

HANFORD SITE

Fifth CERCLA Five-Year Review Report



U.S. DEPARTMENT OF
ENERGY

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Cover Photo: Hanford's 100-K Area
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Fifth CERCLA Five-Year Review Report

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EXECUTIVE SUMMARY

The Hanford Site was established in 1943 to produce nuclear materials for national defense. Many production activities resulted in the disposal of wastes containing hazardous constituents and/or radioactive materials. As a result, in July 1989 the U.S. Environmental Protection Agency (EPA) placed four areas (100, 200, 300, and 1100 Areas) of the Hanford Site on the National Priorities List (NPL) pursuant to the [*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*^a](#) (CERCLA).

In anticipation of the NPL listing, the U.S. Department of Energy (DOE), EPA, and Washington State Department of Ecology (Ecology) entered into the [*Hanford Federal Facility Agreement and Consent Order*^b](#) (Ecology et al. 1989) (Tri-Party Agreement) in May 1989. This agreement established a procedural framework and schedule for developing, implementing, and monitoring [CERCLA](#) response actions on the Hanford Site. The agreement also addresses [*Resource Conservation and Recovery Act of 1976*^c](#) (RCRA) permitting, compliance, closure, post-closure care, and corrective action. The [Tri-Party Agreement](#) is a legally binding agreement between the DOE, EPA, and Ecology that establishes the guidelines and framework for cleaning up the Hanford Site. Since the Hanford Site was placed on the NPL, DOE has made considerable cleanup progress.

For waste site remedial action where hazardous substances, pollutants, or contaminants remain at the site above levels that allow for unlimited use and unrestricted exposure, [CERCLA](#) requires a review every 5 years to evaluate the implementation and performance of a remedy to determine whether the remedy is or will be protective of human health and the environment. The 5-year review requirement applies to all remedial actions selected under [CERCLA §121](#). The methods, findings, and conclusions of the 5-year reviews, including the protectiveness statements, are documented in the 5-year review reports.

The *USDOE Hanford Site First Five-Year Review Report* ([EPA 2001](#)^d) documented the results of the first Hanford Site [CERCLA](#) 5-year review, which EPA Region 10 completed in September 2000. This report covered all portions of the Hanford Site with a [CERCLA](#) decision document and covered areas that contain hazardous substances, pollutants, or contaminants that are to be remediated under [CERCLA](#).

The Second CERCLA Five-Year Review Report for the Hanford Site ([DOE/RL-2006-20](#)^e) documented the results of the second [CERCLA](#) 5-year review that DOE completed in November 2006. The report evaluated the performance of the [CERCLA](#) remedies selected in interim records of decision (ROD), including existing institutional controls in place to prevent exposure to the public and the environment.

^a*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*, 42 USC 9601 et seq. Available online at <https://www.epa.gov/laws-regulations/summary-comprehensive-environmental-response-compensation-and-liability-act>.

^bEcology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, as amended. Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington. Available online at <http://www.hanford.gov/?page=81>.

^c*Resource Conservation and Recovery Act of 1976*, 42 USC §6901 et seq. Available online at <https://www.epa.gov/rcra>.

^dEPA, 2001, *USDOE Hanford Site First Five Year Review Report*, U.S. Environmental Protection Agency, Region 10, Hanford Project Office, Richland, Washington. Available online at <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0088482>.

^eDOE/RL-2006-20, 2007, *The Second CERCLA Five-Year Review Report for the Hanford Site*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=DA04570094>.

The *Hanford Site Third CERCLA Five-Year Review Report* (DOE/RL-2011-56^f) documented the result of the third [CERCLA](#) 5-year review that DOE completed in November 2011. The report evaluated the performance of the [CERCLA](#) remedies selected in RODs, including existing institutional controls in place to prevent exposure to the public and the environment.

The *Hanford Site Fourth CERCLA Five-Year Review Report* (DOE/RL-2016-01, Rev. 0^g) documented the result of the fourth [CERCLA](#) 5-year review that DOE completed in March 2017. The report evaluated the performance of the [CERCLA](#) remedies selected in RODs, including existing institutional controls in place to prevent exposure to the public and the environment.

This report presents the fifth [CERCLA](#) 5-year review for the Hanford Site for the period of 2016 through 2020. The purpose of this review is to evaluate implementation and performance of [CERCLA](#) remedies to determine whether they are, or will be, protective of human health and the environment. This report presents the 5-year review of [CERCLA](#) remedial actions initiated, in progress, or completed at the DOE Hanford Site where the action resulted in hazardous substances, pollutants, or contaminants remaining on site above levels that allow for unlimited use and unrestricted exposure.

Based on EPA's *Comprehensive Five-Year Review Guidance* (EPA 2001a^h), and the detailed review presented in this report, protectiveness statement categories determined for Hanford [CERCLA](#) operable units (OU) can be summarized as follows:

- **No Protectiveness Statement** (not required nor included in this 5-year review because a cleanup remedy had not yet been selected and published in a [CERCLA](#) ROD as of December 31, 2020):
 - Source OUs: 100-OL-1, 200-IA-1, 200-BC-1, 200-CB-1, 200-CP-1, 200-CR-1, 200-CW-1, 200-DV-1, 200-EA-1, 200-IS-1, 200-OA-1, 200-SW-1, 200-SW-2, and 200-WA-1
 - Groundwater OUs: 100-BC-5, 200-BP-5, and 200-PO-1.
- **Not Protective**
 - Source OUs: None
 - Groundwater OUs: None
- **Will Be Protective**
 - Source OUs: 100-DR-1, 100-DR-2, 100-HR-1, 100-HR-2, 100-KR-1ⁱ, 100-KR-2ⁱ, 100-NR-1ⁱ, 300-FF-2, 200-CU-1, 200-CW-3, 200-DF-1, 200-CW-5, 200-PW-1, 200-PW-3, and 200-PW-6

^fDOE/RL-2011-56, 2012, *Hanford Site Third CERCLA Five-Year Review Report*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0093142>.

^gDOE/RL-2016-01, 2017, *Hanford Site Fourth CERCLA Five-Year Review Report*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <https://pdw.hanford.gov/document/0071636H>.

^hEPA, 2001a, *Comprehensive Five-Year Review Guidance*, U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, D.C.

ⁱ Recommendations for identified issues are provided herein.

- Groundwater OUs: 100-HR-3ⁱ, 100-NR-2ⁱ, 200-UP-1ⁱ
- **Short-Term Protective**
 - Source OUs: 100-BC-1, 100-BC-2
 - Groundwater OUs: 100-KR-4ⁱ, 200-ZP-1ⁱ
- **Protective**
 - Source OUs: 100-FR-1, 100-FR-2, 100-IU-2, 100-IU-6, 300-FF-1, 1100-EM-1 (Horn Rapids Landfill)
 - Groundwater OU: 100-FR-3ⁱ, 300-FF-5.

Five-Year Review Summary Forms

In the order generally discussed within the body of this report, the following four sets of Five-Year Review Summary Forms (FYRSF) (based on EPA templates) are included on the following pages as tables FYRSF-1 through FYRSF-4:

- Table FYRSF-1. Five-Year Review Summary Form for the Hanford 100 Area
- Table FYRSF-2. Five-Year Review Summary Form for the Hanford 300 Area
- Table FYRSF-3. Five-Year Review Summary Form for the Hanford 1100 Area
- Table FYRSF-4. Five-Year Review Summary Form for the Hanford 200 Area.

Table FYRSF-1. Five-Year Review Summary Form for the Hanford 100 Area. (6 Pages)

SITE IDENTIFICATION		
Site Name: Hanford 100 Area (USDOE)		
EPA ID: WA3890090076		
Region: 10	State: WA	City/County: Richland/Benton
SITE STATUS		
NPL Status: Final		
Multiple OUs? Yes	Has the site achieved construction completion? No	
REVIEW STATUS		
Lead agency: Other Federal Agency If "Other Federal Agency" was selected above, enter Agency name: U.S. Department of Energy		
Author name (Federal or State Project Manager): Michael W. Cline		
Author affiliation: U.S. Department of Energy Richland Operations Office		
Review period: 09/01/2020 – 02/01/2022		
Date of site inspection: 06/2020 – 07/2020		
Type of review: Statutory		
Review number: 5		
Triggering action date: May 4, 2017		
Due date (five years after triggering action date): May 4, 2022		
Issues/Recommendations		
OU(s) without Issues/Recommendations Identified in the Five-Year Review:		
100-BC-1, 100-BC-2, 100-FR-1, 100-FR-2, 100-IU-2, 100-IU-6, 100-DR-1, 100-DR-2, 100-HR-1, and 100-HR-2		
Issues and Recommendations Identified in the Five-Year Review:		
OU(s): 100-FR-3	Issue Category: Changed Site Conditions	
	Issue: FR3-1. The 100-BC ROD clarified that the State water quality standard of 10 µg/L for hexavalent chromium should be considered throughout the aquifer, not only at the shoreline.	
	Recommendation: FR3-1. Evaluate the 100-FR-3 groundwater OU cleanup timeframe relative to application of the 10 µg/L hexavalent chromium State surface water quality standard as a groundwater cleanup level.	

Table FYRSF-1. Five-Year Review Summary Form for the Hanford 100 Area. (6 Pages)

Affect Current Protectiveness	Affect Future Protectiveness	Implementing Party	Oversight Party	Milestone Date
No	No	Federal Facility	EPA	09/30/2024
OU(s): 100-HR-3	Issue Category: Changed Site Conditions			
	Issue: HR3-1. The 100-BC ROD clarified that the State water quality standard of 10 µg/L for hexavalent chromium should be considered throughout the aquifer, not only at the shoreline.			
	Recommendation: HR3-1. Evaluate the 100-HR-3 groundwater OU cleanup timeframe relative to application of the 10 µg/L hexavalent chromium State surface water quality standard as a groundwater cleanup level.			
Affect Current Protectiveness	Affect Future Protectiveness	Implementing Party	Oversight Party	Milestone Date
No	No	Federal Facility	EPA/State	09/30/2024
OU(s): 100-KR-1, 100-KR-2, 100-KR-4	Issue Category: Remedy Performance			
	Issue: KR1/2/4-1. A full human-health and ecological risk assessment for 100-KR-1 and 100-KR-2 source OUs and the 100-KR-4 groundwater OU has not been finalized.			
	Recommendation: KR1/2/4-1. Finalize a full human-health and ecological risk assessment for the 100-KR-1 and 100-KR-2 source OUs and the 100-KR-4 groundwater OU as part of the 100-K Area RI/FS.			
Affect Current Protectiveness	Affect Future Protectiveness	Implementing Party	Oversight Party	Milestone Date
No	Yes	Federal Facility	EPA	09/30/2022
OU(s): 100-NR-1, 100-NR-2	Issue Category: Remedy Performance			
	Issue: NR1/2-1. A full human-health and ecological risk assessment for the 100-NR-1 source OU and 100-NR-2 groundwater OU has not been finalized.			
	Recommendation: NR1/2-1. Finalize a full human health and ecological risk assessments for the 100-NR-1 source OU and 100-NR-2 groundwater OU.			
Affect Current Protectiveness	Affect Future Protectiveness	Implementing Party	Oversight Party	Milestone Date
No	Yes	Federal Facility	EPA/State	03/30/2023
Protectiveness Statement(s)				
<i>Include each individual OU protectiveness determination and statement. If you need to add more protectiveness determinations and statements for additional OUs, copy and paste the table below as many times as necessary to complete for each OU evaluated in the FYR report.</i>				
<i>Operable Unit:</i> 100-BC-1		<i>Protectiveness Determination:</i> Short-Term Protective		<i>Addendum Due Date (if applicable):</i> N/A

Table FYRSF-1. Five-Year Review Summary Form for the Hanford 100 Area. (6 Pages)

<i>Protectiveness Statement:</i> The remedy at the 100-BC-1 currently protects human health and the environment because implementation of the interim remedy components (primarily involving RTD, backfilling, recontouring, revegetation, and ICs) has demonstrated that all exposure pathways that could result in unacceptable risk areas are being controlled. However, for the remedy to be protective in the long term (based on the findings of the 100-B/C RI/FS (DOE/RL-2010-96), RTD is required at one additional waste site and revised institutional controls are required at multiple waste sites. These waste sites do not present a risk because of current access restrictions at the Site. A final action ROD was issued in September 2021 and is in the process of implementation; protectiveness will continue to be evaluated in future 5-year reviews.		
<i>Operable Unit:</i> 100-BC-2	<i>Protectiveness Determination:</i> Short-Term Protective	<i>Addendum Due Date (if applicable):</i> N/A
<i>Protectiveness Statement:</i> The remedy at the 100-BC-2 currently protects human health and the environment because implementation of the interim remedy components (primarily involving RTD, backfilling, recontouring, revegetation, and ICs) has demonstrated that all exposure pathways that could result in unacceptable risk areas are being controlled. However, for the remedy to be protective in the long term (based on the findings of the 100-B/C RI/FS (DOE/RL-2010-96), revised institutional controls are required at multiple waste sites. These waste sites do not present a risk because of current access restrictions at the Site. A final action ROD was issued in September 2021 and is in the process of implementation; protectiveness will continue to be evaluated in future 5-year reviews.		
<i>Operable Unit:</i> 100-FR-1	<i>Protectiveness Determination:</i> Protective	<i>Addendum Due Date (if applicable):</i> N/A
<i>Protectiveness Statement:</i> The remedy at the 100-FR-1 source OU is protective of human health and the environment, and exposure pathways that could result in unacceptable risk are being controlled. The RAOs for protecting human and ecological receptors from exposure to contamination, and for controlling the sources of groundwater contamination to minimize the impacts to groundwater resources, protect the Columbia River from further adverse impacts, and reduce the degree of groundwater cleanup that may be required under future actions, have been met by RTD of waste sites and the imposition of site-specific ICs at waste sites that do not qualify for unlimited use or unrestricted exposure. The RTD scope has been completed and ICs have been implemented.		
<i>Operable Unit:</i> 100-FR-2	<i>Protectiveness Determination:</i> Protective	<i>Addendum Due Date (if applicable):</i> N/A
<i>Protectiveness Statement:</i> The remedy at the 100-FR-2 source OU is protective of human health and the environment, and exposure pathways that could result in unacceptable risk are being controlled. The RAOs for protecting human and ecological receptors from exposure to contamination, and for controlling the sources of groundwater contamination to minimize the impacts to groundwater resources, protect the Columbia River from further adverse impacts, and reduce the degree of groundwater cleanup that may be required under future actions, have been met by RTD of waste sites and the imposition of site-specific ICs at waste sites that do not qualify for unlimited use or unrestricted exposure. The RTD scope has been completed and ICs have been implemented.		

Table FYRSF-1. Five-Year Review Summary Form for the Hanford 100 Area. (6 Pages)

<i>Operable Unit:</i> 100-FR-3	<i>Protectiveness Determination:</i> Protective	<i>Addendum Due Date (if applicable):</i> N/A
<i>Protectiveness Statement:</i> The remedy at the 100-FR-3 groundwater OU is protective of human health and the environment. The RAOs for preventing human health and ecological receptors from exposure to contaminated groundwater are being met by the implementation and continued management of ICs, expansion of the monitoring well network, and continued monitoring. The RAO of restoring groundwater impacted by the associated source OUs is being met through monitored natural attenuation.		
<i>Operable Unit:</i> 100-IU-2	<i>Protectiveness Determination:</i> Protective	<i>Addendum Due Date (if applicable):</i> N/A
<i>Protectiveness Statement:</i> The remedy at the 100-IU-2 source OU is protective of human health and the environment and exposure pathways that could result in unacceptable risk are being controlled. The RAOs for protecting human and ecological receptors from exposure to contamination, and for controlling the sources of groundwater contamination to minimize the impacts to groundwater resources, protect the Columbia River from further adverse impacts, and reduce the degree of groundwater cleanup that may be required under future actions, have been met by RTD of waste sites. The RTD scope has been completed and ICs have been implemented.		
<i>Operable Unit:</i> 100-IU-6	<i>Protectiveness Determination:</i> Protective	<i>Addendum Due Date (if applicable):</i> N/A
<i>Protectiveness Statement:</i> The remedy at the 100-IU-6 source OU is protective of human health and the environment and exposure pathways that could result in unacceptable risk are being controlled. The RAOs for protecting human and ecological receptors from exposure to contamination, and for controlling the sources of groundwater contamination to minimize the impacts to groundwater resources, protect the Columbia River from further adverse impacts, and reduce the degree of groundwater cleanup that may be required under future actions, have been met by RTD of waste sites. The RTD scope has been completed and ICs have been implemented.		
<i>Operable Unit:</i> 100-DR-1	<i>Protectiveness Determination:</i> Will Be Protective	<i>Addendum Due Date (if applicable):</i> N/A
<i>Protectiveness Statement:</i> The final remedy at the 100-DR-1 source OU is expected to be protective of human health and the environment upon completion. Implementation of the final remedy (primarily involving RTD, backfilling, recontouring, revegetation, pipeline end-capping, and ICs) at the 100-DR-1 OU is ongoing. The remedial activities completed to date and the ongoing management of ICs address unacceptable risks from exposure pathways in the 100-DR-1 OU.		
<i>Operable Unit:</i> 100-DR-2	<i>Protectiveness Determination:</i> Will Be Protective	<i>Addendum Due Date (if applicable):</i> N/A
<i>Protectiveness Statement:</i> The final remedy at the 100-DR-2 source OU is expected to be protective of human health and the environment upon completion. Implementation of the final remedy (primarily involving RTD, backfilling, recontouring, revegetation, and ICs) at the 100 DR-2 OU is ongoing. The remedial activities completed to date and the ongoing management of ICs address unacceptable risks from exposure pathways in the 100-DR-2 OU.		

Table FYRSF-1. Five-Year Review Summary Form for the Hanford 100 Area. (6 Pages)

<i>Operable Unit:</i> 100-HR-1	<i>Protectiveness Determination:</i> Will Be Protective	<i>Addendum Due Date (if applicable):</i> N/A
<i>Protectiveness Statement:</i> The final remedy at the 100-HR-1 source OU is expected to be protective of human health and the environment upon completion. Implementation of the final remedy (primarily involving RTD, backfilling, recontouring, revegetation, and ICs) at the 100-HR-1 OU is ongoing. The remedial activities completed to date and the ongoing management of ICs address unacceptable risks from exposure pathways in the 100-HR-1 OU.		
<i>Operable Unit:</i> 100-HR-2	<i>Protectiveness Determination:</i> Will Be Protective	<i>Addendum Due Date (if applicable):</i> N/A
<i>Protectiveness Statement:</i> The final remedy at the 100-HR-2 source OU is expected to be protective of human health and the environment upon completion. Implementation of the final remedy (primarily involving RTD, backfilling, recontouring, revegetation, and ICs) at the 100-HR-2 OU is ongoing. The remedial activities completed to date and the ongoing management of ICs address unacceptable risks from exposure pathways in the 100-HR-2 OU.		
<i>Operable Unit:</i> 100-HR-3	<i>Protectiveness Determination:</i> Will Be Protective	<i>Addendum Due Date (if applicable):</i> N/A
<i>Protectiveness Statement:</i> The remedy at the 100-HR-3 groundwater OU is expected to be protective of human health and the environment upon completion of construction. ICs are in place and protecting human exposure to contaminated groundwater. Construction of additional wells to optimize the network of pump-and-treat extraction wells, injection wells, and monitoring wells is planned through FY 2026. Implementation of the final remedy at 100-HR-3 (primarily involving groundwater pump-and-treat system operations, monitored natural attenuation, ICs, and performance monitoring) has demonstrated that exposure pathways that could result in unacceptable risks are being controlled.		
<i>Operable Unit:</i> 100-KR-1	<i>Protectiveness Determination:</i> Will Be Protective	<i>Addendum Due Date (if applicable):</i> N/A
<i>Protectiveness Statement:</i> The remedy at the 100-KR-1 source OU is expected to be protective of human health and the environment upon completion of the final remedy. Implementation of the interim remedy (primarily involving RTD, backfilling, recontouring, and revegetation) at the 100-KR-1 OU is ongoing. In the interim, remedial activities completed to date, including ICs, have adequately addressed all exposure pathways that could result in unacceptable risks in these areas.		
<i>Operable Unit:</i> 100-KR-2	<i>Protectiveness Determination:</i> Will Be Protective	<i>Addendum Due Date (if applicable):</i> N/A
<i>Protectiveness Statement:</i> The remedy at the 100-KR-2 source OU is expected to be protective of human health and the environment upon completion of the final remedy. Implementation of the interim remedy (primarily involving RTD, backfilling, recontouring, and revegetation) at the 100-KR-2 OU is ongoing. In the interim, remedial activities completed to date, including ICs, have adequately addressed all exposure pathways that could result in unacceptable risks in these areas.		

Table FYRSF-1. Five-Year Review Summary Form for the Hanford 100 Area. (6 Pages)

<i>Operable Unit:</i> 100-KR-4	<i>Protectiveness Determination:</i> Short-Term Protective	<i>Addendum Due Date (if applicable):</i> N/A
<i>Protectiveness Statement:</i> The interim remedy at the 100-KR-4 groundwater OU currently focuses on hexavalent chromium contamination and currently protects human health and the environment because the KR-4, KW, and KX groundwater treatment systems' operations and the flow-path control components of the interim remedy are ongoing, and they are demonstrating effective progress in reducing contaminant plume sizes and concentrations. ICs have been implemented and continue to ensure that unacceptable risks to human health are being controlled. However, in order for the 100-KR-4 remedy to be protective in the long term, an evaluation of risk for all contaminants in the final RI and FS is needed.		
<i>Operable Unit:</i> 100-NR-1	<i>Protectiveness Determination:</i> Will Be Protective	<i>Addendum Due Date (if applicable):</i> N/A
<i>Protectiveness Statement:</i> The remedy at the 100-NR-1 source OU is expected to be protective of human health and the environment upon completion of the final remedy. Implementation of the interim remedy (primarily involving RTD, backfilling, recontouring, and revegetation) at the 100-NR-1 OU is ongoing. In the interim, remedial activities completed to date, including ICs, have adequately addressed all exposure pathways that could result in unacceptable risks in these areas.		
<i>Operable Unit:</i> 100-NR-2	<i>Protectiveness Determination:</i> Will Be Protective	<i>Addendum Due Date (if applicable):</i> N/A
<i>Protectiveness Statement:</i> The remedy at the 100-NR-2 groundwater OU is expected to be protective of human health and the environment upon completion of the final remedy. Construction of the interim remedy component involving a permeable reactive barrier for addressing strontium-90 contamination has been partly completed, pending reinjection and further expansion. To address TPH-diesel contamination, in situ bioventing system operations and the free-product removal operations are under way to reduce contaminant mass in the lower vadose zone and groundwater, respectively. Additionally, ICs are in place and are preventing human exposure to the groundwater. Groundwater monitoring and MNA also are under way and will continue to help determine a comprehensive final remedy for 100-NR-2 groundwater.		
Sitewide Protectiveness Statement (if applicable)		
<i>For sites that have achieved construction completion, enter a sitewide protectiveness determination and statement.</i>		
<i>Protectiveness Determination:</i> N/A		<i>Addendum Due Date (if applicable):</i> N/A
<i>Protectiveness Statement:</i> N/A – Hanford 100 Area NPL Site remedy construction is still under way among multiple OUs.		

