discharges with strontium-90 contamination do not pose a threat to aquatic receptors in the near-shore area or within the Columbia River because all strontium-90 concentrations are well below the lowest risk-based concentration for aquatic and riparian animals (278 pCi/L) (DOE-STD-1153-2002).

For groundwater, Alternatives 3 through 6 do not provide meaningful additional risk reduction relative to the additional $77 million to $197 million total cost associated with the alternatives. Aquifer restoration would not occur until the strontium-90 PRG is achieved. The time to achieve the strontium-90 PRG in the aquifer is the same in Alternative 2 as it is for Alternatives 3 through 6.

DOE believes that the preferred alternative meets the threshold criteria and provides the best balance of tradeoffs among the other alternatives with respect to the balancing criteria. DOE expects the preferred alternative to satisfy the following statutory requirements of CERCLA Section 121(b): (1) be protective of human health and the environment, (2) comply with ARARs (or justify a waiver), (3) be cost effective, (4) use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable, and (5) satisfy the preference for treatment as a principal element, or explain why the preference for treatment will not be met.

The preferred alternative could be modified or another alternative selected through consideration of state acceptance and Tribal and public comments on this Proposed Plan. After public comment, a CERCLA ROD will be issued, which will identify the selected remedy. A responsiveness summary containing agency responses to significant comments received during the public comment period will be made available with issuance of the ROD.

State Acceptance

EPA is the lead regulatory agency for 100-BC. Ecology is the non-lead regulatory agency and provides input to EPA on cleanup decisions. Ecology will determine if it concurs with the preferred alternative (Alternative 2) after the public comment period on this proposed plan.

Community Participation

The Administrative Record for this proposed remedial action decision is available for review at http://pdw.hanford.gov/. This Proposed Plan and the 100-BC RI/FS report (DOE/RL-2010-96) are available at the repositories listed to the right.

The comment period for this Proposed Plan extends from October 7 through November 6, 2019. Comments on the preferred alternatives, other alternatives, or any element of this Proposed Plan or support information will be accepted through November 6, 2019. Please send comments to the following:

Your Voice Matters

Public input is a key element in the CERCLA decision-making process. The Tribal Nations and the public are encouraged to read and provide comments on the alternatives presented in this Proposed Plan, including the preferred alternative.

Mail: Paula Call
U.S. Department of Energy, Richland Operations Office
P.O. Box 550, MSIN H5-20
Richland, WA 99352

Email: 100BCAreaPP@rl.gov

To request a meeting, please contact Paula Call at 509-376-2048 by October 15, 2019.

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

Hanford Public Information Repository Locations

Administrative Record and Public Information Repository

Richland
2440 Stevens Center Place
Room 1101, Richland, WA 99352
Phone: (509) 376-2530
Website: http://pdw.hanford.gov/

Portland
Portland State University
Branford P. Millar Library
1875 SW Park Avenue
Portland, OR 97207-1151
Phone: (503) 725-4128
Map: http://www.pdx.edu/map.html

Seattle
University of Washington
Suzzallo Library
Government Publications Department
4000 15th Ave NE
Seattle, WA 98195-2900
Phone: (206) 685-3130
Map: http://www.washington.edu/maps/

Richland
Washington State University, Tri-Cities
Consolidated Information Center
2770 Crimson Way, Room 101L
Richland, WA 99354
Phone: (509) 372-7443
Map: http://reading-room.labworks.org/Directions.aspx

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

Preliminary Remediation Goals for Preferred Alternative

Table 6. 100-BC-1 and 100-BC-2 Operable Units Direct Contact Soil Preliminary Remediation Goals for Protection of Human Health (≤4.6 m [15 ft] bgs)

Contaminant	Hanford Site Background Concentration*	PRG	Basis
Radionuclides (pCi/g)			
Carbon-14	—	81	Direct contact residential scenario (1×10^{-4} ELCR) (DOE/RL-2010-96)
Cesium-137	1.1	4.4	
Cobalt-60	0.0084	3.1	
Europium-152	—	3.6	
Europium-154	0.033	4.5	
Nickel-63	—	594	
Strontium-90	0.18	2.3	
Tritium	—	624	
Chemicals (mg/kg)			
Cr(VI)	—	240	Direct contact, MTCA Method B