Table FYRSF -2. Five-Year Review Summary Form for the Hanford 300 Area. (2 Pages)

SITE IDENTIFICATION				
Site Name: Hanford 300 Area (USDOE)				
EPA ID: WA3890090077				
Region: 10	State: WA	City/County: Richland/Benton		
SITE STATUS				
NPL Status: Final				
Multiple OUs? Yes		Has the site achieved construction completion? No		
REVIEW STATUS				
Lead agency: Other Federal Agency If “Other Federal Agency” was selected above, enter Agency name: U.S. Department of Energy				
Author name (Federal or State Project Manager): Michael W. Cline				
Author affiliation: U.S. Department of Energy Richland Operations Office				
Review period: 09/01/2020 – 02/01/2022				
Date of site inspection: 07/2020				
Type of review: Statutory				
Review number: 5				
Triggering action date: May 4, 2017				
Due date (five years after triggering action date): May 4, 2022				
Issues/Recommendations				
OU(s) without Issues/Recommendations Identified in the Five-Year Review:				
300-FF-1, 300-FF-2 and 300-FF-5				
Issues and Recommendations Identified in the Five-Year Review:				
OU(s): None	Issue Category: No Issue			
	Issue: N/A.			
	Recommendation: N/A.			
Affect Current Protectiveness	Affect Future Protectiveness	Implementing Party	Oversight Party	Milestone Date
No	No	Federal Facility	EPA	N/A

Table FYRSF -2. Five-Year Review Summary Form for the Hanford 300 Area. (2 Pages)

Protectiveness Statement(s)		
<i>Include each individual OU protectiveness determination and statement. If you need to add more protectiveness determinations and statements for additional OUs, copy and paste the table below as many times as necessary to complete for each OU evaluated in the FYR report.</i>		
<i>Operable Unit:</i> 300-FF-1	<i>Protectiveness Determination:</i> Protective	<i>Addendum Due Date (if applicable):</i> N/A
<i>Protectiveness Statement:</i> The remedy at the 300-FF-1 source OU is protective of human health and the environment. The RAOs for protecting human and ecological receptors from exposure to contamination, and for controlling the sources of groundwater contamination to minimize the impacts to groundwater resources, and protecting the Columbia River from further impacts, have been met by RTD of waste sites and enhanced attenuation of uranium, and the implementation and continued management of ICs.		
<i>Operable Unit:</i> 300-FF-2	<i>Protectiveness Determination:</i> Will Be Protective	<i>Addendum Due Date (if applicable):</i> N/A
<i>Protectiveness Statement:</i> The final remedy at the 300-FF-2 source OU is expected to be protective of human health and the environment upon completion of the final remedy. Implementation of the final remedy (primarily involving RTD, backfilling, recontouring, and revegetation) at the 300-FF-2 OU is ongoing. In the interim, remedial activities completed to date, including ICs, have adequately addressed all exposure pathways that could result in unacceptable risks in these areas.		
<i>Operable Unit:</i> 300-FF-5	<i>Protectiveness Determination:</i> Protective	<i>Addendum Due Date (if applicable):</i> N/A
<i>Protectiveness Statement:</i> The remedy for the 300-FF-5 groundwater OU is protective of human health and the environment. The RAO to restore groundwater in the 300-FF-5 OU to cleanup levels that include drinking water standards within a timeframe that is reasonable, given the particular circumstances of the site (i.e., by 2041), is being met by implementation of remedy components involving MNA, groundwater monitoring, and enhanced attenuation of uranium. Construction of the remedy component involving enhanced attenuation of uranium was completed in 2018 and documented in 2020; this is expected to reduce the timeframe for achieving uranium cleanup levels. MNA and groundwater monitoring have been implemented and are ongoing. The RAO of preventing human exposure to groundwater containing COC concentrations above cleanup levels is being met by the implementation and the continued management of ICs.		
Sitewide Protectiveness Statement (if applicable)		
<i>For sites that have achieved construction completion, enter a sitewide protectiveness determination and statement.</i>		
<i>Protectiveness Determination:</i> N/A		<i>Addendum Due Date (if applicable):</i> N/A
<i>Protectiveness Statement:</i> N/A – Hanford 300 Area (USDOE) NPL Site remedy construction is still under way among multiple OUs.		

Table FYRSF-3. Five-Year Review Summary Form for the Hanford 1100 Area. (2 Pages)

SITE IDENTIFICATION				
Site Name: Hanford 1100 Area (USDOE)				
EPA ID: WA3890090077				
Region: 10	State: WA	City/County: Richland/Benton		
SITE STATUS				
NPL Status: Deleted				
Multiple OUs? No		Has the site achieved construction completion? Yes		
REVIEW STATUS				
Lead agency: Other Federal Agency If "Other Federal Agency" was selected above, enter Agency name: U.S. Department of Energy				
Author name (Federal or State Project Manager): Michael W. Cline				
Author affiliation: U.S. Department of Energy Richland Operations Office				
Review period: 09/01/2020 – 02/01/2022				
Date of site inspection: 06/02/2020				
Type of review: Statutory				
Review number: 5				
Triggering action date: May 4, 2017				
Due date (five years after triggering action date): May 4, 2022				
Issues/Recommendations				
OU(s) without Issues/Recommendations Identified in the Five-Year Review:				
1100-EM-1				
Issues and Recommendations Identified in the Five-Year Review:				
OU(s): None	Issue Category: No Issue			
	Issue: N/A.			
	Recommendation: N/A.			
Affect Current Protectiveness	Affect Future Protectiveness	Implementing Party	Oversight Party	Milestone Date
No	No	Federal Facility	EPA/State	N/A

Table FYRSF-3. Five-Year Review Summary Form for the Hanford 1100 Area. (2 Pages)

Protectiveness Statement(s)		
<i>Include each individual OU protectiveness determination and statement. If you need to add more protectiveness determinations and statements for additional OUs, copy and paste the table below as many times as necessary to complete for each OU evaluated in the FYR report.</i>		
<i>Operable Unit:</i> 1100-EM-1	<i>Protectiveness Determination:</i> Protective	<i>Addendum Due Date (if applicable):</i> N/A
<i>Protectiveness Statement:</i> The remedy at the 1100-EM-1 OU is protective of human health and the environment. Elements of the remedy that protect human health and the environment involve continuing ICs due to the buried asbestos at the Horn Rapids Landfill (the only 1100-EM-1 site that is not closed out). The remedial action objectives were met at the landfill by offsite disposal of PCB contaminated soils, capping of the landfill in accordance the Asbestos NESHAP (40 CFR 61.151) and providing adequate ICs to prevent future receptor exposure to contamination. The continuing ICs include entry restrictions, notice in deed, land use management, and miscellaneous provisions. Fencing, signage and the existing landfill cap are routinely inspected, maintained and upgraded as needed.		
Sitewide Protectiveness Statement (if applicable)		
<i>For sites that have achieved construction completion, enter a sitewide protectiveness determination and statement.</i>		
<i>Protectiveness Determination:</i> Protective		<i>Addendum Due Date (if applicable):</i> N/A
<i>Protectiveness Statement:</i> N/A – The Hanford 1100 Area (USDOE) Site remedy was removed from the NPL in 1996.		

Table FYRSF-4. Five-Year Review Summary Form for the Hanford 200 Area. (4 Pages)

SITE IDENTIFICATION				
Site Name: Hanford 200 Area (USDOE)				
EPA ID: WA3890090078				
Region: 10	State: WA	City/County: Richland/Benton		
SITE STATUS				
NPL Status: Final				
Multiple OUs? Yes		Has the site achieved construction completion? No		
REVIEW STATUS				
Lead agency: Other Federal Agency If "Other Federal Agency" was selected above, enter Agency name: U.S. Department of Energy				
Author name (Federal or State Project Manager): Michael W. Cline				
Author affiliation: U.S. Department of Energy Richland Operations Office				
Review period: 09/01/2020 – 02/01/2022				
Date of site inspection: 06/2020 – 07/2020				
Type of review: Statutory				
Review number: 5				
Triggering action date: May 4, 2017				
Due date (five years after triggering action date): May 4, 2022				
Issues/Recommendations				
OU(s) without Issues/Recommendations Identified in the Five-Year Review:				
200-CU-1, 200-CW-3, 200-DF-1, 200-CW-5, 200-PW-1, 200-PW-3, 200-PW-6				
Issues and Recommendations Identified in the Five-Year Review:				
OU(s): 200-UP-1	Issue Category: Changed Site Conditions			
	Issue: UP1-1. Concentrations of technetium-99 downgradient from WMA U have increased substantially during this review period, and the interim ROD does not identify an active remedy for this area.			
	Recommendation: UP1-1. Install additional characterization/monitoring wells to better define the extent of technetium-99 downgradient of WMA U, collect at least four quarters of data from the new wells, perform modeling to determine the current state of the contaminant and position of the plume(s), and determine if there is an unacceptable risk due to this contaminant.			
Affect Current Protectiveness	Affect Future Protectiveness	Implementing Party	Oversight Party	Milestone Date
No	No	Federal Facility	EPA	09/30/2025

Table FYRSF-4. Five-Year Review Summary Form for the Hanford 200 Area. (4 Pages)

OU(s): 200-ZP-1	Issue Category: Changed Site Conditions			
	Issue: ZP1-1. Restoration of groundwater to drinking-water levels within the RAO-specified timeframe of 150 years may not be achieved without additional system changes.			
	Recommendation: ZP1-1. Implement the 200-ZP-1 Optimization Study Plan combined with implementing the Ringold Formation Unit A Sampling and Analysis Plan.			
Affect Current Protectiveness	Affect Future Protectiveness	Implementing Party	Oversight Party	Milestone Date
No	Yes	Federal Facility	EPA	09/30/2026
Protectiveness Statement(s)				
<i>Include each individual OU protectiveness determination and statement. If you need to add more protectiveness determinations and statements for additional OUs, copy and paste the table below as many times as necessary to complete for each OU evaluated in the FYR report.</i>				
<i>Operable Unit:</i> 200-UP-1	<i>Protectiveness Determination:</i> Will Be Protective	<i>Addendum Due Date (if applicable):</i> N/A		
<i>Protectiveness Statement:</i> The remedy at the 200-UP-1 groundwater OU is expected to be protective of human health and the environment upon completion of the final remedy. Further characterization of the U-Plant area uranium plume was completed during this 5-year review period. This will be followed by optimization of the uranium plume remedy. The final treatment technology evaluation plan for iodine-129 was released and treatment technologies were evaluated. A viable treatment technology was not identified. Characterization of the chromium plume (total and hexavalent) was completed during this 5-year review period. The plume will be monitored and evaluated for 5 years before a remedy decision is made, which is consistent with the approach identified in the interim ROD. Technetium-99 concentrations have increased downgradient from WMA U. Additional characterization will be performed and the need for a groundwater extraction system will be assessed. The interim action remedy component of groundwater ICs is fully implemented and ensures that exposure pathways that could result in unacceptable risks to human health are being controlled.				
<i>Operable Unit:</i> 200-ZP-1	<i>Protectiveness Determination:</i> Short-Term Protective	<i>Addendum Due Date (if applicable):</i> N/A		
<i>Protectiveness Statement:</i> The remedy at the 200-ZP-1 groundwater OU is currently protective of human health and the environment because the remedy components involving groundwater extraction and treatment, MNA, flow path control, and ICs have been implemented and are being managed. However, in order to meet the long-term RAOs of achieving domestic drinking water levels within 150 years and protecting the Columbia River and its ecological resources from degradation and unacceptable impact caused by contaminants originating from the 200-ZP-1 OU, implementation of the 200-ZP-1 Optimization Plan and the Ringold Formation Unit A Sampling and Analysis Plan need to be implemented over the next 5 years. The optimization study began in 2019 and will continue through FY 2026 (per TPA-CN-1102) due to delays associated with the COVID-related shutdown during March through June 2020 and has an option of 2 additional years, if needed.				

Table FYRSF-4. Five-Year Review Summary Form for the Hanford 200 Area. (4 Pages)

<i>Operable Unit:</i> 200-CU-1	<i>Protectiveness Determination:</i> Will Be Protective	<i>Addendum Due Date (if applicable):</i> N/A
<i>Protectiveness Statement:</i> The remedy at the 200-CU-1 OU (221-U Facility (U Plant) is expected to be protective of human health and the environment upon completion of the final remedy actions. Implementation of the final remedy for the 200-CU-1 OU has been put in hiatus. Once implementation is restarted and the remedy is complete, it is expected to be protective of human health and the environment. The remedial actions completed to date, along with implementation of the pre-construction completion ICs, ensure that exposure pathways that could result in unacceptable risks in this area are being controlled.		
<i>Operable Unit:</i> 200-CW-3	<i>Protectiveness Determination:</i> Will Be Protective	<i>Addendum Due Date (if applicable):</i> N/A
<i>Protectiveness Statement:</i> The remedy at the 200-CW-3 source OU is expected to be protective of human health and the environment upon completion of the final remedy. Implementation of the interim remedy (primarily involving RTD, backfilling, recontouring, and revegetation) at the 200-CW-3 OU has been completed. In the interim, remedial activities completed to date, including ICs, have adequately addressed all exposure pathways that could result in unacceptable risks in these areas.		
<i>Operable Unit:</i> 200-DF-1	<i>Protectiveness Determination:</i> Will Be Protective	<i>Addendum Due Date (if applicable):</i> N/A
<i>Protectiveness Statement:</i> The remedy at the 200-DF-1 OU (ERDF landfill) is expected to be protective of human health and the environment upon completion. In the interim, remedial activities completed to date have adequately addressed all exposure pathways that could result in unacceptable risks in these areas. ERDF is an operating landfill; operation is envisioned to continue for at least another 25 years.		
<i>Operable Unit:</i> 200-CW-5	<i>Protectiveness Determination:</i> Will Be Protective	<i>Addendum Due Date (if applicable):</i> N/A
<i>Protectiveness Statement:</i> The remedy at the 200-CW-5 Operable Unit is expected to be protective upon completion of the final remedy. While the remedy component involving RTD (with disposal at ERDF or WIPP, as appropriate) has not started, ICs are in place to ensure that exposure pathways that could result in unacceptable risks are being controlled.		
<i>Operable Unit:</i> 200-PW-1	<i>Protectiveness Determination:</i> Will Be Protective	<i>Addendum Due Date (if applicable):</i> N/A
<i>Protectiveness Statement:</i> The remedy at the 200-PW-1 Operable Unit is expected to be protective upon completion of the final remedy. While the remedy components involving RTD (with disposal at ERDF or WIPP, as appropriate) has not started, the remedy component involving soil vapor extraction has been successfully completed, and ICs are in place to ensure that exposure pathways that could result in unacceptable risks are being controlled.		

Table FYRSF-4. Five-Year Review Summary Form for the Hanford 200 Area. (4 Pages)

<i>Operable Unit:</i> 200-PW-3	<i>Protectiveness Determination:</i> Will Be Protective	<i>Addendum Due Date (if applicable):</i> N/A
<i>Protectiveness Statement:</i> The remedy at the 200-PW-3 Operable Unit is expected to be protective upon completion of the final remedy. While the remedy component involving enhancement of the existing soil cover has not started, ICs are in place to ensure that exposure pathways that could result in unacceptable risks are being controlled.		
<i>Operable Unit:</i> 200-PW-6	<i>Protectiveness Determination:</i> Will Be Protective	<i>Addendum Due Date (if applicable):</i> N/A
<i>Protectiveness Statement:</i> The remedy at the 200-PW-6 Operable Unit is expected to be protective upon completion of the final remedy. While the remedy components involving RTD and installation of a soil cover has not started, the remedy component involving soil vapor extraction has been successfully completed and ICs are in place to ensure that exposure pathways that could result in unacceptable risks are being controlled.		
Sitewide Protectiveness Statement (if applicable)		
<i>For sites that have achieved construction completion, enter a sitewide protectiveness determination and statement.</i>		
<i>Protectiveness Determination:</i> N/A		<i>Addendum Due Date (if applicable):</i> N/A
<i>Protectiveness Statement:</i> N/A – Hanford 200 Area (USDOE) NPL Site remedy construction is still under way among multiple OUs.		

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CONTENTS

1.0	INTRODUCTION.....	1-1
1.1	Background	1-6
1.1.1	History and Basis for Taking Action on Cleanup	1-6
1.1.2	Land Use	1-8
1.2	Remedial Actions.....	1-10
1.2.1	Institutional Controls.....	1-10
1.3	Review Process	1-12
2.0	RIVER CORRIDOR (100 AREA AND 300 AREA NATIONAL PRIORITIES LIST SITES AND 1100 AREA)	2-1
2.1	Introduction.....	2-1
2.2	100 Area National Priorities List Site	2-3
2.3	100 Area Operable Units.....	2-5
2.3.1	100-BC Operable Units	2-5
2.3.1.1	100-BC-1 and 100-BC 2 Source Operable Units	2-5
2.3.2	100-F/IU Operable Units	2-15
2.3.2.1	100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 Source Operable Units	2-17
2.3.2.2	100-FR-3 Groundwater Operable Unit.	2-27
2.3.3	100-D/H Operable Units.....	2-39
2.3.3.1	100-DR-1, 100-DR-2, 100-HR-1 and 100-HR-2 Source Operable Units	2-39
2.3.3.2	100-HR-3 Groundwater Operable Unit.....	2-55
2.3.4	100-K Operable Units.....	2-73
2.3.4.1	100-KR-1 Source Operable Unit	2-73
2.3.4.2	100-KR-2 Source Operable Unit	2-81
2.3.4.3	100-KR-4 Groundwater Operable Unit.....	2-91
2.3.5	100-N Operable Units.....	2-108
2.3.5.1	100-NR-1 Source Operable Unit	2-108
2.3.5.2	100-NR-2 Groundwater Operable Unit.....	2-117
2.4	300 Area National Priorities List Site	2-134
2.4.1	300 Area Operable Units	2-137
2.4.1.1	300-FF-1 and 300-FF-2 Source Operable Units.....	2-137
2.4.1.2	300-FF-5 Groundwater Operable Unit.....	2-152
2.5	1100 Area 1100-EM-1 Operable Unit (Horn Rapids Landfill)	2-168
3.0	CENTRAL PLATEAU (200 AREA NATIONAL PRIORITIES LIST SITE).....	3-1
3.1	Background	3-1

3.2	200 Area Operable Units.....	3-4
3.3	200 Area Operable Units Included in this Review	3-7
3.3.1	200 Area Groundwater Operable Units Included in this Review.....	3-7
3.3.1.1	200-UP-1 Groundwater Operable Unit	3-8
3.3.1.2	200-ZP-1 Groundwater Operable Unit.....	3-23
3.3.2	200 Area Source Operable Units Included in this Review	3-40
3.3.2.1	200-CU-1 Source Operable Unit	3-40
3.3.2.2	200-CW-3 Source Operable Unit	3-45
3.3.2.3	200-DF-1 Source Operable Unit.....	3-50
3.3.2.4	200-CW-5, 200-PW-1, 200-PW-3, and 200-PW-6 Source Operable Units	3-54
4.0	REFERENCES	4-1

APPENDICES

A	INSTITUTIONAL CONTROLS	A-i
B	HANFORD SITE EXISTING CLEANUP DECISIONS.....	B-i
C	SOIL AND GROUNDWATER CLEANUP LEVELS FOR SELECTED 100 AREA AND 300 AREA OPERABLE UNITS WITH FINAL ACTION RECORDS OF DECISION.....	C-i

FIGURES

1-1.	Major Regions of the Hanford Site: Hanford Reach National Monument, River Corridor, and Central Plateau.	1-2
1-2.	Hanford Site Land-Use Map (DOE/EIS-0222-SA-02).....	1-9
1-3.	Generalized Decision Logic for Choosing a Protectiveness Determination.	1-15
2-1.	Location of 100-BC-1 and 100-BC-2 Source Operable Units.	2-6
2-2.	Geographic Distribution and WIDS Reclassification Status of the 100-BC-1 and 100-BC-2 Source Operable Unit Waste Sites as of December 2020.....	2-11
2-3.	Location of 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and 100-IU-6 Operable Units.....	2-16
2-4.	Geographic Distribution and WIDS Reclassification Status of the 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 Source Operable Unit Waste Sites as of December 2020.....	2-23
2-5.	100-FR-3 Well and Aquifer Tube Locations (2020).	2-36
2-6.	100-FR-3 Groundwater OU Plumes in 2015 (left) and 2020 (right).	2-37
2-7.	100-FR-3 Trend Plots of Contaminant Plume Areas (2003-2020).....	2-37
2-8.	Location of 100-D and 100-H Area Operable Units.....	2-40

2-9.	Geographic Distribution and WIDS Reclassification Status of the 100-DR-1 and 100-DR-2 Source Operable Unit Waste Sites as of December 2020.....	2-50
2-10.	Geographic Distribution and WIDS Reclassification Status of the 100-HR-1 and 100-HR-2 Operable Unit Waste Sites as of December 2020.	2-51
2-11.	Locations of 100-HR-3 (100-D Area) Wells and Aquifer Tubes Sampled in 2020.	2-67
2-12.	Locations of 100-HR-3 (100-H Area) Wells and Aquifer Tubes Sampled in 2020.	2-68
2-13.	100-HR-3 Groundwater Operable Unit Plumes in 2015 (top) and 2020 (bottom).	2-70
2-14.	100-HR-3 Trend Plots of Contaminant Plume Areas (2003-2020).	2-71
2-15.	Location of 100-K Area Operable Units.....	2-74
2-16.	Geographic Distribution and WIDS Reclassification Status of the 100-KR-1 and 100-KR-2 Source Operable Unit Waste Sites as of December 2020.....	2-78
2-17.	Locations of 100-KR-4 Wells and Aquifer Tubes Sampled in 2020.....	2-102
2-18.	100-KR-4 Groundwater OU Plumes in 2015 (left) and 2020 (right).....	2-104
2-19.	100-KR-4 Trend Plots of Contaminant Plume Areas (2003-2020).	2-105
2-20.	Location of 100-N Area Operable Units.....	2-109
2-21.	Geographic Distribution and WIDS Reclassification Status of 100-NR-1 Source Operable Unit Waste Sites as of December 2020.	2-113
2-22.	Locations of 100-NR-2 Wells and Aquifer Tubes Sampled in 2020.....	2-129
2-23.	100-NR-2 Groundwater OU Plumes in 2015 (left) and 2020 (right).....	2-130
2-24.	100-NR-2 Trend Plots of Contaminant Plume Areas (2003-2020).	2-130
2-25.	300 Area Operable Units.	2-136
2-26.	Geographic Distribution and WIDS Reclassification Status of the 300-FF-1 and 300-FF-2 Source Operable Unit Waste Sites as of December 2020.....	2-147
2-27.	Locations of 300-Area Wells and Aquifer Tubes Sampled in 2020.....	2-163
2-28.	300-FF-5 Groundwater Contaminant Plumes in 2015 (left) and 2020 (right).	2-164
2-29.	300-FF-5 Groundwater Contaminant Plumes Near 316-4, 618-10, and 618-11 Waste Sites in 2015 (left) and 2020 (right).	2-165
2-30.	300-FF-5 Groundwater OU and Nearby Plumes in 2015 (left) and 2020 (right).	2-166
2-31.	300-FF-5 Trend Plots of Contaminant Plume Areas (2003-2020).....	2-167
2-32.	Aerial View of 1100-EM-1 OU, Horn Rapids Landfill.....	2-170
3-1.	Source Operable Units in the Central Plateau.	3-5
3-2.	Hanford Groundwater Operable Units.....	3-6
3-3.	Location of 200-UP-1 and 200-ZP-1 Groundwater Operable Units.....	3-9
3-4.	200-West Pump and Treat System.....	3-16
3-5.	Locations of 200-UP-1 Wells Sampled in 2020.....	3-19
3-6.	200-UP-1 and 200-ZP-1 Groundwater Operable Unit Plumes in 2015 (top) and 2020 (bottom).	3-20
3-7.	200-UP-1 Trend Plots of Contaminant Plume Areas (2003-2020).....	3-21
3-8.	Locations of 200-ZP-1 Wells Sampled in 2020.....	3-34
3-9.	200-UP-1 and 200-ZP-1 Groundwater Operable Unit Plumes in 2015 (top) and 2020 (bottom).	3-37

3-10.	200-ZP-1 Trend Plots of Contaminant Plume Areas (2003-2020).	3-38
3-11.	Aerial View of 200-DF-1 OU, Environmental Restoration Disposal Facility	3-50

TABLES

1-1.	Operable Units Addressed in this Report.	1-4
1-2.	Categories, Types, and Objectives of Sitewide Controls. ^{a, b}	1-10
2-1.	Chapter 2 Scope – Hanford NPL Sites and Operable Units Located in the River Corridor.	2-1
2-2.	Decision Documents for the 100-BC-1 and 100-BC-2 Source Operable Units.....	2-7
2-3.	100-BC-1 and 100-BC-2 Source Operable Unit Cleanup Status.	2-10
2-4.	Decision Documents for the 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 Source Operable Units.	2-17
2-5.	Waste Site Remediation Summary for 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 Source Operable Units.	2-24
2-6.	Decision Documents for the 100-FR-3 Groundwater Operable Unit.	2-28
2-7.	Estimated Times for 100-FR-3 Groundwater to Achieve Cleanup Levels.	2-32
2-8.	Overview of 100-FR-3 Remedy Implementation.	2-32
2-9.	Overview of 100-FR-3 Groundwater Contaminant Plumes. ^a	2-35
2-10.	Decision Documents for the 100-DR-1, 100-DR-2, 100-HR-1 and 100-HR-2 Source Operable Units.	2-41
2-11.	100-DR-1, 100-DR-2, 100-HR-1, and 100-HR-2 Source Operable Units Cleanup Status.	2-49
2-12.	Decision Documents for the 100-HR-3 Groundwater Operable Unit.	2-56
2-13.	Overview of 100-HR-3 Groundwater OU Remedy Implementation.	2-65
2-14.	Contaminant Mass Removed from 100-HR-3 Groundwater Extraction Systems.	2-66
2-15.	Overview of 100-HR-3 Groundwater Contaminant Plumes. ^a	2-69
2-16.	Decision Documents for the 100-KR-1 Source Operable Unit.....	2-75
2-17.	100-KR-1 and 100-KR-2 Source Operable Units Cleanup Status.	2-79
2-18.	Decision Documents for the 100-KR-2 Source Operable Unit.	2-82
2-19.	Decision Documents for the 100-KR-4 Groundwater Operable Unit.	2-92
2-20.	Overview of 100-KR-4 Interim Action Remedy Implementation.	2-100
2-21.	Contaminant Mass Removed from 100-KR-4 Groundwater Operable Unit Extraction Systems.....	2-100
2-22.	Overview of 100-KR-4 Groundwater Contaminant Plumes. ^a	2-103
2-23.	Decision Documents for the 100-NR-1 Source Operable Unit.....	2-110
2-24.	100-NR-1 Operable Unit Cleanup Status.	2-112
2-25.	Decision Documents for the 100-NR-2 Groundwater Operable Unit.	2-118
2-26.	Overview of 100-NR-2 Operable Unit Interim Action Remedy Implementation.	2-125
2-27.	Overview of 100-NR-2 Groundwater Contaminant Plumes. ^a	2-128

2-28.	Decision Documents for the 300 Area Source Operable Units (300-FF-1 and 300-FF-2).	2-138
2-29.	300-FF-1 and 300-FF-2 Cleanup Status.	2-148
2-30.	Decision Documents for the 300-FF-5 Groundwater Operable Unit.	2-153
2-31.	Overview of 300-FF-5 Groundwater OU Remedy Implementation.	2-160
2-32.	Overview of 300-FF-5 Groundwater Contaminant Plumes. ^a	2-162
2-33.	Decision Documents for the 1100-EM-1 Source Operable Unit, Horn Rapids Landfill.....	2-169
3-1.	Decision Documents for the 200-UP-1 Groundwater Operable Unit.....	3-10
3-2.	Overview of 200-UP-1 Interim Action Remedy Implementation.	3-14
3-3.	Contaminant Mass (or Activity) Removed from Aquifer by the Waste Management Area S-SX Groundwater Extraction System ^a	3-16
3-4.	Contaminant Mass (or Activity) Removed from Aquifer by the U-Plant Area Groundwater Extraction System ^a	3-17
3-5.	Overview of 200-UP-1 Groundwater Contaminant Plumes. ^a	3-18
3-6.	Decision Documents for the 200-ZP-1 Groundwater Operable Unit.	3-24
3-7.	Overview of 200-ZP-1 Groundwater Operable Unit Remedy Implementation.	3-30
3-8.	00-West Area Pump and Treat Performance. ^a	3-33
3-9.	Overview of 200-ZP-1 Groundwater Contaminant Plumes. ^a	3-36
3-10.	Decision Documents for the 200-CU-1 Source Operable Unit.....	3-41
3-11.	Decision Documents for the 200-CW-3 Source Operable Unit.....	3-46
3-12.	200-CW-3 Source Operable Unit Cleanup Status.....	3-48
3-13.	Decision Documents for the 200-DF-1 Source Operable Unit.	3-51

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ACRONYMS

AFFF	aqueous firefighting foam
CERCLA	<i>Comprehensive Environmental Response, Compensation, and Liability Act of 1980</i>
CLUP	Comprehensive Land Use Plan
COC	contaminants of concern
COPC	contaminants of potential concern
COVID-19	Coronavirus 2019 pandemic
CPE	Comprehensive Plume Evaluation
CUL	cleanup levels
CY	calendar year
DCE	dichloroethene
DOE	U.S. Department of Energy
DOE-HQ	U.S. Department of Energy, Headquarters
DOE-RL	U.S. Department of Energy, Richland Operations Office
DST	double-shell tank
DWS	drinking water standard
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
ESD	Explanation of Significant Difference
FS	feasibility study
FY	fiscal year
HAB	Hanford Advisory Board
HAMMER	Volpentest Hazardous Materials Management and Emergency Response Federal Training Center
HCP-EIS	<i>Hanford Comprehensive Land Use Plan Environmental Impact Statement</i>
HRNM	Hanford Reach National Monument
IC	institutional control
IROD	interim record of decision
ISRM	in situ reduction-oxidation manipulation
MCL	maximum concentration level
MNA	Monitored Natural Attenuation
MTCA	“Model Toxics Control Act – Cleanup,”
NCP	“National Oil and Hazardous Substances Pollution Contingency Plan”
NESHAP	“National Emission Standards for Hazardous Air Pollutants”
NHPA	<i>National Historic Preservation Act of 1966</i>
NPL	National Priorities List
O&M	operation and maintenance
OU	operable unit
PCB	polychlorinated biphenyl
PFAS	polyfluoroalkyl substances
PMP	performance monitoring plan
PNNL	Pacific Northwest National Laboratory
PRB	permeable reactive barrier
PRG	preliminary remediation goal
PUREX	Plutonium/Uranium Extraction
RAG	remedial action goal
RAO	remedial action objective

RCRA	<i>Resource Conservation and Recovery Act of 1976</i>
RD/RAWP	Remedial Design/Remedial Action Work Plan
RDR/RAWP	Remedial Design Report/Remedial Action Work Plan
REDOX	REDuction-OXidation
RI	remedial investigation
RI/FS	remedial investigation/feasibility study
ROD	record of decision
RODA	record of decision amendment
RPO	remedial process optimization
RTD	removal, treatment (as required), and disposal
RUM	Ringold upper mud
Rwia	Ringold Formation member of Wooded Island - Unit A
Rwie	Ringold Formation member of Wooded Island - Unit E
SAP	sampling and analysis plan
SEMS	Superfund Environmental Management System
SNF	spent nuclear fuel
SST	single-shell tank
SVE	soil vapor extraction
TCE	trichloroethene
TPH	total petroleum hydrocarbon
Tri-Party Agreement	<i>Hanford Federal Facility Agreement and Consent Order</i>
TRU	transuranic
TSD	treatment, storage, and disposal
USFWS	U.S. Fish and Wildlife Service
WIDS	Waste Information Data System
WIPP	Waste Isolation Pilot Plant
WMA	Waste Management Area

1.0 INTRODUCTION

This report presents the fifth *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* ([CERCLA](#)) 5-year review of remedial actions at the U.S. Department of Energy (DOE)-owned and -managed Hanford Site in accordance with the [CERCLA](#) and *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) ([Ecology et al. 1989](#)). This 5-year review follows the U.S. Environmental Protection Agency's (EPA) *Comprehensive Five-Year Review Guidance* ([EPA 2001a](#)).

Purpose. The 5-year review evaluates the implementation and performance of a remedy to determine whether the remedy is or will be protective of human health and the environment. The methods, findings, and conclusions of these reviews are documented in the 5-year review reports. The reports also identify any issues found during the review and provide recommendations to address them.

Cleanup Authority. Through [Executive Order 12580](#), the President has delegated many management responsibilities for federal facilities to Executive Branch agencies, including DOE. Under [Executive Order 12580](#), DOE is designated as the lead agency responsible for conducting response actions (removal and remedial) at facilities under its control, including the Hanford Site. Both [CERCLA](#) and [Executive Order 12580](#) mandate that, as the federal lead agency, DOE will conduct response actions (removal and remedial) at the Hanford Site.

Requirement. One responsibility of a federal lead agency is to review the status of response actions no less frequently than once every 5 years for sites where remaining contamination precludes unlimited use and unrestricted exposure to determine whether the selected remedies at a site remain protective of human health and the environment. DOE is required to implement 5-year reviews in a manner consistent with [CERCLA](#) and [40 CFR 300](#), "National Oil and Hazardous Substances Pollution Contingency Plan" (NCP).

Scope. National priorities among known or threatened releases of hazardous substances, pollutants, or contaminants throughout the United States and its territories are found in the EPA's National Priorities List (NPL). The NPL is intended primarily to guide EPA in determining which sites warrant further investigation. When the Hanford Site (also referred herein as "the Site") was placed on the NPL on November 3, 1989, it was divided into the 100, 200, 300, and 1100 Areas. These NPL designations were based on the extent of contamination present and do not correlate to the commonly recognized Site boundaries. Each NPL site was divided into operable units (OU) (a grouping of individual sites based primarily on geographic area or common waste sources) to simplify the management of response actions.

Source OUs address a variety of contaminated media (e.g., soil, sludge, debris) and waste site types (e.g., ponds, cribs, ditches, landfills, tanks, pipelines, and structures) across the Hanford Site. The OUs were established to address cleanup at the 100 Area, 200 Area, 300 Area, and 1100 Area NPL sites. The 100, 300, and 1100 Areas are in the River Corridor while the 200 Area is on the Central Plateau. The River Corridor and the Central Plateau are shown in Figure 1-1. This 5-year review covers [CERCLA](#) cleanup projects comprising 23 source OUs and 7 groundwater OUs. For this document, "source OU" broadly applies to non-groundwater OUs that comprise potential contamination at the surface and infers contamination in the vadose zone.

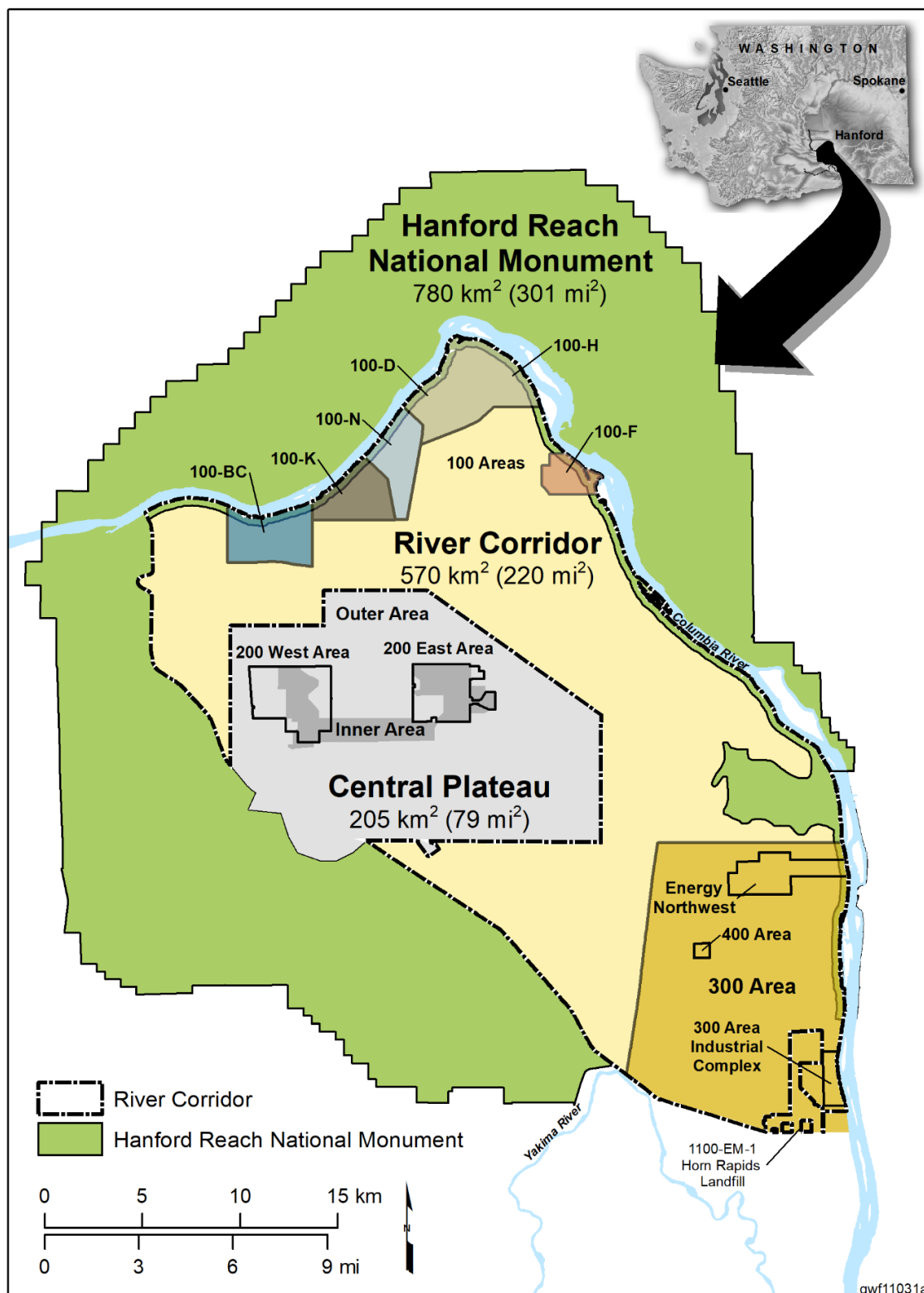


Figure 1-1. Major Regions of the Hanford Site: Hanford Reach National Monument, River Corridor, and Central Plateau.

[CERCLA](#) remedial action decisions are documented in formal records of decision (ROD). These remediation decisions can be found in the Administrative Record for the Hanford Site, which can be queried for specific OUs (<http://pdw.hanford.gov/arpir/index.cfm/predefinedSearch?canType=OpUnit>).

Table 1-1 lists the OUs addressed in this report in a chronology of the primary decision document types that have been published for each OU. Table 1-1 lists the following types of documents:

- **Interim Remedial Action Record of Decision (IROD).** An interim action is limited in scope and only addresses areas/media that will also be addressed by a final site/OU ROD.
- **Record of Decision (ROD).** The ROD documents the selected remedial action for a site or operable unit(s). The NCP directs the lead agency to produce a ROD documenting all facts, analyses of facts, and site-specific policy determinations considered in the course of selecting a remedial action as well as statutory requirements.
- **Record of Decision Amendment (RODA).** The RODA revises an IROD or ROD to incorporate changes to the IROD's or ROD's scope. Fundamental Changes involve an appreciable change or changes in the scope, performance, and/or cost of a remedy or may be a number of significant changes that together have the effect of a fundamental change.
- **Explanation of Significant Differences (ESD).** The ESD is a standalone document that describes changes to an IROD or ROD. Significant changes generally involve a change to a component of a remedy that does not fundamentally alter the overall cleanup approach.

DOE established December 31, 2020, as the end point for including decision documents issued in this fifth 5-year review report. Decision documents issued after December 31, 2020, will be addressed in the next (sixth) 5-year review.

This 5-year review does not include the 17 OUs that did not have interim or final remedial action RODs as of December 31, 2020; most of these OUs are undergoing the remedial investigation/feasibility study (RI/FS) process or are in the remedy decision process. As cleanup decisions are made for these OUs and documented in a ROD and field construction of the remedy begins, the OUs will be evaluated for protectiveness and included in a future 5-year review report. The specific Hanford Site OUs currently holding this pre-ROD status are 14 source OUs (i.e., 100-OL-1, 200-BC-1, 200-CB-1, 200-CP-1, 200-CR-1, 200-CW-1, 200-DV-1, 200-EA-1, 200-IA-1, 200-IS-1, 200-OA-1, 200-SW-1, 200-SW-2, and 200-WA-1) and 3 groundwater OUs (i.e., 100-BC-5, 200-BP-5, and 200-PO-1). This report also does not include the 100-IU-1, 100-IU-3, 100-IU-4, and 100-IU-5 source OUs; a 1996 ROD ([EPA et al. 1996](#)) determined that no further remediation was necessary and that a [CERCLA](#) 5-year review does not apply. While a determination was made in 1993 to officially remove Hanford's 1100 Area (including OUs 1100-EM-1, 1100-EM-2, 100-EM-3, and 1100-IU-1) from the NPL, per *EPA, Superfund Record of Decision: USDOE Hanford 1100-Area* ([EPA/ROD/R10-93/063](#)), as amended, the 1100-EM-1 OU is included in this report because it still includes one waste site (the Horn Rapids Landfill) that has institutional controls (ICs) due to buried asbestos (a hazardous substance). As long as asbestos remains at the landfill site and prevents the property from being released for unlimited use and unrestricted exposure, the landfill will be included in [CERCLA](#) 5-year reviews.

Table 1-1. Operable Units Addressed in this Report.

Operable Unit	CERCLA DECISION DOCUMENT – Type and Year																		
	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
RIVER CORRIDOR – 100 Area NPL Site																			
100-BC-1			IRA		RODA	IRA	IRA	IRA				ESD					ESD		
100-BC-2					RODA	IRA	IRA	IRA				ESD					ESD		
100-FR-1					RODA	IRA	IRA	IRA				ESD					ESD		
100-FR-2					RODA	IRA	IRA	IRA				ESD					ESD		
100-FR-3																			
100-IU-2							IRA					ESD					ESD		
100-IU-6							IRA	ESD				ESD					ESD		
100-DR-1			IRA		RODA	IRA	IRA	IRA				ESD					ESD		
100-DR-2					RODA	IRA	IRA	IRA				ESD					ESD		
100-HR-1			IRA		RODA	IRA	IRA	IRA				ESD					ESD		
100-HR-2							IRA	IRA				ESD					ESD		
100-HR-3							RODA				ESD						ESD		
100-KR-1					RODA	IRA	IRA					ESD					ESD		
100-KR-2					RODA	IRA	IRA	IRA				ESD	RODA				ESD		
100-KR-4																			
100-NR-1					IRA		IRA	IRA									ESD		ESD
100-NR-2							IRA	IRA									RODA		ESD
RIVER CORRIDOR – 300 Area NPL Site																			
300-FF-1					ROD			ESD											
300-FF-2									IRA			ESD					ESD		
300-FF-5					IRA			ESD											ESD
RIVER CORRIDOR – 1100 Area																			
1100-EM-1	ROD																ESD		
CENTRAL PLATEAU – 200 Area NPL Site																			
200-UP-1					IRA												ESD		
200-ZP-1			IRA															IRA	
200-CU-1																			
200-CW-3							IRA						ROD						
200-DF-1			ROD	ESD	RODA	RODA	RODA	RODA									ESD	RODA	
200-PW-1																			
200-PW-3																			
200-PW-6																			
200-CW-5																			

Legend:

NOTE: The 100-KR-2 Operable Unit has two separate interim records of decision in 1999
 ESD = explanation of significant differences
 IRA = interim remedial action record of decision
 ROD = final remedial action record of decision
 RODA = record of decision amendment

Five-Year Review Schedule. The EPA published the first 5-year review report, *USDOE Hanford Site First Five Year Review Report* ([EPA 2001b](#)), which covers the period from 1996 through 2000, in 2001. The second, third, and fourth 5-year review reports for the Hanford Site are [DOE/RL-2006-20](#), *The Second CERCLA Five-Year Review Report for the Hanford Site* (2001-2005), [DOE/RL-2011-56](#), *Hanford Site Third CERCLA Five-Year Review Report* (2006-2010), as amended by Errata Sheet “Hanford Site Third Comprehensive Environmental Response, Compensation and Liability Act Five-Year Review Report, April 2012,” ([12-EMD-0070](#)) for the period of 2006 through 2010, and the fourth 5-year review report is [DOE/RL-2016-01](#), *Hanford Site – Fourth CERCLA Five-Year Review Report* (2011-2015). The trigger date for subsequent reviews corresponds to EPA’s concurrence signature date for the preceding 5-year review report. DOE will conduct the sixth 5-year review, which will address remedy implementation and performance for the period from 2021 through 2025, in 2026.

Report Structure. This report has been designed to follow EPA guidance, which identifies the required and desired content of [CERCLA](#) 5-year review reports, as well as the proper evaluation and determination of protectiveness for [CERCLA](#) OUs. To meet these objectives and align with the Hanford Site’s cleanup decision framework, this report is organized by source and groundwater OUs, which are segregated by their location either in the River Corridor or on the Central Plateau, as follows:

- Chapter 2, River Corridor National Priorities List Sites, presents the evaluations of remedy implementation and performance for 21 source and groundwater OUs in the 100 and 300 Area NPL sites and the 1100 Area.
- Chapter 3, Central Plateau National Priorities List Sites, presents the evaluations of remedy implementation and performance for nine source and groundwater OUs in the 200 Area NPL Site.