References: DOE/RL-92-24, *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes*.
DOE/RL-96-12, *Hanford Site Background: Part 2, Soil Background for Radionuclides*.
DOE/RL-2010-96, *Remedial Investigation/Feasibility Study for the 100-BC-1, 100-BC-2, and 100-BC-5 Operable Units*.
ECF-HANFORD-11-0038, *Soil Background Data for Interim Use at the Hanford Site*.
* Hanford Site background values for radionuclides are provided in DOE/RL-96-12. Hanford Site background values for nonradionuclides are provided in DOE/RL-92-24 and ECF-HANFORD-11-0038.

bgs = below ground surface
Cr(VI) = hexavalent chromium
ELCR = excess lifetime cancer risk
MTCA = "Model Toxics Control Act—Cleanup" (WAC 173-340)
PRG = preliminary remediation goal

Table 7. 100-BC-1 and 100- BC-2 Operable Units Soil Preliminary Remediation Goals for Protection of Groundwater and Surface Water

Contaminant	Preliminary Remediation Goal (Ground Surface to Water Table)[a,b]
	Residential Irrigation
Radionuclides $\left(\frac{pCi*m}{g}\right)$	
Strontium-90	2,120
Tritium	60
Chemicals (mg/kg)	
Cr(VI)	2.0

a. Soil preliminary remediation goals protective of groundwater and surface water are provided on a unit-length basis (per meter) for radionuclides. To apply these preliminary remediation goals, divide the listed value by a representative length (in meters) across the waste site decision unit in the general direction of groundwater flow to obtain the value for evaluation use.

b. Preliminary remediation goals for groundwater and surface water protection for carbon-14, cesium-137, cobalt-60, europium-152, europium-154, and nickel-63 are not identified because model predictions indicate that there is no breakthrough of these contaminants within 1,000 years; therefore, they will not impact groundwater or surface water at levels that pose a risk.

bgs = below ground surface
Cr(VI) = hexavalent chromium

Table 8. Preliminary Remediation Goals for 100-BC-5 Operable Unit Groundwater

COC	Units	Preliminary Remediation Goal	Basis
Strontium-90	pCi/L	8	DWS
Tritium		20,000	
Cr(VI)*	µg/L	10/48	Washington State freshwater criterion/ MTCA groundwater cleanup level
TCE		4	MTCA groundwater cleanup level

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

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

MTCA groundwater cleanup levels are from WAC 173-340-720, "Model Toxics Control Act—Cleanup," "Groundwater Cleanup Standards."

* Preliminary remediation goals for Cr(VI) are 48 µg/L in the upland groundwater and 10 µg/L where groundwater discharges to surface water.

COC = contaminant of concern
Cr(VI) = hexavalent chromium
DWS = drinking water standard
MTCA = "Model Toxics Control Act—Cleanup"
TCE = trichloroethene

Acronym List

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
COPC	contaminant of potential concern
CPS	calcium polysulfide
CRC	Columbia River Component
Cr(III)	trivalent chromium
Cr(VI)	hexavalent chromium
DOE	U.S. Department of Energy
DWS	drinking water standard
Ecology	Washington State Department of Ecology
ELCR	excess lifetime cancer risk
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ERDF	Environmental Restoration Disposal Facility
ESD	explanation of significant difference
FS	feasibility study
HRNM	Hanford Reach National Monument
IC	institutional control
MNA	monitored natural attenuation
MTCA	"Model Toxics Control Act—Cleanup" (WAC 173-340)
NCP	National Contingency Plan ("National Oil and Hazardous Substances Pollution Contingency Plan" [40 CFR 300])
O&M	operations and maintenance
OU	operable unit
P&T	pump and treat
pCi/g	picocuries per gram
pCi/L	picocuries per liter
PRG	preliminary remediation goal
RAO	remedial action objective

RCBRA	River Corridor Baseline Risk Assessment
RCRA	*Resource Conservation and Recovery Act of 1976*
RI	remedial investigation
ROD	Record of Decision
ROM	rough order of magnitude
RTD	removal, treatment, and disposal
TCE	trichloroethene
TMV	toxicity, mobility, or volume
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order* (Ecology et al., 1989a)
Tri-Party Agreement Agencies	U.S. Department of Energy, U.S. Environmental Protection Agency, and Washington State Department of Ecology
UU/UE	unlimited use/unrestricted exposure
USFWS	U.S. Fish and Wildlife Service

Glossary

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

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

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

Aquitard: A zone within an aquifer that does not yield water easily.

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

***Code of Federal Regulations*:** The codification of the general and permanent rules published in the *Federal Register* by the executive departments and agencies of the federal government. It is divided into 50 titles that represent broad areas subject to federal regulation. Each volume of the Code is updated once each calendar year.

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

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

Contaminant of ecological concern: A contaminant that has the potential to pose possible ecological risk at a site.