While each OU write-up is tailored to the precise makeup of the subject OU, they all contain the same basic information:

- A brief description of the OU
- An aerial map showing the OU location on the Site
- A chronology table briefly describing the decision documents relevant to the OU
- A list of remedial action objectives (RAOs^j) taken directly from the ROD
- A description of the remedy components
- A discussion of the progress at that OU since the last [CERCLA](#) 5-year review
- A table summarizing the OU cleanup status
- A diagram of the OU showing waste sites and cleanup status
- A technical assessment that answers specific questions posed by the EPA guidance
- A discussion of any new issues and/or corrective actions involving the OU since the last review
- A protectiveness statement that explains how well the remedy for the OU is working.

In addition, each groundwater OU section contains an overview table summarizing the remedy implementation. The table lists the decision documents, briefly describes the associated RAOs, lists the contaminants of concern (COC), and provides a list of the remedy components and an estimate of each component’s construction and implementation progress, along with the estimated operation and maintenance (O&M) time for each component and, based on the O&M duration, an estimated completion year. Remedial process optimization (RPO), such as adding new injection/extraction wells or adjusting injection/extraction rates for a pump-and-treat operation is considered part of the O&M phase.

^jAn RAO is a general description of what the cleanup will accomplish (e.g., restoration of groundwater to drinking water standards). RAOs serve as the design basis for the remedy and facilitates the 5-year review determination of protectiveness of human health and the environment.

The table's implementation status chart reflects a snapshot of each remedy component as it was in December 2020; the table does not reflect planned studies or remedy modifications, nor speculate on future changes based on current or future studies or findings.

Each groundwater OU section also contains a table providing the contaminant plume concentration and extent in 2015 and 2020, a map showing the OU's well locations, plume maps comparing the contaminant plumes from 2015 and 2020, and a trend plot showing the changes in contaminant plume areas since remediation began.

1.1 Background

The Hanford Site was established in 1943 to produce nuclear materials for national defense and is managed by the DOE, Richland Operations Office (DOE-RL), and DOE, Office of River Protection. The city of Richland, the nearest population center, adjoins the southeastern Hanford Site boundary.

The Hanford Site covers approximately 1,500 km² (580 mi²) adjacent to the city of Richland, Washington (Figure 1-1). The original site was 1,740 km² (670 mi²) and included buffer areas across the Columbia River in Grant and Franklin counties. Some of this land was returned to private use and now supports orchards and irrigated fields.

When it was established, the Hanford Site was divided into numerically designated areas. These areas served to identify the locations for reactor, chemical separation, and related activities for producing and purifying special nuclear materials and other nuclear activities. Six reactor areas were established along the Columbia River in Hanford's 100 Area. The 200 Areas include the 200-East and 200-West Areas and are, respectively, about 11.2 and 8.0 km (7 and 5 mi) south and 11.2 and 19.3 km (7 and 12 mi) west of the Columbia River where chemical separations of the irradiated fuel took place. Reactor fuel reprocessing took place in the 200 Areas. The 300 Area, located adjacent to the Columbia River and immediately north of the city of Richland, contained reactor fuel manufacturing plants and research and development laboratories. The 1100 Area, located southwest of the 300 Area and just north of Richland, served as the central warehousing, vehicle maintenance, and transportation operations center for the Hanford Site. As shown in Figure 1-1, Hanford's 100, 300, and 1100 Areas are in a location known as the River Corridor. Hanford's 200 Areas are in a location known as the Central Plateau.

1.1.1 History and Basis for Taking Action on Cleanup

In early 1943, the U.S. Army Corps of Engineers selected the Hanford Site as the location for plutonium production for national defense. For over 20 years, activities were dedicated primarily to producing plutonium and managing the resulting waste. In later years, activities became increasingly diverse, involving research and development for advanced reactors and renewable energy technologies. The end of the Cold War precipitated the shutdown of the Site's plutonium production and management facilities.

When the cleanup project was initiated in 1989 with the signing of the Tri-Party Agreement ([Ecology et al. 1989](#)), efforts to characterize known and suspected areas of contamination began. Early [CERCLA](#) RI/FS and [Resource Conservation and Recovery Act of 1976](#) (RCRA) facility investigation/corrective measures study work plans indicated that 7 to 10 years of characterization would be needed before cleanup alternatives could be evaluated and decisions made; however, for many OUs, the characterization process has taken much longer (Table 1-1).

Based on early Hanford Site waste disposal practices and known spills and releases to the environment, the Hanford Site potentially qualified for listing on the [CERCLA](#) NPL. The DOE initiated a preliminary assessment/site investigation that included a comprehensive review of historical records including facility operating records; data from groundwater, surface water, soil, and air monitoring and sampling; aerial

photographs; interviews with workers; and physically walking the Site to identify potentially disturbed areas. Using the information gathered during these activities, as documented in *Hazard Ranking System Evaluation of CERCLA Inactive Waste Sites at Hanford* ([PNL-6456](#)), EPA determined that the Site qualified for inclusion on the NPL.

The preliminary assessment/site investigation also revealed that exposure to some contaminants posed a potential threat to human health and the environment. As a result, DOE established a ‘bias for action’ approach to cleanup. The bias for action allowed DOE, with regulatory agency approval, to conduct removal actions in areas that pose a potential immediate threat to human health and the environment. This resulted in taking interim remedial actions before fully characterizing the type, level, and extent or degree of contamination and before developing final [CERCLA](#) remedy selection RODs.

In anticipation of the NPL listing, DOE entered into the Tri-Party Agreement ([Ecology et al. 1989](#)) with the Washington State Department of Ecology (Ecology) and the EPA. The legally binding agreement established regulatory guidelines and the framework for achieving the cleanup. For each OU, the Tri-Party Agreement ([Ecology et al. 1989](#)) designates either EPA or Ecology as the lead regulatory agency. By federal law, DOE is the lead agency to implement [CERCLA](#). The official list of waste sites that need [CERCLA](#) remedial action is included in the *Hanford Federal Facility Agreement and Consent Order Action Plan* (Tri-Party Agreement Action Plan) ([Ecology et al. 2011](#)), Appendix C. The Waste Information Data System (WIDS) database maintains information for each of these waste sites as required by the Tri-Party Agreement Action Plan. WIDS is managed in accordance with [TPA-MP-14](#), *Maintenance of the Waste Information Data System (WIDS)*.

The Tri-Party Agreement’s ([Ecology et al. 1989](#)) scope is broader than this review. It addresses regulated [RCRA](#) units and the cleanup of past-practice units required under [RCRA](#) and/or [CERCLA](#). Active [RCRA](#) treatment, storage, and disposal (TSD) units, such as the tank farms, are not part of this review. Although this review does not cover [RCRA](#) TSD activities, the Tri-Party Agencies (DOE, EPA, and Ecology) are integrating closure of inactive TSD facilities with [CERCLA](#) waste site cleanup, as the Tri-Party Agreement ([Ecology et al. 1989](#)) intended. The Tri-Party Agencies also are applying a groundwater cleanup strategy, set forth in *Hanford’s Groundwater Management Plan: Accelerated Cleanup and Protection* ([DOE/RL-2002-68](#)), that integrates the authorities and requirements of the [Atomic Energy Act of 1954](#), [CERCLA](#), and [RCRA](#).

The Tri-Party Agreement also allows the lead regulatory agency an option to perform independent 5-year reviews. EPA exercised this option in calendar year (CY) 2000 and conducted the first [CERCLA](#) 5-year review of response actions for the Hanford Site. This first review evaluated the performance of the remedies selected in interim action RODs, including the existing ICs to prevent exposure to the public and the environment. The first review also identified deficiencies and corrective actions to address the deficiencies. The review concluded that the selected remedies were protective or would be protective when the remedial action was completed. In April 2001, EPA released the First 5-Year Review Report ([EPA 2001b](#)), which documented those results. Consistent with [CERCLA](#) and [Executive Order 12580](#), DOE conducted the second (2005-2006), third (2006-2010) and fourth (2011-2015) 5-year reviews. They used the same approach as EPA in conducting these reviews, following EPA’s *Comprehensive Five-Year Review Guidance* ([EPA 2016](#)). This fifth CERCLA 5-year review for 2016-2020 also followed [EPA \(2016\)](#), as well as elements of *Five-Year Review Recommended Template* ([EPA 2016](#)) and supplemental guidance.

Because sufficient information about the level and extent of contamination was not available to support final decisions, interim action decision documents (interim action RODs, expedited response action approvals, and action memorandums) were developed during the earlier years for Site cleanup. During interim cleanup actions, samples were collected and analyzed to evaluate the progress of the action and to

increase understanding of the types, levels, and extent of the contamination and more complete remedial actions. These remedial actions addressed the contaminants of greatest concern in the areas where the environmental threat was known to be highest. As a result, cleanup focused for several years in areas that posed the highest risk to the Columbia River (River Corridor, Table 1-1). The focus has continued to be on activities intended to protect the Columbia River primarily by using excavation, treatment and disposal, and groundwater pump-and-treat systems, to remove source contaminants from the soil and groundwater.

1.1.2 Land Use

Cleanup decisions take into consideration the current and reasonably anticipated future land use.

The *Hanford Comprehensive Land Use Plan Environmental Impact Statement (HCP-EIS)* (DOE/EIS-0222-F, see Section 4.0 for access to document) addresses land use planning for the Hanford Site. The final selection of land-use designations, map, policies, and procedures, as documented in the HCP-EIS and ROD ([64 FR 61615](#)), defines the Site's Comprehensive Land Use Plan (CLUP). The acronym "HCP-EIS" is used when addressing the analysis of the environmental impacts and the [National Environmental Policy Act](#) process for this environmental impact statement. The Hanford Site's land use map, as presented in *Supplement Analysis of the Hanford Comprehensive Land-Use Plan Environmental Impact Statement* ([DOE/EIS-0222-SA-02](#)), is shown in Figure 1-2.

As stated in the HCP-EIS, "the CLUP is a living document designed to identify a course over an extended period of development and management of resources, yet the plan is flexible enough to accommodate a wide spectrum of both anticipated and future mission conditions." The HCP-EIS will remain in effect as long as DOE retains legal control of some portion of the Hanford Site, which is expected to be longer than 50 years.

EPA and Ecology believe that, beyond the reasonably anticipated future land use designations in the HCP-EIS, other uses (including residential use) are reasonably anticipated future land uses for some Hanford areas. The future land uses that have thus far served as the basis for cleanup levels defined in Hanford RODs vary:

- Residential land use has served as the basis for 100 Area cleanup levels
- Residential land use and industrial land use served as basis for cleanup levels in the 300 Area, depending on location
- Residential land use served as the basis for cleanup in the 1100 Area (except for the Horn Rapids Landfill)
- Industrial use and residential have thus far been the bases for Central Plateau/200 Area cleanup levels, depending on location.

Additional detail on land use is provided in later sections of this report.

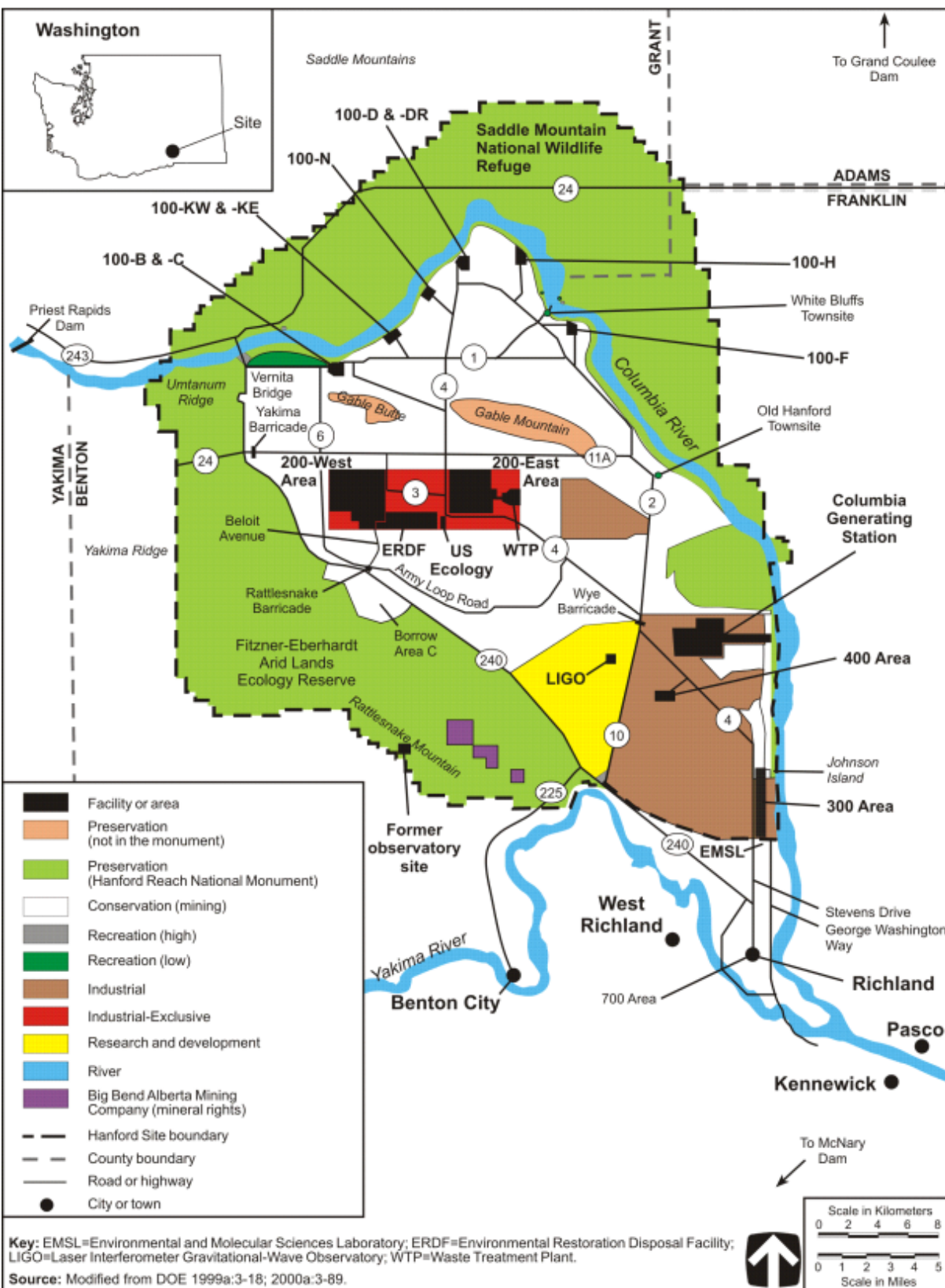


Figure 1-2. Hanford Site Land-Use Map ([DOE/EIS-0222-SA-02](#)).

1.2 Remedial Actions

Remedial actions under way at the Hanford Site, which vary by OU, are described in detail in Chapters 2 and 3. Common remedy components for source and groundwater OUs are noted below:

- **Source OUs.** Decontaminate and demolish buildings; removal, treatment (as required), and disposal (RTD) of contaminated soil, debris, piping, landfills, and engineered structures; treat in situ; backfill, recontour, and revegetate; and implement ICs
- **Groundwater OUs.** Extract, treat, and reinject groundwater; treat in situ via chemical additions; use reactive barriers; enhanced attenuation and monitored natural attenuation; groundwater monitoring; and implement ICs.

Because ICs are often a common remedy component for both source and groundwater OUs, they are discussed in more detail in the following subsection.

1.2.1 Institutional Controls

ICs have been and continue to be a critical element of Hanford Site operations since the Site's inception as part of the Manhattan Project. Because of the nature of the Manhattan Project and later nuclear materials production activities, public access to the Site was prohibited; the prohibition was strictly enforced using signs, fences, sophisticated monitoring technology, and armed patrols. With the change in mission to environmental cleanup, the need for some of the more aggressive controls has been reduced. However, being protective of human health (for public and Site workers) and the environment (including biota and physical assets) while protecting the integrity of a response action to minimize exposure to residual contamination continues to be a priority and requires that certain ICs remain in place. ICs may be applicable to individual waste sites, for OUs, or for the entire Site. Table 1-2 summarizes the categories, types, and objectives of ICs in use at the Hanford Site as of December 2020, the end of this 5-year review period.

Table 1-2. Categories, Types, and Objectives of Sitewide Controls.^{a, b} (2 Pages)

Category	Types	Objectives
Access Controls	Warning Notices • Signs • Monuments	• Provide visual identification and warning of hazardous or sensitive areas • Provide information on restrictions, access information, contact information, and emergency information • Limit access to the site or portions of the site
	Entry Restrictions	• Control human access to hazardous or sensitive areas • Ensure adequate training for those who enter hazardous or sensitive areas • Avoid disturbance and exposure to remedies such as engineered barriers or an effective vegetative soil layer • Provide a basis for the enforcement of access restrictions
	Fencing	• Prevent unauthorized human access to hazardous or sensitive areas • Provide protective barriers to standard industrial hazards • Provide visual warnings • Avoid disturbance and exposure to remedies such as engineered barriers or an effective vegetative soil layer

Table 1-2. Categories, Types, and Objectives of Sitewide Controls.^{a, b} (2 Pages)

Category	Types	Objectives
Land-Use Management	Land-use and real property controls	• Ensure that use of the land is compatible with any hazards that exist • Ensure that any changes in use of the land are adequately assessed before being allowed
	Site Evaluation Excavation Permits	• Avoid unplanned disturbance or infiltration • Inform and protect workers regarding potential exposure to hazardous waste • Avoid the creation of potential pathways for the migration of hazardous waste
	Industrial Use	• Maintain industrial use designation
	Enhanced Recharge	• Minimize water infiltration with the potential to enhance contaminant transport to groundwater^c
	Irrigation Control	• Eliminate the potential for irrigation water to mobilize residual contaminants in the soil
Groundwater-Use Management	Land-use and real property controls, excavation permits	• Ensure proper use of groundwater
Barriers	Engineered Controls	• Isolate contaminants from the accessible environment • Maintain engineered cap
Information Controls	Administrative Support, archives and libraries	• Maintain and provide access to information on the location and nature of contamination
	Notifications and restrictions	• Ensure that any changes in the property ownership or control or oversight will be communicated to the appropriate parties and required notifications will be made • Ensure that the ICs are maintained beyond change of ownership, as appropriate • Notify Benton County Sheriff's Office of trespassing incidents
	Notice in Deed	• Ensure that the actual land use is limited to the designated land use
Miscellaneous	Administrative	• Compliance with administrative requirements such as updating the Sitewide IC Plan (DOE/RL-2001-41)

^a Source: DOE/RL-2001-41, 2019, *Sitewide Institutional Controls Plan for Hanford CERCLA Response Actions and RCRA Corrective Action*, Rev. 9, U.S. Department of Energy, Richland Operations Office Richland, Washington. Available online at <https://pdw.hanford.gov/document/AR-01129>.

^b See IC Plan in footnote "a" (above) for more detailed descriptions of Hanford's IC Categories, Types and Objectives.

^c The Enhanced Recharge IC, as applicable (for example) to certain waste sites in the 300 Area, is to be accomplished by preventing irrigation or landscape watering, controlling drainage from low permeability areas such as paved parking lots or buildings, and preventing bare gravel or bare sand covers.

IC = institutional control

DOE has prepared and maintains [DOE/RL-2001-41](#), *Sitewide Institutional Controls Plan for Hanford CERCLA Response Actions and RCRA Corrective Action*. This document provides a consolidated and detailed description of the ICs required by the [CERCLA](#) documents (e.g., interim and final RODs, ROD amendments, ESDs, Tri-Party Agreement change notices, cleanup verification packages, and work plans) for each OU. These ICs prevent such remedies as engineered barriers or a vegetated soil layer from being disturbed and help protect the public, DOE employees, contractors, and/or any combination of the following groups:

- **Non-DOE Entities Using DOE Land.** Individuals associated with an organization other than DOE or its contractors who are located on the Hanford Site or are conducting activities on the Hanford Site. DOE has leased some areas within the Site boundaries to other government organizations (e.g., Energy Northwest Columbia Generating Station, the US Ecology Commercial Low-Level Radioactive Disposal Site, and the National Science Foundation Laser Interferometer Gravitational-Wave Observatory operated by the California Institute of Technology and the Massachusetts Institute of Technology). DOE has also recently transferred approximately 664 ha (1,641 ac) to the Tri-City Development Council Community Reuse Organization by quitclaim deed. Inclusion of areas (and management of ICs) as reported in the 5-year reviews are based on CERCLA RODs, not the leasing status of a property.
- **Hanford Site Visitors.** Individuals who access the Hanford Site for Site-related purposes (e.g., public tours).
- **Inadvertent Intruders.** Individuals who inadvertently access the Site (e.g., stray onto the Site from recreational areas along the Columbia River shoreline).

DOE has the primary responsibility for assessing the performance of the ICs to ensure their effectiveness and identifying any need to adjust the ICs based on performance findings. DOE and a subset of its prime contractors^k assess the ICs and annually report on their effectiveness to EPA and Ecology at the Hanford Site's 100/300 Area unit managers' meetings and at the 200 Area project manager's meetings.

The annual assessment results typically are presented during the September meeting and captured in minutes that are published in the Administrative Record (see example in Attachments 4 and 6 at <https://pdw.hanford.gov/document/AR-04230>). The annual IC assessments are also now captured in an annual report (e.g., *FY2020 Sitewide Institutional Control Assessment*, [HNF-65616](#)). The annual IC assessment reports document results of assess each of Hanford's [CERCLA](#) OU ICs, including waste site-specific ICs. The Sitewide IC assessments, in conjunction with the [CERCLA](#) 5-year review, is a "roll up" of these reviews and is the basis for evaluating the ICs' effectiveness. Five annual IC assessments have been performed since the last 5-year review. Appendix A, Table A-1, summarizes the assessment results for this 5-year period.

1.3 Review Process

The process for reviewing source OUs and groundwater remediation OUs generally included the following activities:

Document Gathering and Data Review. The first step in producing this *Hanford Site Fifth CERCLA 5-Year Review Report* involved gathering data to evaluate the OUs with active remedial actions. Information and data gathered and reviewed included remedy performance and operational requirements, compliance and findings, recommendations, and action items from The *Hanford Site Fourth CERCLA Five-Year Review Report* ([DOE/RL-2016-01](#)). Data gathered and reviewed for performance and operational requirements included RODs, ROD amendments, ESDs, and remedial design reports/remedial action work plans (RDR/RAWP). Groundwater monitoring data were reviewed and assessed for trends in contaminant plume size, river shoreline impacts, and progress toward full implementation of the remedy components. WIDS entries were reviewed, along with waste site cleanup documentation (e.g., waste site

^k The prime contractors assessing institutional controls during this 5-year review period of 2016 through 2020 were Mission Support Alliance, LLC, CH2M HILL Plateau Remediation Company, and Battelle (as manager of the Pacific Northwest National Laboratory).

cleanup verification packages). The results from annual IC assessments, including any breaches/violations of ICs, also were gathered and reviewed. Together, this information and data supported the technical basis for performing this 5-year review.

Site Visits and Field Evaluation. DOE representatives and DOE contractor staff regularly perform field evaluations. DOE and regulatory personnel actively oversee the cleanup activities and are frequently in the field inspecting the contractors' work. When necessary, field evaluations are conducted with the DOE contractor performing the work under consideration to review potential issues identified during the data gathering and review portion of the review process. Annual assessments of ICs also are performed and presented to Site regulators each fall; the results of IC inspections are also published each year (e.g., [HNF-65616, FY2020 Sitewide Institutional Control Assessment](#)).

Community Notification and Involvement. Assessment of the 30 OUs addressed in this report required an extensive number of focused personal interviews, team discussions, and information and data exchanges among DOE managers and project leads, Site contractors' OU project managers and lead scientists, as well as with the lead regulatory agency (EPA and Ecology) staff assigned to each OU. While the focused dialogue to support development of this report took place primarily during 2020 and 2021, DOE, EPA, Ecology, and other Site stakeholders are actively involved in OU remedy implementation and performance matters interacted via the unit managers' meetings and project managers' meetings (generally held bimonthly) throughout the 5-year review period. Considerations for this report (covering 2016-2020) began soon after Hanford's previous 5-year review ([DOE/RL-2016-01](#)) was completed on May 5, 2017.

- On May 24, 2017, shortly after completing the previous 5-year review, DOE issued a notice of completion of the review (sent from hanford-info@listserve.wa.gov to over 1,000 recipients), providing access to the report and soliciting questions about the report.
- On June 7, 2017, DOE presented the results of the 2011-2015 review to the Hanford Advisory Board (HAB); see presentation within the HAB's website at: <https://www.hanford.gov/page.cfm/hab>. The HAB is a non-partisan body that provides informed recommendations and advice to DOE, EPA and Ecology on policy issues related to cleanup of the Hanford Site. The HAB includes roughly 75 members from local government interests, local business interests, the Hanford workforce, regional citizen/environmental/public interest organizations, local and regional public health, Tribal governments, the State of Oregon, local universities, and the public at large. HAB Consensus Advice from recent years (e.g., HAB Consensus Advice #283, #278, #283, #290, #303 and #304), also presented on the HAB website (<https://www.hanford.gov/page.cfm/hab>), were reviewed in support of this 5-year review.
- On November 23, 2020, DOE published a Hanford Site Notification in the local newspaper (the Tri-City Herald) to announce the start of this 5-year review, provide a weblink to all previous reviews, and to solicit information to be considered or questions about the upcoming review for years 2016-2020.
- Shortly after completion of this 5-year review, DOE will issue a notice of completion of the review, providing access to the report and soliciting questions about the report.

Support for Action Item Discussions. DOE held discussions with the respective lead regulatory agency to address outstanding recommendations or performance issues. Action items resulting from these discussions and draft report reviews are included in this report.

Technical Assessment. The technical assessment evaluates the risk input factors, including the following: current and future land-use changes and associated exposure pathways; site conditions, such as the degree to which remedy performance is based on the original assumptions; and contaminant toxicity.

In determining the protectiveness of the remedies, DOE considered the following technical assessment questions from EPA guidance ([EPA 2001a](#)):

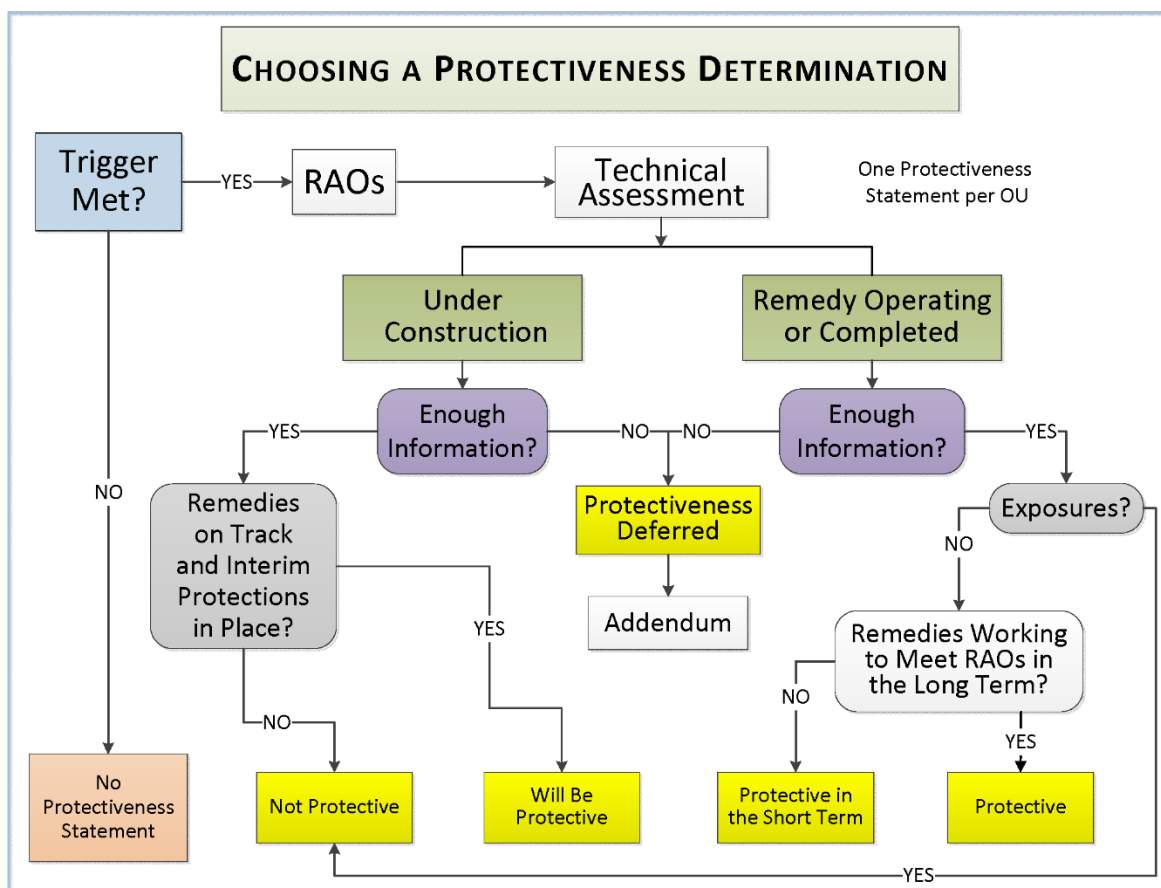
- *Question A -- Is the remedy functioning as intended by the decision documents?*
- *Question B -- Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of remedy selection still valid?*
- *Question C -- Has any **other** information come to light that could call into question the protectiveness of the remedy?*

Protectiveness Statement Development. DOE evaluated the OUs in each of Hanford's NPL site (i.e., 100 Area, 200 Area, and 300 Area) as well as one waste site located in Hanford's 1100 Area. DOE used the three technical assessment questions provided in the EPA guidance to evaluate the success of implementing the selected remedies against the RAOs and cleanup criteria established in the ROD. Protectiveness statements for each OU were developed in accordance with the process outlined in EPA's Comprehensive Five-Year Review Guidance ([EPA 2001a](#)); the EPA memo, "Clarifying the Use of Protectiveness Determinations for [CERCLA](#) Five Year Reviews" ([OSWER 9200.2-111](#)); as well as the general decision logic presented in Figure 1-3.

Report Development. After DOE and their contractors completed the previously noted activities they assembled a comprehensive report for peer review by the project managers, scientists, and engineers from the Site contractor organizations, DOE, EPA, and Ecology. Several stakeholders (e.g., Oregon Department of Energy and Yakama Nation) provided feedback on the draft 5-year review report as well.

The narratives for the individual OUs, or, in some cases, groups of similar source OUs, are presented in a generally common format covering the OU's background, the chronology of the decision documents, the selected remedial action, progress since the previous 2011-2015 review, a technical assessment, identification of any new issues and corrective actions, and a protectiveness statement for each OU.

Next 5-Year Review. As required under [CERCLA](#), the lead agency must conduct a periodic 5-year review of its remedies as long as contaminants pose a threat to human health and the environment. Because [CERCLA](#) remedial actions are expected to continue, the next Hanford Site 5-year review will cover the period from January 2021 through December 2025, with the 5-year review report issued and transmitted to EPA by March 2027, and EPA's letter of concurrence or non-concurrence written by May 4, 2027.



This figure directly applies for OUs with final action RODs (i.e., 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2 and 100-IU-6; 100-DR-1, 100-DR-2, 100-HR-1, 100-HR-2, 100-HR-3; 300-FF-1, 300-FF-2, and 300-FF-5; 200-CW-5, 200-PW-1, 200-PW-3 and 200-PW-6; 200-ZP-1 OUs; and 1100 Area). All other OUs addressed in this report are working under interim action RODs; the figure can apply to these OUs by following the “Under Construction” (left green box) condition.

Figure 1-3. Generalized Decision Logic for Choosing a Protectiveness Determination.

A Forward Look. The Tri-Party Agencies expect that Hanford’s next 5-year review (addressing remedy implementation and performance for years 2021-2025) will include additional focus on the topic of releases of per- and polyfluoroalkyl substances (PFAS) to the environment. According to EPA, the scope of PFAS contamination in the United States and the potential threat to public health makes the federal government’s task to address this contamination particularly challenging and urgent. PFAS are a class of man-made chemicals that have been manufactured and used in a variety of industries since the 1940s. Per “Memorandum for Heads of Departmental Elements: Addressing Per- and Polyfluoroalkyl Substances at the Department of Energy,” (DOE 2021) PFAS were first produced on an industrial scale for use in uranium separation activities during the Manhattan Project; thousands of chemical formulations have since been developed. PFAS substances have also been widely used in private industry due to their resistance to grease, water, oil, and heat and are often found in stain-resistant carpeting, water-resistant clothing, non-stick and grease-resistant food contact materials (e.g., cookware and food packaging), and aqueous firefighting foam (AFFF). These chemicals do not break down easily in the environment or the human body due to their strong carbon-fluorine bond, and certain PFAS substances have been found to be

associated with adverse human health impacts. Addressing these substances is a complex environmental challenge due to the number of formulations that exist, their varying impacts on the human body, and their ubiquitous environmental presence due to their widespread uses.

In recognition of the need for a comprehensive approach to PFAS contamination and use, U.S. Department of Energy, Headquarters (DOE-HQ) has recently developed a policy to aid in DOE's effort to assess, contain, reduce, and/or remove PFA contamination and use throughout the DOE complex (including Hanford). Per the 2021 DOE-HQ policy addressing PFAS ([DOE 2021](#)), one of its initiatives is to appropriately characterize historic PFAS use and releases at DOE sites with a focus on the following:

- Understanding the Manhattan Project and Cold War era sources and volumes of PFAS used and disposed of, with initial focus on uranium processing operations
- Assessing AFFF releases to the environment from fire suppression systems, fire-fighter training operations, and emergencies resulting in AFFF use
- Identifying other uses and incidents of disposal of PFAS associated with research and operational maintenance of equipment
- Conducting ongoing testing and monitoring for PFAS at levels exceeding established health advisory levels or regulatory limits.

Since, as of early 2022, the potential magnitude of PFAS use and release at the Hanford Site has not been assessed, there is no substantive information to include in this report. Information to be gathered during 2022 through 2025, initially as a Hanford sitewide assessment, will be included in the next (2021-2025) CERCLA five-year review report. The PFAS assessment should consider uses beyond that of AFFF including, but not limited to, metal plating, vehicle/machine washing operations, use of corrosion inhibitors.

For purposes of tracking an issue and recommendation for the Hanford Site in EPA's Superfund Environmental Management System (SEMS) database, the PFAS issue and recommendation can be summarized as follows:

- **Issue PFAS-1:** Historic use and releases of PFAS at Hanford has not been characterized.
- **Recommendation PFAS-1:** Assess and document Hanford's sitewide assessment of historic PFAS use and potential release areas (Milestone Date: September 30, 2024).

The PFAS-1 issue/recommendation noted above will be entered and tracked in SEMS at an OU-specific level for the aggregate of Hanford OUs. However, for document efficiency purposes, this issue/recommendation is not hereinafter repeated within this 5-year review report.

2.0 RIVER CORRIDOR (100 AREA AND 300 AREA NATIONAL PRIORITIES LIST SITES AND 1100 AREA)

2.1 Introduction

This chapter presents Hanford's [CERCLA](#) 5-year review assessments for OUs that are located in a region of the Site known as the River Corridor. As shown in Figure 1-1, the River Corridor encompasses nearly 570 km² (220 mi²) directly south and west of the Columbia River, and includes Hanford's 100-BC, 100-K, 100-N, 100-D, 100-H, and 100-F Reactor site areas, the 300 Area, and one isolated waste site in Hanford's 1100 Area. The River Corridor represents almost 40% of the Hanford Site's overall footprint.

Two of the three Hanford NPL sites (i.e., the Hanford 100 Area, and 300 Area NPL sites) are included in the River Corridor. Table 2-1 provides a list and brief description of the 17 source OUs and the 6 associated groundwater OUs in the 100 and 300 Area NPL sites and one waste site within the 1100 Area. Collectively, the source OUs in the River Corridor contain more than 1,000¹ waste sites. Approximately 85% of these waste sites had been remediated under RODs and/or interim remedial action RODs as of the end of this 5-year review period (December 2020).

The 100 Area NPL site comprises nine retired plutonium production reactors, numerous support facilities, and solid- and liquid-waste disposal sites with contaminated groundwater and soil. The 300 Area NPL site (located immediately north of the city of Richland, Washington) includes an industrial complex that was used for uranium fuel fabrication and research and development activities for the Hanford Site; the 300 Area also includes a number of waste disposal sites and areas of contaminated groundwater. Hanford's 1100 Area was officially deleted from the NPL in 1996 (see details in Section 2.4); however, one waste site (the Horn Rapid Landfill, also part of the River Corridor) contains asbestos. As long as asbestos, a hazardous substance, remains at the landfill site and prevents the property from being released for unlimited use and unrestricted exposure, the landfill will be included in Hanford's 5-year review.

Table 2-1. Chapter 2 Scope – Hanford NPL Sites and Operable Units Located in the River Corridor. (2 Pages)

Hanford Area	CERCLA OU	Brief Description ^a	Report Section
100 Area			2.3
100-BC			2.3.1
	100-BC-1	Waste sites (~59) in the 100-B/C Reactor areas	
	100-BC-2	Waste sites (~29) in the 100-B/C Reactor areas	
	100-BC-5 ^b	Contaminated groundwater from 100-BC-1/2 sites	N/A ^b
100-F/IU			2.3.2
	100-FR-1	Waste sites (~78) in the 100-F Reactor area	
	100-FR-2	Waste sites (~19) in the 100-F Reactor area	
	100-IU-2	Waste sites (~56) in the old White Bluffs townsite area, recently expanded to include westward areas	
	100-IU-6	Waste sites (~52) in the old Hanford Townsite area, recently expanded to include southward areas	
	100-FR-3	Contaminated groundwater from 100-FR-1/2 sites	
100-D/H			2.3.3

¹This value represents "Accepted" waste sites in WIDS as of December 2020 ([TPA-MP-14](#)).

Table 2-1. Chapter 2 Scope – Hanford NPL Sites and Operable Units Located in the River Corridor. (2 Pages)

Hanford Area	CERCLA OU	Brief Description ^a	Report Section
	100-DR-1	Waste sites (~96) in the 100-D Reactor area	
	100-DR-2	Waste sites (~39) in the 100-DR Reactor area	
	100-HR-1	Waste sites (~55) in the 100-H Reactor area	
	100-HR-2	Waste sites (~21) in the 100-H Reactor area	
	100-HR-3	Contaminated groundwater from 100-DR-1/2 and 100-HR-1/2 sites	
100-K			2.3.4
	100-KR-1	Waste sites (~17) in the 100-K Reactor areas ^c	
	100-KR-2	Waste sites (~127) in the 100-K Reactor areas	
	100-KR-4	Contaminated groundwater from 100-KR-1/2 sites	
100-N			2.3.5
	100-NR-1	Waste sites (~141) in the 100-N Reactor area	
	100-NR-2	Contaminated groundwater from 100-NR-1 sites	
100-OL			
	100-OL-1 ^b	Former/pre-Hanford orchard land sites in 100 Area	N/A ^b
300 Area			2.4
300-FF			2.4.1
	300-FF-1	Waste sites (~39) in the 300 Area ^c	
	300-FF-2	Waste sites (~127) in the 300 Area	
	300-FF-5	Contaminated groundwater from 300-FF-1/2 sites	
1100 Area			2.5
1100-EM			2.5
	1100-EM-1	Waste site (1), Horn Rapids Landfill, in the 1100 Area	

Legend

Source OU

Groundwater OU

^a Number of waste sites noted in parentheses represents the number of “Accepted” sites noted in WIDS (not including subsites) in accordance with TPA-MP-14, as of December 2020 and subsequent corrections per TPA Change C-20-03. Numbers may change as sites are added or deleted per processes defined in TPA-MP-14.

^b 100-BC-5 and 100-OL-1 are not included in this CERCLA 5-year review because both OUs were in the RI/FS stage and neither interim- nor final-action RODs had been issued as of December 2020.

^c Waste sites in this OU are principally soils sites contaminated by liquid waste discharges.

TPA Change C-20-03, 2021, *River Corridor Waste Site Updates in the Tri-Party Agreement, Appendix C*, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <https://pdw.hanford.gov/document/AR-14219>.

TPA-MP-14, 2011, *Maintenance of the Waste Information Data System (WIDS)*, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1109271360>.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601 et seq, Public Law 107-377.

N/A = not applicable

OU = operable unit

RI/FS = remedial investigation/feasibility study

2.2 100 Area National Priorities List Site

Background

The 100 Area NPL Site is located in the northern portion of the Hanford Site and encompasses approximately 427 km² (165 mi²) along the Columbia River. The 100 Area includes six reactor areas (100-BC, 100-K, 100-N, 100-D/DR, 100-H, and 100-F). There are two reactors each at 100-B/C, 100-D, and 100-K and one reactor each at 100-F, 100-H, and 100-N.

Eight of the nine 100 Area reactors were constructed between 1944 and 1955 and used Columbia River water for once-through cooling. The water was then discharged back to the river or to liquid waste disposal sites in the soil. The discharged cooling water contained radioactive materials and hazardous waste constituents that resulted in contaminated soil (source sites) and groundwater. The 100-N Reactor, constructed in the early 1960s, differed from the others in that it had a dual purpose of producing electricity as well as tritium and special nuclear material.

Collectively, reactor operations in the 100 Area resulted in a large number of contaminated facilities, buried pipelines, buried waste, buried and exposed disposal cribs, disposal trenches, river structures, shoreline sites, and unplanned release sites and regions of contaminated vadose zone and groundwater. Spent nuclear fuel (SNF) from the reactors in the 100 Area, previously stored in two water-filled basins in the 100-K Area, has been removed. The 100KE Basin has been decommissioned and demolished; decommissioning of the 100KW Basin is ongoing. Cleanup in the 100 Area is being accomplished through the 14 source OUs and 5 groundwater OUs identified in Table 2-1.

Progress since the last (2011-2015) [CERCLA](#) 5-year review includes more than 50 waste sites that have had remedial actions implemented in the 100 Areas. These sites have been reclassified in WIDS as either interim no-action, final no-action, interim closed, or final closed, with completion of the action approved by the lead regulatory agency. Approval is documented through the waste site reclassification forms that are included with a waste site cleanup verification package or remaining sites verification package. In accordance with the Tri-Party Agreement ([Ecology et al. 1989](#)), the status and other descriptive information on each waste site is maintained in the WIDS database. Since the last 5-year review, continuous groundwater remediation has been under way. Expanded pump-and-treat systems have been operating in the 100-D, 100-H, and 100-K Areas, and in situ barrier technology has been deployed in the 100-N Area. The individual OU discussions provide additional information. Annual summary reports for the 100 Area Pump and Treat remedy performance and operations can be accessed at <http://www.hanford.gov/page.cfm/SoilGroundwaterAnnualReports>. In addition, a ROD was issued in 2018 for the 100-DR-1, 100-DR-2, 100-HR-1, and 100-HR-2 source OUs, and the 100-HR-3 groundwater OU.

100 Area NPL Site's Land and Water Uses

Given that land use helps form the basis for exposure assessment assumptions and risk characterization conclusions under [CERCLA](#), the 100 Area NPL Site's current and reasonably anticipated future land uses, current ground and surface water uses, and potential future beneficial uses of groundwater are described in the following subsections. The basis for the following narrative is the 100 Area's most recent CERCLA ROD (*Record of Decision Hanford 100 Area Superfund Site 100-BC-1, 100-BC-2, and 100-BC-5 Operable Units* [[EPA 2021a](#)]).

Current Onsite and Surrounding Land Use

Land use in the 100 Area is currently controlled by DOE, with the U.S. Fish and Wildlife Service (USFWS) managing the Hanford Reach National Monument (HRNM) (*Hanford Reach National Monument: Final Comprehensive Conservation Plan and Environmental Impact Statement*, Adams,

Benton, Grant and Franklin Counties, Washington [[USFWS 2008](#)]), and the National Park Service operating the B Reactor as part of the Manhattan Project National Historic Park. DOE and USFWS manage this federally-owned land to protect natural and cultural resources while cleanup activities are being conducted.

The 100 Area mostly comprises undeveloped land that is used for waste management (including remediation), environmental monitoring, tourism, and conservation and restoration activities. The segment of the Columbia River adjacent to the 100-Area is used for a variety of recreational activities. The National Park Service hosts tours open to the public of any age at the B Reactor National Historic Landmark. The land use farther away, beyond the Hanford boundaries, contains irrigated agriculture and to the south and east are the cities of Richland, West Richland, Kennewick, and Pasco. All OUs within the 100 Area currently have ICs in place for access control and land-use management as implemented through [DOE/RL-2001-41](#), *Sitewide Institutional Controls Plan for Hanford CERCLA Response Actions and RCRA Corrective Actions*.

The 100 Area contains shrub-steppe vegetation, an important habitat for many native species of wildlife and plants. The vegetation in the upland areas is typically sparse, partly due to clearance during site operations. Revegetation efforts following interim waste site remediation have been successful in re-establishing plants in many areas, including native sagebrush and grass species. Vegetation found in riparian zones reflects the transition between aquatic and upland ecosystems; because of the occasional steepness of the shoreline, the transition from riparian to upland vegetation is, in certain locations, abrupt. Species lists have been compiled for the major classes of vertebrates that have been observed on the site or within the Hanford Reach of the Columbia River and include 46 species of mammals, 145 species of birds, 10 species of reptiles, 5 species of amphibians, and more than 45 species of fish ([PNNL-6415](#)).

Anticipated Future Land Use

In June 2000, the HRNM was established within the boundaries of the Hanford Site. *The Establishment of the Hanford Reach National Monument* ([65 FR 37253](#)) 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 Area is conservation, preservation, and recreation. As described in DOE/EIS-0222-F, *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement* (see Section 4.0 for access to document), and [DOE/EIS-0222-SA-01](#), *Supplement Analysis, Hanford Comprehensive Land-Use Plan Environmental Impact Statement*, the area is reserved for the management, protection, and preservation of archaeological, cultural, ecological, and natural resources. Limited public access would be consistent with resource preservation. Tribal access and use is an anticipated future use, such as traditional gathering and ceremonies. EPA and Ecology believe that other uses, including residential use, are reasonably anticipated future land use for these areas. The residential-based cleanup levels allow for conservation, preservation, and recreational uses.