Contaminant of potential concern (COPC): Hazardous substances, pollutants, or contaminants that have been found, or are likely to be present, that could potentially represent risk to human health and the environment. The effects depend upon the amount of the contaminant present, the toxicity of the contaminant, and the way the contaminant is or might be contacted. COPCs are evaluated to develop a list of contaminants that should be considered for remediation and to screen out contaminants that are unlikely to be a threat to human health and the environment.

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

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

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

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

Exposure point concentration (EPC): An exposure point concentration is the value that represents a conservative estimate of the chemical concentration available from a particular medium (e.g., soil or groundwater) or route of exposure (e.g., ingestion or inhalation).

Extraction well: A well designed to pump groundwater from the aquifer to the surface.

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

Hazard index: The sum of more than one hazard quotient for multiple substances and/or multiple exposure pathways. The hazard index is calculated separately for chronic, subchronic, and shorter duration exposures. Potential noncarcinogenic (systemic) effects are characterized by comparing projected intakes of chemicals to toxicity values (i.e., reference doses). The numerical risk or hazard quotient estimates that result are a ratio. The ratio of the intake over the reference dose (hazard index) is compared to unity (1.0). If the quotient is less than 1, then the systemic effects are assumed not to be of concern; if the hazard quotient is greater than 1, then the systemic effects are assumed to be of concern. The hazard index is the sum of the hazard quotients. The hazard index is calculated by summing hazard quotients for each chemical across all exposure routes.

In situ treatment: In situ treatment includes methods to separate and remove or degrade contaminants in place. Methods of in situ degradation generally involve adding agents to soil or groundwater (via injection wells or permeable barriers) that facilitate chemical or biological changes that reduce contaminant mobility, toxicity, and/or concentration. Chemical reduction is an in situ treatment technology.

Injection well: A groundwater well designed to inject water into an aquifer.

Institutional control (IC): Nonengineered instruments, such as administrative and legal controls, that help to minimize the potential for exposure to contamination and/or to protect the integrity of a response action.

Interim action: Implemented before final remedy selection designed to address risks to human health and the environment.

Interim safe storage: It consists of ensuring that facility hazardous substances are and will remain safe and secure. Used to reduce the footprint of the reactor building to the primary shield wall, while sealing all openings such that the facility is in an environmentally safe and secure condition while awaiting disposition.

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

Monitored natural attenuation (MNA): MNA refers to the reliance on natural attenuation processes (within the context of a carefully controlled and monitored cleanup approach) to achieve site-specific remedial objectives within a timeframe that is reasonable compared to other methods. The natural attenuation processes

include a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, TMV, or concentration of contaminants in soil and groundwater. These in situ processes include biodegradation; dispersion; dilution; sorption; volatilization; and chemical or biological stabilization, transformation, or destruction of contaminants.

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

No action: Sites that can be released for unrestricted land use because they pose no unacceptable risk to human health and the environment. A No Action alternative is required to be considered under CERCLA in making a remedial action selection.

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

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

Preferred alternative: The remedial action proposed after an evaluation of a range of viable alternatives. The preferred alternative must be protective of human health and the environment.

Preliminary remediation goal (PRG): PRGs are established during the FS, are based on readily available information, such as chemical specific ARARs or other reliable information and are modified as more information becomes available during the RI/FS.

Principal threat waste: are those source material considered to be highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to human health and the environment should exposure occur.

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

Pump and treat (P&T): The extraction of contaminated groundwater and treatment of contaminants with one or more technologies.

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

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

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

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

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

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

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

Tri-Party Agreement: The Tri-Parties signed the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al., 1989a) on May 15, 1989. The general purposes of the agreement are as follows: to ensure that environmental impacts are thoroughly investigated and appropriate response actions taken as necessary to protect human health and the environment; to provide a framework for permitting of treatment, storage, and disposal units; to ensure compliance with the *Resource Conservation and Recovery Act of 1976* (RCRA) and RCW 70.105D for treatment, storage, and disposal units; to establish a procedural framework and schedule for developing, prioritizing, implementing, and monitoring appropriate response actions at the Hanford Site in accordance with CERCLA, the NCP, Superfund guidance and policy, and RCRA guidance and policy; and to facilitate cooperation, exchange of information, and coordinated participation of the parties in such actions.

Tri-Party Agreement Agencies: Three agencies composed of DOE, EPA, and Ecology.

Unlimited use/unrestricted exposure: The level of cleanup at which there is an acceptable level of risk for land uses.

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

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

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