Current Ground and Surface Water Uses

Groundwater from certain locations in the 100 Area is currently contaminated above drinking water standards (DWSs). Under current site use conditions and controls, the only complete human exposure pathway to groundwater in the 100 Area is the potential for limited exposure to groundwater during research and monitoring activities. The 100 Area groundwater is not being used for drinking water.

The Columbia River is the second largest river in the contiguous United States in terms of total flow and is the only surface water body at the 100 Area. The Columbia River is the principal source of drinking water for the Tri-Cities, the Hanford Site, and many downstream communities. The Columbia River is used for irrigation and recreation, which includes fishing, hunting, boating, water skiing, diving, and swimming. In addition, treaty reserved Tribal fishing rights are exercised and considered a current use of the Columbia River.

Potential Future Groundwater Uses

The NCP ([40 CFR 300.430\(a\)\(1\)\(iii\)\(F\)](#)) 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.” Washington State regulations contain a similar expectation ([WAC 173-340-720\[1\]\[a\]](#)).

Given the nature of the groundwater in the 100 Area, potential beneficial groundwater uses include drinking water, irrigation, and industrial uses. Drinking water use includes other domestic uses such as bathing and cooking.

2.3 100 Area Operable Units

Progress and assessments of protectiveness at the 100 Area source and groundwater OUs are described in the following sections.

2.3.1 100-BC Operable Units

The 100-BC Area is in the northwest portion of the Hanford Site and adjacent to the Columbia River. The 100-BC Area encompasses the 100-BC-1 and 100-BC-2 source OUs and the 100-BC-5 groundwater OU. Figure 2-1 shows the general locations of the 100-BC-1 and 100-BC-2 source OUs. The 100-BC-5 OU encompasses the area of groundwater contamination originating from these source OUs.

2.3.1.1 100-BC-1 and 100-BC 2 Source Operable Units

Prior to 2021, the 100-BC-1 and 100-BC-2 OUs underwent waste site remediation in accordance with interim action RODs; protectiveness evaluations for 100-BC-1 and 100-BC-2 source OUs are presented in this section. The 100-BC-5 groundwater OU, however, did not have a ROD for interim action nor final action prior to 2021. In 2021, EPA and DOE signed a ROD for final action at the 100-BC Area, which include the 100-BC-1, 100-BC-2, and 100-BC-5 OUs. The final action ROD is not included in this 5-year review.

Background

The 105B Reactor was constructed in 1943 and operated from 1944 through 1968 when it was retired from service. In 2008, the 105B Reactor was designated as a National Historic Landmark by the National Park Service; public tours have been offered since 2009. The 105C Reactor began operations in September 1952. It used as many of the existing 105B Reactor facilities as possible by expanding these facilities and/or cross-tying pipelines between facilities. The most significant shared facilities were the river pump house, reservoir, and inert gas system. The 105C Reactor was permanently shut down in April 1969 and in situ stabilized in 1998.

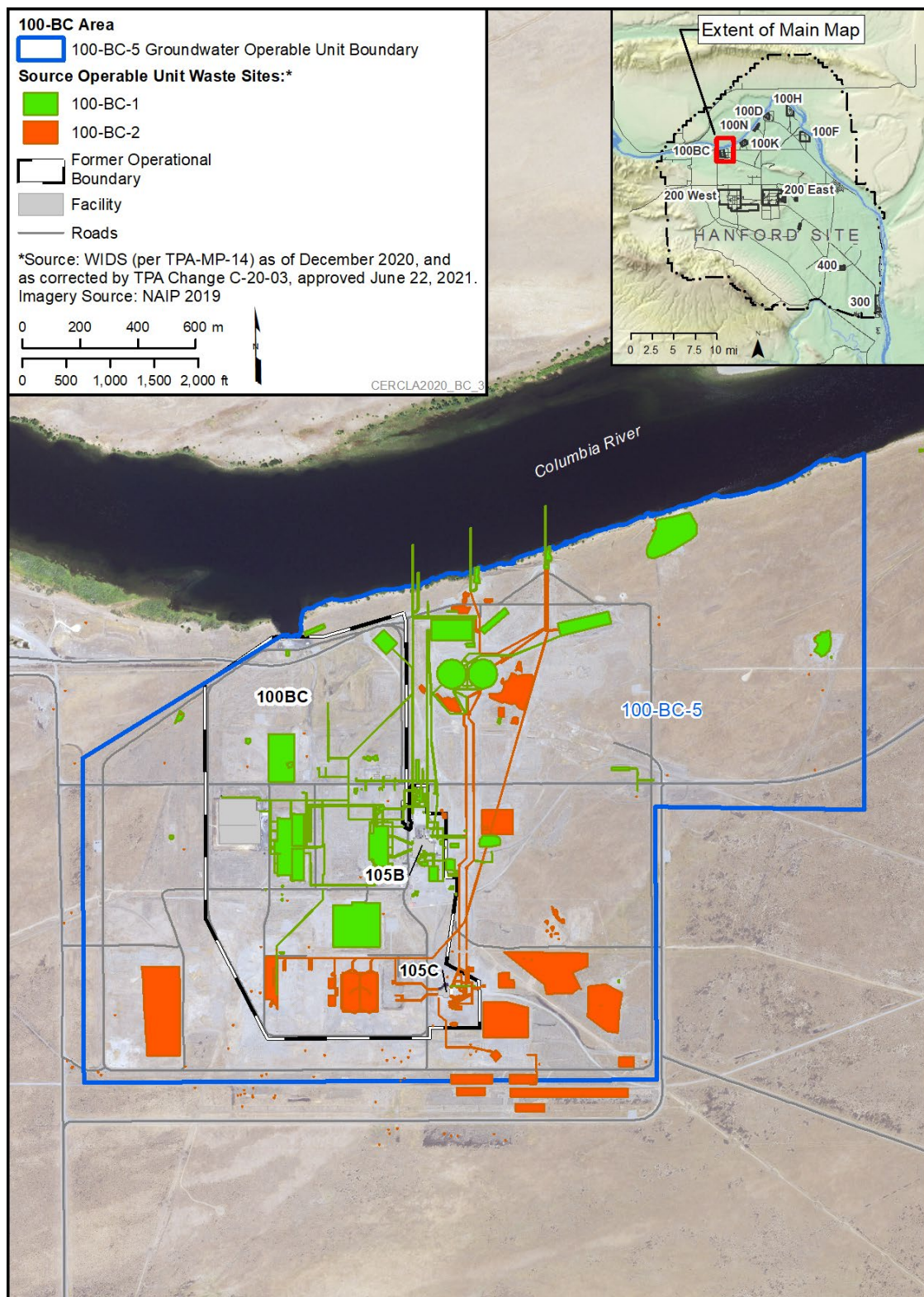


Figure 2-1. Location of 100-BC-1 and 100-BC-2 Source Operable Units.

The 100-BC-1 OU contains waste units associated with the original facilities constructed to support 105B Reactor operations, as well as the cooling water retention facilities that supported both the 105B and 105C Reactors. Waste sites in the 100-BC-1 OU include solid waste burial grounds, effluent pipelines, tanks, outfall structures, retention basins, and liquid waste receiving sites (i.e., unlined trenches, cribs, and French drains). The 100-BC-2 OU contains waste sites associated with the facilities that supported 105C Reactor operations and other waste sites at the 100-BC Area, including most of the solid waste burial grounds.

Chronology

Table 2-2 lists the remedial action decision documents relevant to source operable unit response actions in the 100-BC Area as of December 31, 2020.

Table 2-2. Decision Documents for the 100-BC-1 and 100-BC-2 Source Operable Units. (2 Pages)

Date	Location	Title
9/1995	EPA/ROD/R10-95/126	<i>Declaration of Record of Decision for the 100-BC-1, 100-DR-1, and 100-HR-1 Operable Units.</i> This interim action ROD requires removal of contaminated soil, structures, and debris using the observational approach, treatment by thermal desorption to remove organics and/or soil washing for volume reduction or as needed to meet waste disposal criteria, disposal of contaminated materials at ERDF, and backfill of excavated areas followed by revegetation.
4/1997	EPA/AMD/R10-97/044	<i>Amendment to the Interim Action Record of Decision for the 100-BC-1, 100-DR-1, and 100-HR-1 Operable Units.</i> This amendment to the interim action ROD incorporates 34 additional waste sites into the ROD; refines remedial cost estimates for the original 37 sites and additional 34 sites based on actual data, streamlining, and lessons learned; and eliminates the soil washing treatment option before disposal. The additional waste sites included in this ROD Amendment were from 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-KR-1, and 100-KR-2 source OUs.
7/1999	EPA/ROD/R10-99/039	<i>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 Remaining Sites.</i> This interim action ROD requires RTD for 46 sites; adds a plug-in approach for the RTD remedy for both remaining 100 Area and 200 North sites and newly identified 100 Area sites added by ESD; disposal of debris from B, D, H, and K Reactors to ERDF; and provides decision framework for leaving waste in place, generally below 4.6 m (15 ft) depth.
9/2000	EPA/ROD/R10-00/121	<i>Interim Action Record of Decision. 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-2, 100-HR-2, 100-KR-2 Operable Units (100 Area Burial Grounds).</i> This interim action ROD requires removal of contaminated soil, structures, and debris; treatment as needed; disposal of waste at ERDF; backfilling; and revegetation. It applies to 45 burial grounds in the 100 Area.
2/2004	EPA 2004	<i>Explanation of Significant Difference for the 100 Area Remaining Sites Interim Remedial Action Record of Decision.</i> The ESDs adds 28 sites to the ROD; adds 10 CFR 1022 and 40 CFR 6 , Appendix A as ARARs to the ROD; and revises annual ICs report date to coincide with the due date for the Sitewide IC Plan (DOE/RL-2001-41) for Hanford CERCLA response actions.
11/2007	08-AMRC-0033	<i>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).</i> This ESD establishes the limit of RTD excavation at the 118-B-1 Burial Ground considering the balancing factors in the ROD and requires additional ICs to protect groundwater and the Columbia River.

Table 2-2. Decision Documents for the 100-BC-1 and 100-BC-2 Source Operable Units. (2 Pages)

Date	Location	Title
8/2009	EPA et al. 2009	<i>Explanation of Significant Difference for the 100 Area Remaining Sites Interim Remedial Action Record of Decision.</i> This ESD authorizes adding 200-CW-3 OU wastes sites, 99 newly discovered waste sites, and 87 candidate sites using the plug-in approach in the ROD and any newly discovered waste sites documented in the Administrative Record and an annual fact sheet.
3/2011	DOE et al. 2011	<i>Tri-Party Agreement Fact Sheet: 100 Area “Plug-In” and Candidate Waste Sites For Calendar Year 2010 , Annual listing of waste sites plugged into the remove, treat and dispose remedy in the 1999 interim action Record of Decision for the 100 Area Remaining Sites.</i> This is the annual listing of candidate waste sites for confirmatory sampling and waste sites plugged into the RTD remedy in the 1999 interim action ROD for the 100 Area Remaining Sites.
1/2013	DOE et al. 2013	<i>Tri-Party Agreement Fact Sheet: 100 Area “Plug-In” and Candidate Waste Sites For Calendar Year 2012, Annual listing of waste sites plugged into the remove, treat and dispose remedy in the 1999 interim action Record of Decision for the 100 Area Remaining Sites.</i> This is the annual listing of candidate waste sites for confirmatory sampling and waste sites plugged into the RTD remedy in the 1999 interim action ROD for the 100 Area Remaining Sites.

ARAR = applicable or relevant and appropriate requirement
 CERCLA= *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
 CFR = *Code of Federal Regulations*
 ERDF = Environmental Restoration Disposal Facility
 ESD = explanation of significant differences
 IC = institutional control
 OU = operable unit
 ROD = record of decision
 RTD = removal, treatment (as required), and disposal

See Appendix B for a consolidated list of decision documents for Hanford Site OUs.

Remedial Action

Goals and Objectives. The RAOs noted in the three interim action RODs for the 100-BC-1 and 100-BC-2 source OUs, as listed above in Table 2-2, varied. The RAOs for the 100-BC-1 and 100-BC-2 waste sites, as stated in the 1995 interim action ROD ([EPA/ROD/R10-95/126](#)), were as follows:

- RAO 1. Protect human and ecological receptors from exposure to contaminants in soil, structures, and debris by dermal exposure, inhalation, or ingestion of radionuclides, inorganics, or organics.
- RAO 2. Control the sources of groundwater contamination to minimize the impacts to groundwater resources, protect the Columbia River from further adverse impacts, and reduce the degree of groundwater cleanup that may be required under future actions.
- RAO 3. To the extent practicable, return soil concentrations to levels that allow for unlimited future use and exposure. Where it is not practicable to remediate to levels that will allow for unrestricted use in all areas, ICs and long-term monitoring will be required.

The RAOs for the 100-BC-1 and 100-BC-2 waste sites, as stated in the 1999 interim action ROD ([EPA/ROD/R10-99/039](#)), included RAO 1 and RAO 2, as noted above, but did not include RAO 3. The RAOs for the 2000 interim action ROD ([EPA/ROD/R10-00/121](#)), which addressed 100 Area burial

grounds, also included RAO1 and RAO 2, as noted above, but it included a different RAO 3 as stated below:

- RAO 3. Provide conditions suitable for future land use of the 100 Areas.

Principal requirements for achieving the RAOs are described in each of the respective interim action RODs, as amended.

Remedy Components. The 1995 ROD ([EPA/ROD/R10-95/126](#)), as amended; the 1999 ROD ([EPA/ROD/R10-99/039](#)), as amended, and the 2000 ROD ([EPA/ROD/R10-00/121](#)), as amended; share the same basic remedy components, which generally include the following:

- Remove contaminated soil, structures, and debris from 100 Area source waste sites using the observational approach, which uses field data and analytical screening during remediation to guide the extent of excavation. Remediation proceeds until field screening and verification sampling demonstrate that cleanup goals have been achieved.
- Treat the waste, as required, to meet applicable waste disposal criteria.
- Dispose of contaminated materials at the Environmental Restoration Disposal Facility (ERDF).
- Backfill excavated areas and revegetate.
- Implement ICs.

Detailed descriptions of the remedy components are provided in the “Selected Remedy” section of each respective ROD, as amended.

Remedy Implementation Progress Prior to this Review Period ([DOE/RL-2016-01](#)). Work on the interim remedy, as outlined in the previous section, began in 1995. Before 2016, interim remedial actions for most (over 95%) of the waste sites had been completed.

Issues/Corrective Actions from the Previous (2011-2015) 5-Year Review Report ([DOE/RL-2016-01](#)). No issues or actions were noted for the 100-BC-1 or 100-BC-2 OU in the previous (2011-2015) [CERCLA](#) 5-year review.

Protectiveness Statement from the Previous (2011-2015) 5-Year Review Report ([DOE/RL-2016-01](#)). The protectiveness statement from the previous (2011-2015) 5-year review report for the 100-BC-1 and 100-BC-2 OUs was as follows:

***100-BC-1 Source OU – Will Be Protective.** The remedy at the 100-BC-1 source OU is expected to be protective of human health and the environment upon completion of the final remedy. Implementation of the interim remedy (primarily involving RTD, backfilling, recontouring, revegetation, and ICs) at the 100-BC-1 OU has demonstrated that exposure pathways that could result in unacceptable risks are being controlled.*

***100-BC-2 Source OU – Will Be Protective.** The remedy at the 100-BC-2 source OU is expected to be protective of human health and the environment upon completion of the final remedy. Implementation of the interim remedy (primarily involving RTD, backfilling, recontouring, revegetation, and ICs) at the 100-BC-2 OU has demonstrated that exposure pathways that could result in unacceptable risks are being controlled.*

Accomplishments. Collectively, the interim action ROD RAOs for 100-BC-1 and 100-BC-2 source OUs were achieved in 2015. The only remaining waste site assigned to these source OUs that has not been reclassified (as of December 30, 2020) is 100-B-15, which is associated with the river effluent pipelines.

During this 5-year review period, the following key documents were finalized and published in 2019:

- [DOE/RL-2010-96](#), *Remedial Investigation / Feasibility Study for the 100-BC-1, 100-BC-2 and 100-BC-5 Operable Units* (Rev. 0)
- [DOE/RL-2016-43](#), *Proposed Plan for the 100-BC-1, 100-BC-2 and 100-BC-5 Operable Units* (Rev. 0).

Table 2-3 summarizes the waste site cleanup status for the 100-BC-1 and 100-BC-2 waste sites. Figure 2-2 shows the relative distribution (noted by geographic centers of waste site footprints) and closure status (per WIDS) as of December 2020 for the waste sites in the 100-BC-1 and 100-BC-2 source OUs.

Table 2-3. 100-BC-1 and 100-BC-2 Source Operable Unit Cleanup Status.

Source OU	Number of Waste Sites ^a	Sites Dispositioned ^b			
		Pre-2016	2016 – 2020	Total	Percent
100-BC-1	59	58	0	58	98
100-BC-2	29	29	0	29	100
Total	88	87	0	87	99%

^a Number of waste sites in the OU, according to WIDS as of December 2020 (and subsequently corrected per TPA Change C-20-03). Actual numbers change if sites are added to and/or removed from an OU in accordance with DOE and regulatory agency approvals.

^b Number of sites dispositioned; includes the number of sites that have been reclassified in WIDS as of December 2020 (and subsequently corrected per TPA Change C-20-03), as either interim closed, final closed, interim no-action, or final no-action in accordance with the guideline TPA-MP-14.

TPA-MP-14, 2011, *Maintenance of the Waste Information Data System (WIDS)*, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1109271360>.

TPA Change C-20-03, 2021, *River Corridor Waste Site Updates in the Tri-Party Agreement, Appendix C*, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <https://pdw.hanford.gov/document/AR-14219>.

DOE = U.S. Department of Energy

OU = operable unit

ROD = record of decision

TPA = Tri-Party Agreement

WIDS = Waste Information Data System

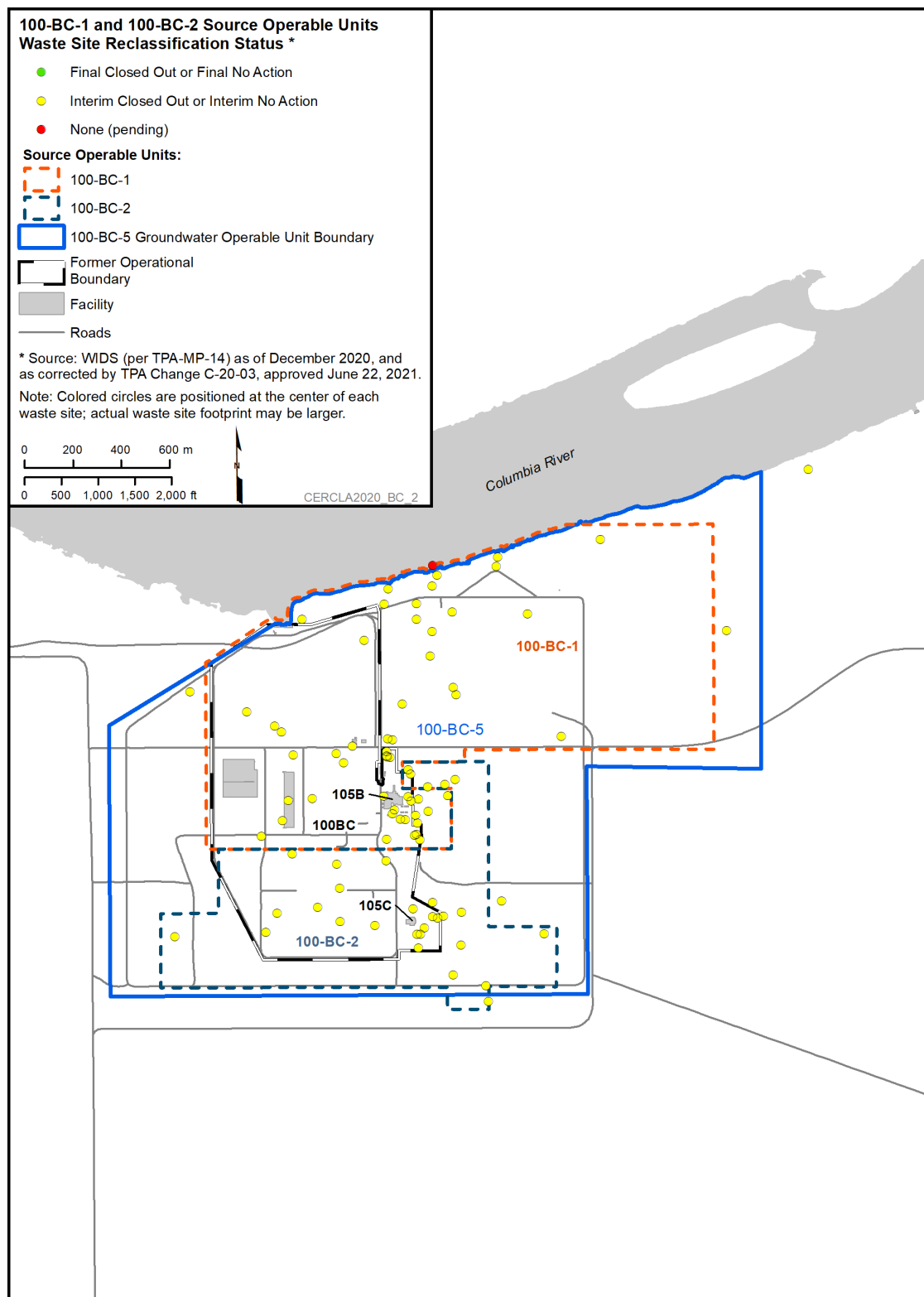


Figure 2-2. Geographic Distribution and WIDS Reclassification Status of the 100-BC-1 and 100-BC-2 Source Operable Unit Waste Sites as of December 2020.

Remedy Implementation. As described in the Accomplishments section above, over 98% of all accepted waste sites in the 100-BC-1 and 100-BC-2 OU have been remediated in accordance with the interim Action ROD; the remediation was accomplished prior to 2016. ICs have been implemented and maintained during this 5-year review period to prohibit irrigation and to control access to residual soil and groundwater contamination above standards for unlimited use and unrestricted exposure.

Technical Assessments

The 5-year review determines whether the remedy at a site is or, upon completion, will be protective of human health and the environment. The following sections provide the response to EPA's technical assessment questions for the 100-BC-1 and 100-BC-2 OUs' remedy. The response establishes a framework for organizing and evaluating data and ensuring that all relevant issues are considered when determining the protectiveness of the remedy.

Is the remedy functioning as intended by the decision documents?

The interim remedy (primarily involving RTD, backfilling, revegetation, and ICs) is functioning as intended by the interim action RODs (as amended). As of December 2020, 87 of the 88 100-BC-1 and 100-BC-2 waste sites had been remediated. The only 100-BC-1 OU waste site that has not yet been reclassified is 100-B-15 (100-BC River Effluent Pipelines).

In accordance with [TPA-MP-14](#), the 100-BC-1 and 100-BC-2 remediated waste sites have been documented in WIDS as either interim closed or interim no-action. Cleanup verification packages, including sampling data and other technical information, to support the reclassification to interim closed or no-action are included in the Hanford Site Administrative Record for the 100-BC-1 and 100-BC-2 OUs. The remedial action goals (RAG) (contaminant-specific soil cleanup criteria developed to ensure that remedial actions to be implemented will meet the RAOs) are described in Chapter 2 of the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* ([DOE/RL-96-17](#), Rev. 6). Additionally, in accordance with EPA guidance in *Close Out Procedures for National Priorities List Sites* ([EPA 540-R-98-016](#)), remedial actions are documented in *100-BC-1 Operable Unit Interim Remedial Action Report* ([DOE/RL-2011-49](#)), and *100-BC-2 Operable Unit Interim Remedial Action Report* ([DOE/RL-2015-47](#)).

The RAOs for the 100-BC-1 and 100-BC-2 remediated waste sites, and the methods used for achieving the RAOs through the interim remedial actions are summarized as follows:

- RAO 1. Protect human and ecological receptors from exposure to contaminants in soil, structures, and debris by dermal exposure, inhalation, or ingestion of radionuclides, inorganics, or organics.
 - Will be achieved through excavation to [WAC 173-340](#), “Model Toxics Control Act – Cleanup,” (MTCA) levels for organic and inorganic chemical constituents in soil to support unrestricted (residential) use.
 - Will be achieved human health total radiological dose standards of less than 15 mrem/yr above background for radionuclides.
- RAO 2. Control the sources of groundwater contamination to minimize the impacts to groundwater resources, protect the Columbia River from further adverse impacts, and reduce the degree of groundwater cleanup that may be required under future actions.
 - Will be achieved through protection such that contaminant levels in soil after remediation do not result in an adverse impact to groundwater that exceeded any nonzero maximum contaminant level goals under the [Safe Drinking Water Act of 1974](#) or Method B cleanup levels under MTCA.

- Levels of contaminants in the soil after remediation do not result in an impact to groundwater and the Columbia River that could exceed the ambient water quality criteria under the [Clean Water Act of 1977](#) for protection of fish or Method B cleanup levels under [WAC 173-340-730](#). Because no ambient water quality criteria have been established for radionuclides, maximum contaminant levels from national primary DWSs were used.
- The protection of receptors (aquatic species, with emphasis on salmon) in surface waters will be achieved by reducing or eliminating further contaminant loadings to groundwater such that receptors at the groundwater discharge in the Columbia River are not subject to any additional adverse risks. [Note: The final ROD for the 100-BC Area ([EPA 2021a](#)), (not evaluated as part of this (2016-2020) 5-year year review, requires a future task to evaluate the benthic communities in relation to the hexavalent chromium cleanup level; those additional biological studies will be integrated into the sampling and analysis portion of the future remedial design/remedial action work plan (RD/RAWP) for 100-BC-5. These studies will be discussed more in the next (2021-2025) 5-year review.]
- RAO 3. To the extent practicable, return soil concentrations to levels that allow for unlimited future use and exposure. Where it is not practicable to remediate to levels that will allow for unrestricted use in all areas, ICs and long-term monitoring will be required.
 - Will be achieved by removing waste sites to the bottom of the engineered structure, and providing ICs, as required. ICs include prevention of uncontrolled drilling or excavation into the deep zone (i.e., below 4.6 m [15 ft] and prohibiting irrigation for 140 years). As of December 2020, the IC of prohibiting irrigation applies to only two waste sites: 128-B-3 in the 100-BC-1 OU and 118-B-1 in the 100-BC-2 OU.

ICs for the 100-BC-1 and 100-BC-2 source OUs, as required by the interim action RODs (as amended), are further described in the latest version of *Remedial Design Report, Remedial Action Work Plan for the 100 Area* ([DOE/RL-96-17](#)) and are actively managed. Specific details associated with each IC also have been incorporated into *Sitewide Institutional Controls Plan for the Hanford CERCLA Response Actions and RCRA Corrective Actions* ([DOE/RL-2001-41](#)); this report is routinely updated within 180 days after publication of each decision document that addresses ICs. The ICs for the 100-BC-1 and 100-BC-2 OUs include waste-site-specific ICs (e.g., drilling and excavation restrictions for waste sites where residual contamination remains at depth and an irrigation restriction for one 100-BC-2 site to prevent migration of tritium into the groundwater) and general-areas ICs, including access control (warning notices and entry restrictions), land-use management (land use and excavation permits), groundwater-use management, and miscellaneous provisions. These ICs are assessed annually and DOE presents a summary including any noted issues or actions to the Site regulators each fall at the unit managers' meeting. The presentation is documented in the 100/300 Area Unit Managers' Meeting minutes, which are archived in the Hanford Site Administrative Record (see examples in Attachments 4 and 6 at the following link: <https://pdw.hanford.gov/document/AR-04230>). The annual IC assessments are also now captured in an annual report (e.g., [HNF-65616, FY2020 Sitewide Institutional Control Assessment](#)). The 100-BC-1 and 100-BC-2 source OU waste sites that were inspected during the 2020 assessment included:

- 100-B-14:1, 100-B-21:4, 100-B-5, 100-B-8:1, 100-B-8:2, 100-C-6:1, 100-C-6:2, 100-C-6:3, 100-C-6:4, 100-C-9:1, 100-C-9:3, 100-C-9:4, 116-B-1, 116-B-11, 116-B-12, 116-B-16, 116-B-2, 116-B-3, 116-B-4, 116-B-6A, 116-B-7, 116-C-1, 116-C-2A, 116-C-2B, 116-C-2C, 116-C-3, 116-C-5, 118-B-1, 118-B-6, 118-C-1, 118-C-3:2, 128-B-3, 132-B-6 and 132-C-2.

During the 5-year review period of 2016 through 2020, appropriate ICs for the 100-BC-1 and 100-BC-2 source OUs were found to be in place and maintained, and the objectives for the ICs are being met.

Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of remedy selection still valid?

The exposure assumptions and interim RAOs used at the time of interim remedy selection were still valid as of December 2020. However, there have been changes to toxicity data and cleanup levels, they are captured in the RI/FS ([DOE/RL-2010-96](#)) and the final ROD for the 100-BC Area ([EPA 2021a](#)). Details on verification of waste site cleanup are provided within the interim remedial action reports for 100-BC-1 and 100-BC-2 ([DOE/RL-2011-49](#) and [DOE/RL-2015-47](#)), respectively. Remedial action objectives for the interim action RODs in the River Corridor broadly addressed protecting human and ecological receptors and controlling sources of potential contamination to groundwater and the Columbia River. Associated cleanup levels were developed based on unrestricted use. More recent remedial investigation evaluations ([DOE/RL-2010-96](#)) have typically determined that interim remedial actions remain protective considering updated guidance and parameters. A few exceptions arise when using risk-based, instead of dose-based, radionuclide values for a few radionuclides where radioactive decay will meet slightly lower values in a reasonable timeframe. These exceptions are specifically considered and addressed in the 100-BC Area's RI/FS ([DOE/RL-2010-96](#)) for a final ROD. Though beyond the scope of this (2016-2020) assessment, a final Action ROD for the 100-BC Area was issued in September 2021 ([EPA 2021a](#)).

Has any other information come to light that could call into question the protectiveness of the remedy?

The RI/FS evaluation ([DOE/RL-2010-96](#)) has indicated some continuing source contamination to groundwater and this information was incorporated into the evaluation of remedial alternatives that supported the final ROD (issued in 2021 [[EPA 2021a](#)], after this 5-year review period).

Issues/Recommendations During this Review Period

Issues. No issues specific to the 100-BC-1 and 100-BC-2 OUs were identified during this 5-year review.

Recommendations. No corrective actions are recommended.

Protectiveness Statements

100-BC-1 Source OU – Short-Term Protective. The remedy at the 100-BC-1 currently protects human health and the environment because implementation of the interim remedy components (primarily involving RTD, backfilling, recontouring, revegetation, and ICs) has demonstrated that all exposure pathways that could result in unacceptable risk areas are being controlled. However, for the remedy to be protective in the long term (based on the findings of the 100-B/C RI/FS [[DOE/RL-2010-96](#)]), RTD is required at one additional waste site and revised ICs are required at multiple waste sites. These waste sites do not present a risk because of current access restrictions at the Site. A final action ROD was issued in September 2021 ([EPA 2021a](#)) and is in the process of implementation; protectiveness will continue to be evaluated in future 5-year reviews.

100-BC-2 Source OU – 100-BC-2 Source OU – Short-Term Protective. The remedy at the 100-BC-2 currently protects human health and the environment because implementation of the interim remedy components (primarily involving RTD, backfilling, recontouring, revegetation, and ICs) has demonstrated that all exposure pathways that could result in unacceptable risk areas are being controlled. However, for the remedy to be protective in the long term (based on the findings of the 100-B/C RI/FS [[DOE/RL-2010-96](#)]), revised ICs are required at multiple waste sites. These waste sites do not present a risk because of current access restrictions at the Site. A final action ROD was issued in September 2021

and is in the process of implementation; protectiveness will continue to be evaluated in future 5-year reviews.

2.3.2 100-F/IU Operable Units

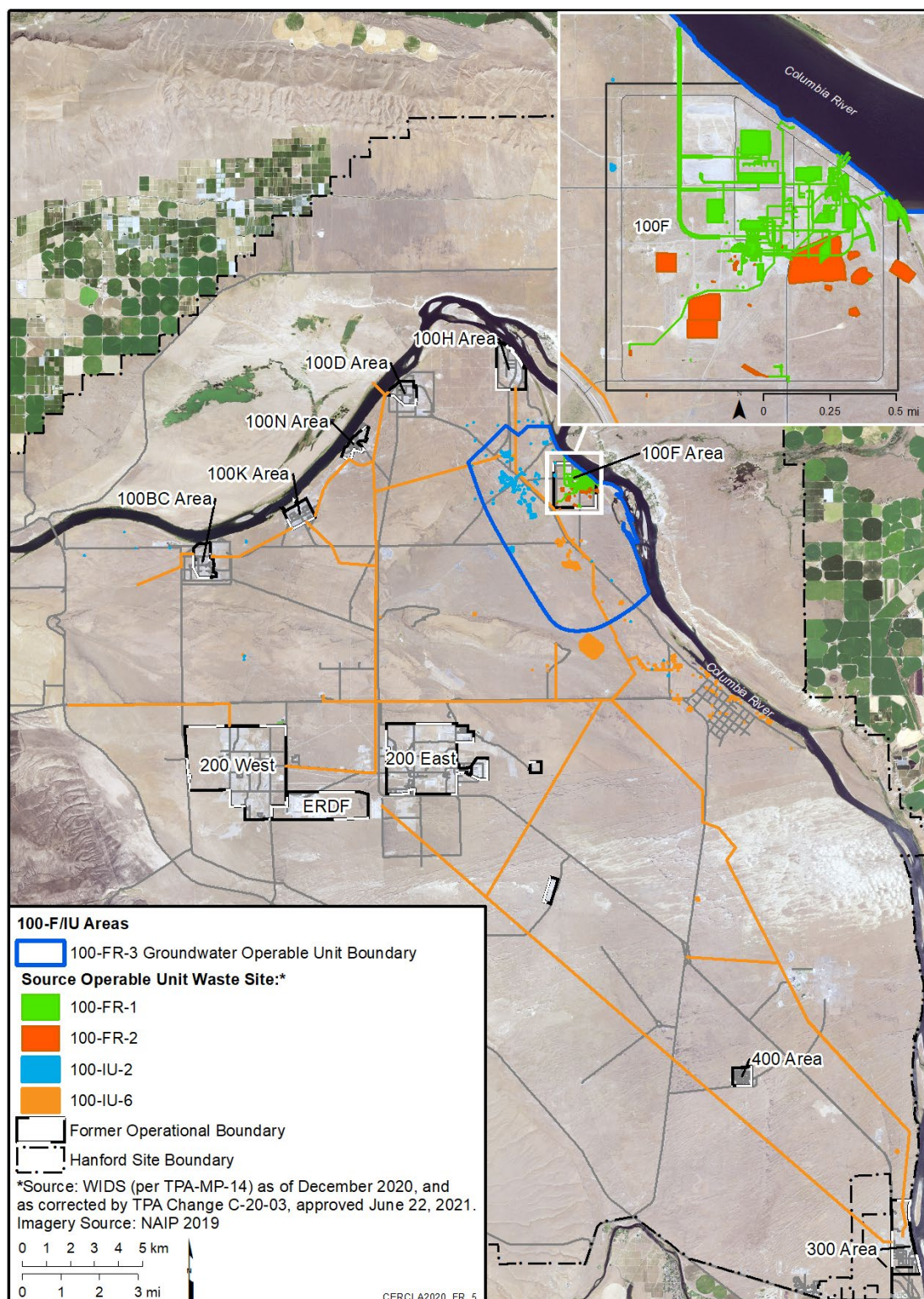
This section describes three OUs in the 100-F Area and two adjacent OUs that include waste sites within a large portion of the Hanford Site's 600 Area. The 100-F Area contains the following two source OUs and one groundwater OU that are associated primarily with 105F Reactor operations:

- 100-FR-1 OU, principally 100-F Area liquid waste disposal sites
- 100-FR-2 OU, principally soil and solid waste disposal sites
- 100-FR-3 OU, groundwater contamination originating from the 100-F Area source OUs.

Adjacent to the 100-F Area OUs and within the 600 Area are the following two source OUs:

- 100-IU-2 OU originally contained waste sites from the old White Bluffs Townsite but was expanded in 2014 to include a vast region to the west
- 100-IU-6 OU originally contained waste sites from the old Hanford Townsite but was expanded in 2014 to include a vast region to the south.

Figure 2-3 shows the relative locations of the 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and 100-IU-6 OUs.



Note: The majority of the orange linear features in 100-IU-6 are associated with WIDS waste site 600-235 (buried lead-sheath telecommunication cables).

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

2.3.2.1 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 Source Operable Units**Background**

The 105F Reactor was constructed from 1943 to 1945 and operated from 1945 to 1965. Most of the facilities associated with the 105F Reactor also were retired in 1965. The 100-FR-1 and 100-FR-2 source OUs include contaminant sources that are generally related to the operational and waste management process for the former 105F Reactor and neighboring biological research facilities, while the 100-FR-3 groundwater OU contains the contamination in the underlying groundwater.

The 600 Area contains construction support facilities that were used during the Hanford Works Project, as well as sites associated with the pre-Hanford Works agricultural community. To address the remediation efforts effectively, the 600 Area was originally divided into 13 OUs. Six of the OUs have since been designated as 200 Area waste groupings; waste sites in the 1100-IU-1, 100-IU-1, and 100-IU-3 OUs were deleted from the NPL; the 100-IU-4 and 100-IU-5 OUs were closed out via a no-action ROD; and the 100-IU-2 and 100-IU-6 OUs have since been remediated.

Chronology

Table 2-4 lists remedial action decision documents relevant to the 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 source OUs as of December 31, 2020.

Table 2-4. Decision Documents for the 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 Source Operable Units. (2 Pages)

Date	Location	Title
4/1997	EPA/AMD/R10-97/044	<i>Amendment to the Interim Action Record of Decision for the 100-BC-1, 100-DR-1, and 100-HR-1 Operable Units.</i> This amendment adds 34 waste sites to the ROD; refines remedial cost estimate for all 71 sites based on actual data, streamlining, and lessons learned; and eliminates the soil washing treatment option before disposal. It also expands the ROD's scope to include radioactive liquid waste sites in the 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-KR-1, and 100-KR-2 OUs.
7/1999	EPA/ROD/R10-99/039	<i>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 Remaining Sites.</i> This interim action ROD requires RTD for 46 sites, adds a plug-in approach for the RTD remedy for both remaining 100 Area and 200 North sites, and for newly identified 100 Area sites added by ESDs; disposal of debris from the B, D, H, and K Reactors to ERDF; and provides a decision framework for leaving waste in place, generally below the 4.6 m (15 ft) depth.
6/2000	EPA/ESD/R10-00/045	<i>Explanation of Significant Difference for the 100-Area Remaining Sites Record of Decision USDOE Hanford 100 Area 100-IU-6 Operable Unit.</i> This ESD plugs the 600-23 and JA Jones #1 waste sites into the Remaining Sites ROD.
9/2000	EPA/ROD/R10-00/121	<i>Interim Action ROD: 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-2, 100-HR-2, 100-KR-2 Operable Units (100 Area Burial Grounds).</i> This ROD requires removal of contaminated soil, structures, and debris; treatment as needed; disposal at ERDF; backfill; and revegetation. It applies to 45 burial grounds in the 100 Area.
2/2004	EPA 2004	<i>Explanation of Significant Difference for the 100 Area Remaining Sites Interim Remedial Action Record of Decision.</i> This ESD adds 28 waste sites to the ROD; adds 10 CFR 1022 and 40 CFR 6 , Appendix A as ARARs to the ROD; and revises annual ICs report due date to be consistent with that noted in the Hanford's Sitewide ICs Plan.

Table 2-4. Decision Documents for the 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 Source Operable Units. (2 Pages)

Date	Location	Title
8/2009	DOE et al. 2009	<i>Explanation of Significant Difference for the 100 Area Remaining Sites Interim Remedial Action Record of Decision.</i> Authorizes adding 200-CW-3 OU waste sites, 99 newly discovered waste sites, and 87 candidate sites using the plug-in approach in the ROD and any newly discovered waste sites that will be documented in the Administrative Record and in an annual fact sheet.
3/2011	DOE et al. 2011	<i>Tri-Party Agreement Fact Sheet: 100 Area “Plug-In” and Candidate Waste Sites For Fiscal Year 2010, Annual listing of waste sites plugged into the remove, treat and dispose remedy in the 1999 interim action Record of Decision for the 100 Area.</i> This is the annual listing of candidate waste sites for confirmatory sampling and waste sites plugged into the RTD remedy in the 1999 interim action ROD for the 100 Area Remaining Sites.
2/2012	DOE et al. 2012	<i>Tri-Party Agreement Fact Sheet: 100 Area “Plug-In” and Candidate Waste Sites For Calendar Year 2011, Annual listing of waste sites plugged into the remove, treat and dispose remedy in the 1999 interim action Record of Decision for the 100 Area.</i> This is the annual listing of candidate waste sites for confirmatory sampling and waste sites plugged into the RTD remedy in the 1999 interim action ROD for the 100 Area Remaining Sites.
1/2013	DOE et al. 2013	<i>Tri-Party Agreement Fact Sheet: 100 Area “Plug-In” and Candidate Waste Sites For Calendar Year 2012, Annual listing of waste sites plugged into the remove, treat and dispose remedy in the 1999 interim action Record of Decision for the 100 Area.</i> This is the annual listing of candidate waste sites for confirmatory sampling and waste sites plugged into the RTD remedy in the 1999 interim action ROD for the 100 Area Remaining Sites.
9/2014	EPA 2014	<i>Record of Decision, Hanford 100 Area Superfund Site 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and 100-IU-6 Operable Units.</i> This final action ROD requires RTD at 91 waste sites; ICs at 15 waste sites; no additional action because interim remedial actions have been completed at 198 waste sites; monitored natural attenuation to address nitrate, hexavalent chromium, trichloroethene, and strontium-90 in 100-FR-3 groundwater; and ICs.

ESD = explanation of significant differences

IC = institutional control

OU = operable unit

ROD = record of decision

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

See Appendix B for a consolidated list of decision documents for Hanford Site OUs.

Remedial Action

Goals and Objectives. The final RAOs for the 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 Source OUs, as specified in the 2014 ROD ([EPA 2014](#)), are RAOs 3 through 6:

- RAO 3. Prevent unacceptable risk from contaminants migrating and/or leaching through soil that will result in groundwater concentrations that exceed standards and risk-based thresholds for protection of surface water and groundwater.
- RAO 4. Prevent unacceptable risk to human health and ecological receptors from exposure to the upper 4.6 m (15 ft) of soil, structures, and debris contaminated with nonradiological constituents at concentrations above the unrestricted land-use standards for human health (provided in MTCA Method B) or soil contaminant levels protective of ecological receptors.

- RAO 5. Prevent unacceptable risk to human health and ecological receptors from exposure to the upper 4.6 m (15 ft) of soil, structures, and debris contaminated with radiological constituents. For human health and ecological receptors:
 - Prevent exposure to radiological constituents at concentrations at or above a dose rate limit that causes an Excess Lifetime Cancer Risk threshold of 1×10^{-6} to 1×10^{-4} above background for the residential exposure scenario.
 - Protect ecological receptors based on a dose rate limit of 0.1 rad/day for terrestrial wildlife populations.
- 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.

Remedy Components. The final action ROD ([EPA 2014](#)), as signed in 2014, provided the following summary-level descriptions of the major components of the selected remedy for the 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 source OUs (i.e., RTD); the italicized text in the following box is a direct quote from the ROD ([EPA 2014](#)).

Excerpt from ROD (EPA 2014):

RTD at Waste Sites for 100-IU-2 and 100-IU-6 – RTD of 91 waste sites identified in Table 1 to achieve RAOs and cleanup levels as follows: (a) RTD the soil and debris with COCs exceeding cleanup levels identified in Table 5 above as deep as 4.6 m (15 ft) bgs to protect human health and ecological receptors from direct exposure to contaminants, (b) RTD the soil and debris below 4.6 m (15 ft) bgs with COCs exceeding cleanup levels in Table 6 [referring to tables in the ROD] for groundwater and river protection and (c) the excavated waste sites will be backfilled and recontoured, after which native vegetation will be planted, and established. Contaminated soil and debris with concentrations above the cleanup levels will be excavated from the waste sites using shallow and deep excavation technology, treated as necessary to meet applicable land disposal restriction and disposal facility requirements and sent to ERDF, which is considered onsite, or another facility approved by EPA.

Institutional Controls Component Common to All OUs. ICs are required before, during and after the active phase of remedial action implementation where ICs are needed to protect human health and the environment. ICs are used to control access to residual contamination in soil and groundwater above standards for unlimited use and unrestricted exposure. DOE shall be responsible for implementing, maintaining, reporting on and enforcing ICs. Although the DOE may later transfer these procedural responsibilities to another party by contract, property transfer agreement or through other means, the DOE shall retain ultimate responsibility for remedy integrity and ICs. In the event that land is transferred out of federal ownership, deed restrictions (proprietary controls such as easements and covenants) are required that are legally enforceable against subsequent property owners.

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

The following institutional control performance objectives are required to be met as part of this remedial action. Land-use controls will be maintained until cleanup levels are achieved and the concentrations of hazardous substances are at such levels to allow for unlimited use and unrestricted exposure and EPA authorizes the

removal of restrictions. ICs to be implemented by DOE to support achievement of the RAOs include the following:

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

Measures that are necessary to ensure continuation of ICs shall be taken before any lease or transfer of any land subject to ICs. DOE will provide notice to Ecology and EPA at least 6 months before any transfer or sale of land subject to ICs so that the lead regulatory agency can be involved in discussions to ensure that appropriate provisions are included in the transfer terms or conveyance documents to maintain effective ICs. If it is not possible for DOE to notify Ecology and EPA at least 6 months before any transfer or sale, DOE will notify Ecology and EPA as soon as possible, but no later than 60 days before the transfer or sale of any property subject to ICs. In addition to the land transfer notice and discussion provisions, DOE further agrees to provide Ecology and EPA with similar notice, within the same time frames, as to federal-to-federal transfer of property. DOE shall provide a copy of the executed deed or transfer assembly to Ecology and EPA. DOE shall notify EPA and Ecology immediately upon discovery of any activity inconsistent with the specific ICs.

Institutional Controls Component Unique to 100-FR-1 and 100-FR-2 – The following institutional control performance objectives are required to be met as part of this remedial action for 100-FR-1 and 100-FR-2 OUs. Land-use controls will be maintained until cleanup levels are achieved and the concentrations of hazardous substances are at such levels to allow for unlimited use and unrestricted exposure and EPA authorizes the removal of restrictions. ICs to be implemented by DOE to support achievement of the RAOs include the following:

- *Exposure to contamination deeper than 4.6 m (15 ft) bgs is not anticipated. Where contamination at depth exceeds the residential use cleanup levels, ICs are required to ensure future activities do not bring this contamination to the surface or otherwise result in exposure to contaminant concentrations that exceed the cleanup levels.*
- *Prohibit irrigation over or near waste site 116-F-14 that represents an unacceptable surface water protection risk.*

Transition from Interim to Final Action for 100-FR-1, 100-FR-2, 100-IU-2 and 100-IU-6 – In-progress interim action shall use the cleanup levels in this ROD immediately upon issuance of this ROD. All other aspects of the

interim actions shall continue to be performed in accord with the existing RD/RAWP. DOE shall develop, and submit for EPA approval, a new RD/RAWP prepared in accordance with the Tri-Party Agreement. When the new RD/RAWP is approved, that document will direct future remedial actions and will replace all interim action ROD work plan requirements.

Remedy Implementation Progress Prior to this Review Period ([DOE/RL-2016-01](#), Rev. 0). Work on the interim remedy involving RTD, backfilling, recontouring, revegetating, and implementing ICs had been ongoing since 1997. Before 2016, remedial actions for all but one waste site at the 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 source OUs had been completed.

The RAOs for 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 waste sites remediated under the interim RODs and the methods used for achieving the RAOs through interim remedial actions were summarized in the following interim remedial action reports for the 100-F Area (e.g., [DOE/RL-2013-08](#), *100-FR-1 Interim Remedial Action Report*; [DOE/RL-2009-63](#), *100-FR-2 Operable Unit Interim Remedial Action Report*; [DOE/RL-2011-48](#), *100-F/IU-2/IU-6 Area Segment 1 Interim Remedial Action Report*; [DOE/RL-2012-14](#), *100-F/IU-2/IU-6 Area Segment 3 Interim Remedial Action Report*; [DOE/RL-2013-34](#), *Segment 5 and 400 Area Interim Remedial Action Report*).

An evaluation of the final ROD RAOs for sites closed under interim action RODs was also completed prior to 2016. In accordance with [TPA-MP-14](#), *Maintenance of the Waste Information Data System (WIDS)*, remediated waste sites have been documented in the WIDS as either final closed or final no-action. Cleanup verification packages (including sampling data and other technical information) to support the reclassification to final closed or final no-action are included in the Hanford Site Administrative Record for the 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 source OUs. Cleanup levels for these source OUs are published in Tables 5 and 6 in the ROD ([EPA 2014](#)).

Issues/Corrective Actions from the Previous (2011-2015) 5-Year Review Report ([DOE/RL-2016-01](#), Rev. 0). No issues or actions were noted for the 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 source OUs in the previous (2011-2015) [CERCLA](#) 5-year review.

Protectiveness Statement from the Previous (2011-2015) 5-Year Review Report ([DOE/RL-2016-01](#), Rev. 0). The protectiveness statement from the previous (2011-2015) 5-year review report for the 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 source OUs was as follows:

100-FR-1 Source OU – Protective. *The remedy at the 100-FR-1 source OU is protective of human health and the environment, and exposure pathways that could result in unacceptable risk are being controlled.*

The RAOs for protecting human and ecological receptors from exposure to contamination, and for controlling the sources of groundwater contamination to minimize the impacts to groundwater resources, protect the Columbia River from further adverse impacts, and reduce the degree of groundwater cleanup that may be required under future actions, have been met by RTD of waste sites and the imposition of site-specific ICs at waste sites that do not qualify for unlimited use or unrestricted exposure. The RTD scope has been completed and ICs have been implemented.

100-FR-2 Source OU – Protective. *The remedy at the 100-FR-2 source OU is protective of human health and the environment and exposure pathways that could result in unacceptable risk are being controlled.*

The RAOs for protecting human and ecological receptors from exposure to contamination, and for controlling the sources of groundwater contamination to minimize the impacts to groundwater resources, protect the Columbia River from further adverse impacts, and reduce the degree of groundwater cleanup that may be required under future actions, have been met by RTD of waste sites and the imposition of site-specific ICs at waste sites that do not qualify for unlimited use or unrestricted exposure. The RTD scope has been completed and ICs have been implemented.

100-IU-2 Source OU – Protective. *The remedy at the 100-IU-2 source OU is protective of human health and the environment and exposure pathways that could result in unacceptable risk are being controlled.*

The RAOs for protecting human and ecological receptors from exposure to contamination, and for controlling the sources of groundwater contamination to minimize the impacts to groundwater resources, protect the Columbia River from further adverse impacts, and reduce the degree of groundwater cleanup that may be required under future actions, have been met by RTD of waste sites. The RTD scope has been completed and ICs have been implemented.

100-IU-6 Source OU – Protective. *The remedy at the 100-IU-6 source OU is protective of human health and the environment and exposure pathways that could result in unacceptable risk are being controlled.*

The RAOs for protecting human and ecological receptors from exposure to contamination, and for controlling the sources of groundwater contamination to minimize the impacts to groundwater resources, protect the Columbia River from further adverse impacts, and reduce the degree of groundwater cleanup that may be required under future actions, have been met by RTD of waste sites. The RTD scope has been completed and ICs have been implemented.

Progress Since 2011-2015 Review

Accomplishments. Accomplishments for the 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 source OUs during the past 5 years can be summarized as follows:

- ICs for the 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 source OUs, where applicable, were effectively managed, regularly assessed, and maintained.
- Completed reclassification of the 600-349 waste site in the 100-IU-6 OU (fieldwork was completed in 2014).

Remedy Implementation. All but one waste site in the 100-FR-1, 100-FR-2, 100-IU-2 and 100-IU-6 source OUs were reclassified in WIDS to final no-action or final-closed prior to this (2016-2020) review period. Reclassification of the remaining site, 600-349, was completed during the current review period.

Figure 2-4 shows general locations and closure status as of December 2020 for waste sites in the 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 OUs. Table 2-5, which summarizes waste site remediation for the 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 OUs, includes metrics on waste site status during the previous and current 5-year review periods.

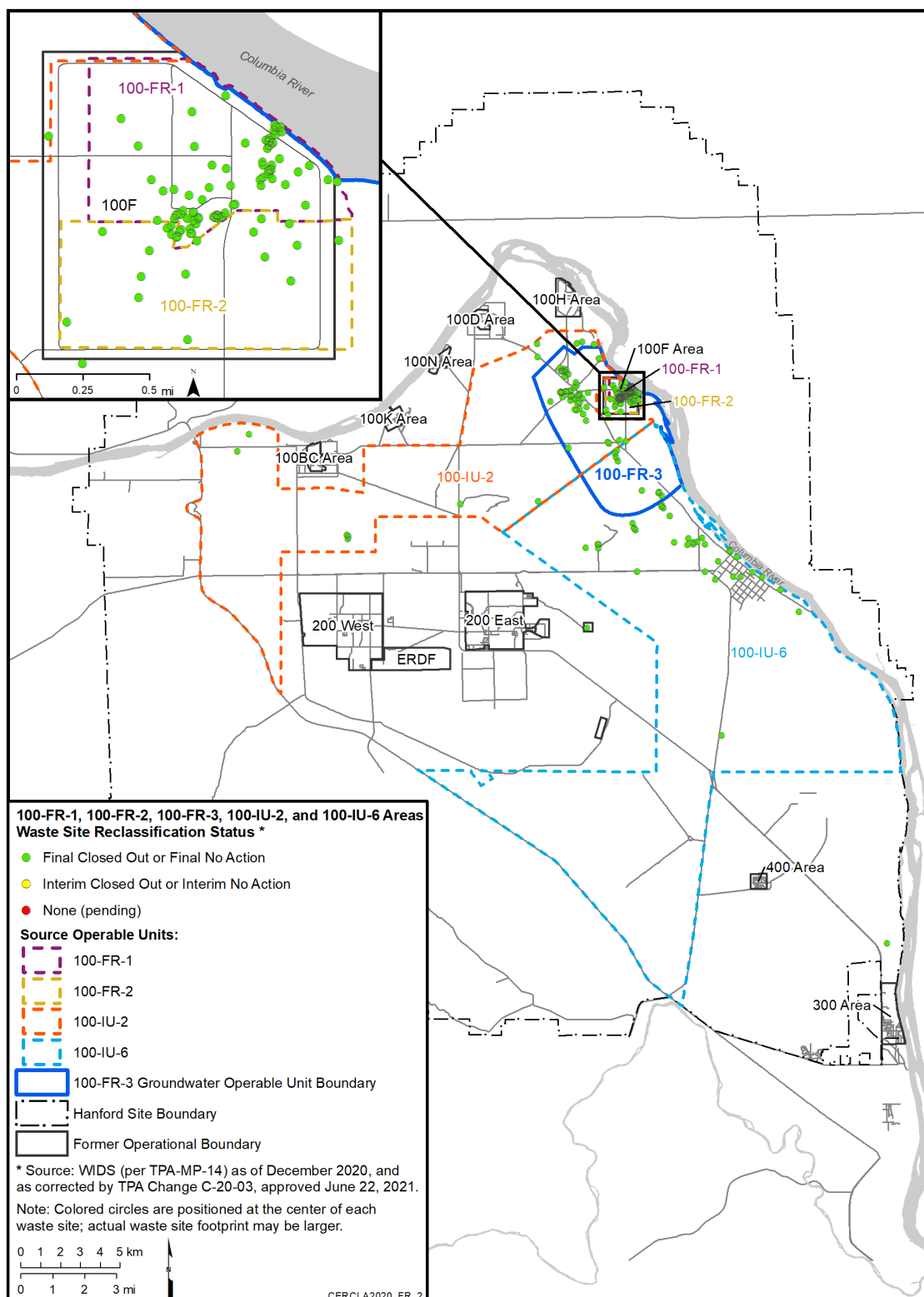


Figure 2-4. Geographic Distribution and WIDS Reclassification Status of the 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 Source Operable Unit Waste Sites as of December 2020.

Table 2-5. Waste Site Remediation Summary for 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 Source Operable Units.

Source OU	Number of Waste Sites ^a	Sites Dispositioned ^b			
		Pre-2016	2016 – 2020	Total	Percent
100-FR-1	78	78	0	78	100
100-FR-2	19	19	0	19	100
100-IU-2	56	56	0	56	100
100-IU-6	52	51	1	52	100
Total	205	204	1	205	100%

^a Approximate number of waste sites within the OU, according to WIDS, as of December 2020 (and subsequently corrected per TPA Change C-20-03). Actual numbers change if sites are added to or moved from a given OU in accordance with DOE and regulatory agency approvals.

^b Approximate number of sites dispositioned; includes the number of sites that have been reclassified in WIDS as of December 2020 (and subsequently corrected per TPA Change C-20-03) as either interim closed, final closed, interim no-action, or final no-action in accordance with the guideline TPA-MP-14.

TPA-MP-14, 2011, *Maintenance of the Waste Information Data System (WIDS)*, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1109271360>.

TPA Change C-20-03, 2021, *River Corridor Waste Site Updates in the Tri-Party Agreements, Appendix C*, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <https://pdw.hanford.gov/document/AR-14219>.

DOE = U.S. Department of Energy

WIDS = Waste Information Data System

OU = operable unit

Upon issuance of the final action ROD ([EPA 2014](#)) in November 2014, all cleanup levels established in the ROD were applicable for all in-progress cleanup actions. All other aspects of the interim action continued in accordance with the existing RDR/RAWPs.

[Note: Appendix C of this 5-year review report identifies the soil cleanup levels for protection of human health, groundwater, and surface water as presented in Tables 5 and 6 of the 2014 ROD ([EPA 2014](#)).]

The RDR/RAWP ([DOE/RL-2014-44](#)) was issued in August 2015. The RDR/RAWP included an addendum for soils ([DOE/RL-2014-44-ADD1](#), *Remedial Design Report Remedial Action Work Plan Addendum for 100-FR-1 100-FR-2 100-IU-2 and 100-IU-6 Soils*) and another addendum for groundwater (see Section 2.3.2.2). Waste sites previously dispositioned under interim RODs in the 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 were evaluated and the evaluation determined that they met the final ROD RAOs.

ICs have been implemented and maintained during this 5-year review period to control access to residual contamination in soil and groundwater above standards for unlimited use and unrestricted exposure.

Technical Assessments

The 5-year review determines whether the remedy at a site is or, upon completion, will be protective of human health and the environment. The following is the technical assessment response to the technical assessment questions provided in the EPA guidance for the 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 OUs remedy. The following response also establishes a framework for organizing and evaluating data and ensuring that all relevant issues are considered when determining the protectiveness of the remedy.

Is the remedy functioning as intended by the decision documents?

The remedy for the 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 source OUs has been implemented and is working within the specified RAOs per the ROD ([EPA 2014](#)). Remediation of 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 source OU waste sites has been completed and the waste sites reclassified in the WIDS as either final closed-out or final no-action. With the completion of source OU remediation, continued decline of groundwater contaminants in the 100-FR-3 OU is anticipated.

An evaluation of the final ROD RAOs for sites closed under interim action RODs was also completed prior to 2016. In accordance with [TPA-MP-14](#), *Maintenance of the Waste Information Data System (WIDS)*, remediated waste sites have been documented in the WIDS as either final closed or final no-action. Cleanup verification packages (including sampling data and other technical information) to support the reclassification to final closed or final no-action are included in the Hanford Site Administrative Record for the 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 source OUs. Cleanup levels for these source OUs are published in Tables 5 and 6 in the ROD ([EPA 2014](#)).

ICs for the 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 source OUs, as required by the ROD ([EPA 2014](#)), are described in the latest version of the RDR/RAWP ([DOE/RL-2014-44](#)). Specific details associated with each applicable IC have been incorporated into *Sitewide Institutional Controls Plan for the Hanford CERCLA Response Actions and RCRA Corrective Actions* ([DOE/RL-2001-41](#)), which is routinely updated within 180 days after publication of each decision document that addresses ICs. The ICs implemented for the 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 OUs include waste-site-specific ICs (drilling and excavation restrictions for portions of 100-FR-1 and 100-FR-2 because of deep contamination and an irrigation restriction for one 100-FR-1 OU site that presents a surface water protection risk). They also include general-areas ICs including access control (warning notices and entry restrictions), land-use management (land use and excavation permits), groundwater-use management, and miscellaneous provisions. Figure 7 of the ROD ([EPA 2014](#)) is a map of the 100-FR-1 and 100-FR-2 OU IC boundary; it also depicts the location of the waste sites associated with ICs for deep contamination and the one site with the IC to prevent irrigation. These ICs are assessed annually and DOE presents a summary, including any noted issues or actions, to the Site regulators each fall at the unit managers meeting. The presentation is documented in the meeting minutes, which are archived in the Hanford Site Administrative Record (see example in Attachment 2 and 4 at the following link: <https://pdw.hanford.gov/document/AR-04230>). The annual IC assessments are also now captured in an annual report (e.g., *FY2020 Sitewide Institutional Control Assessment*, [HNF-65616](#)). The 100-FR-1 and 100-FR-2 source OU waste sites that were inspected during the 2020 assessment included:

- 100-F-10, 100-F-19:1, 100-F-19:2, 100-F-19:3, 100-F-29, 100-F-34, 116-F-12, 116-F-14, 116-F-2, 116-F-6, 116-F-9, 118-F-6, 118-F-8:3, 118-F-8:4, and UPR-100-F-1.

During the 5-year review period of 2016 through 2020, three signage issues were specifically noted for the 100-FR-1 and 100-FR-2 OUs: one English-language warning sign along the Columbia River was found to be down (due to high winds) in 2020; both the English and Spanish signs were reinstalled on skids and stabilized with cinder blocks; and one warning sign at the west entrance to the 100-F Area was found down (also due to high winds) in 2017 and 2020 and was reinstalled.

Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of remedy selection still valid?

The exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of remedy selection (2014) are still valid. DOE regularly monitors toxicity data and applicable cleanup levels for chemicals as part of ongoing risk assessment and preliminary remediation goal (PRG) development needs for other OUs. There have been no significant promulgated changes to relevant cleanup levels or to the sources of toxicity data underlying cleanup level development since the time of the ROD.

Has any other information come to light that could call into question the protectiveness of the remedy?

No new information is known that could call into question the protectiveness of the remedy for these OUs.

Issues/Recommendations During this Review Period

Issues. No issues specific to the 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 source OUs were identified during this 5-year review.

Recommendations. No corrective actions are recommended.

Protectiveness Statements

100-FR-1 Source OU – Protective. The remedy at the 100-FR-1 source OU is protective of human health and the environment; exposure pathways that could result in unacceptable risk are being controlled.

The RAOs for protecting human and ecological receptors from exposure to contamination, and for controlling the sources of groundwater contamination to minimize the impacts to groundwater resources, protect the Columbia River from further adverse impacts, and reduce the degree of groundwater cleanup that may be required under future actions have been met by RTD of waste sites and the imposition of site-specific ICs at waste sites that do not qualify for unlimited use or unrestricted exposure. The RTD scope has been completed and ICs have been implemented.

100-FR-2 Source OU – Protective. The remedy at the 100-FR-2 source OU is protective of human health and the environment and exposure pathways that could result in unacceptable risk are being controlled.

The RAOs for protecting human and ecological receptors from exposure to contamination, and for controlling the sources of groundwater contamination to minimize the impacts to groundwater resources, protect the Columbia River from further adverse impacts, and reduce the degree of groundwater cleanup that may be required under future actions have been met by RTD of waste sites and the imposition of site-specific ICs at waste sites that do not qualify for unlimited use or unrestricted exposure. The RTD scope has been completed and ICs have been implemented.

100-IU-2 Source OU – Protective. The remedy at the 100-IU-2 source OU is protective of human health and the environment and exposure pathways that could result in unacceptable risk are being controlled.

The RAOs for protecting human and ecological receptors from exposure to contamination, and for controlling the sources of groundwater contamination to minimize the impacts to groundwater resources, protect the Columbia River from further adverse impacts, and reduce the degree of groundwater cleanup that may be required under future actions have been met by RTD of waste sites. The RTD scope has been completed and ICs have been implemented.

100-IU-6 Source OU – Protective. The remedy at the 100-IU-6 source OU is protective of human health and the environment and exposure pathways that could result in unacceptable risk are being controlled.

The RAOs for protecting human and ecological receptors from exposure to contamination, and for controlling the sources of groundwater contamination to minimize the impacts to groundwater resources, protect the Columbia River from further adverse impacts, and reduce the degree of groundwater cleanup that may be required under future actions have been met by RTD of waste sites. The RTD scope has been completed and ICs have been implemented.

2.3.2.2 100-FR-3 Groundwater Operable Unit.

Background

The 100-FR-3 Groundwater OU (as previously shown in Figure 2-3) is 1 of 10 groundwater OUs on the Hanford Site, and 1 of 6 groundwater OUs located in the River Corridor. The 100-FR-3 OU encompasses groundwater contaminated by releases from the 100-FR-1 and 100-FR-2 source OU waste sites (Section 2.3.2.1). Because the groundwater conditions are not static, geographical boundaries of the 100-FR-3 OU are fluid. However, for convenience the OU is typically depicted with the boundaries illustrated in Figure 2-3.

Current land uses in the 100-F Area include interim safe storage of the 105F Reactor; public access to the 100-F Area is restricted.

COCs for the 100-FR-3 groundwater OU are nitrate, hexavalent chromium, strontium-90, and trichloroethene (TCE).

In the northeastern portion of the 100-F Area, groundwater generally flows to the northeast, toward the Columbia River. In the southwestern portion of the 100-F Area, groundwater flows to the east. South of the 100-F Area, groundwater flows toward the south-southeast, parallel to the Columbia River. Flow is restricted by areas where the water table intersects a low-permeability mud unit. During seasonal periods of high river stage, the hydraulic gradient reverses near the river and surface water can flow into the aquifer.

Contaminant concentrations in 100-FR-3 groundwater are above cleanup levels and withdrawal for purposes other than research and monitoring is prohibited. Under current site-use conditions and controls, the only complete human exposure pathway to groundwater is the potential for limited exposure from intermittent seeps along the Columbia River or during remediation, research, and monitoring activities. The 100-FR-3 groundwater is not being used for drinking water.

A summary of 100-FR-3 groundwater OU condition, as of 2020, is included in [DOE/RL-2020-60](#), *Hanford Site Groundwater Monitoring Report for 2020*. Additionally, the Hanford Site Groundwater Monitoring Report for 2020 and prior calendar years are also available online at <http://www.hanford.gov/page.cfm/SoilGroundwaterAnnualReports>.

Chronology

Table 2-6 lists the remedial action decision documents associated with the 100-FR-3 groundwater OU as of December 31, 2020.

Table 2-6. Decision Documents for the 100-FR-3 Groundwater Operable Unit.

Date	Location	Title
09/2014	EPA 2014	<i>Record of Decision, Hanford 100 Area Superfund Site, 100-FR-1, 100-FR-3, 100-IU-2, 100-FR-3, 100-IU-2, and 100-IU-6 Operable Units.</i> This final action ROD presents the selected remedies involving RTD at 91 waste sites; ICs at 15 waste sites; no additional action at 198 waste sites as a result of interim remedial actions completed; monitored natural attenuation to address nitrate, hexavalent chromium, trichloroethene, and strontium-90 in 100-FR-3 OU groundwater, and ICs.
07/2019	EPA 2019b	<i>Explanation of Significant Differences for the 100-FR-3 Operable Unit Record of Decision, Hanford Site, Benton County, Washington.</i> This ESD allows for miscellaneous solid waste generated in support of the 100-FR-3 final action to be collected and stored at a Central Plateau storage facility prior to disposal.

ESD explanation of significant difference RTD = removal, treatment (as required), and disposal
IC = institutional control ROD = record of decision
OU = operable unit

See Appendix B for a consolidated list of decision documents for Hanford Site OUs.

Remedial Actions

Goals and Objectives. In accordance with the NCP, “EPA expects to return useable ground waters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site” ([40 CFR 300.430](#) [a][1][iii][F]). EPA generally defers to state definitions of groundwater classification provided under EPA-endorsed Comprehensive State Groundwater Protection Programs ([EPA/540/G-88/003](#)).

Groundwater from the 100-FR-3 OU is contaminated and is not currently withdrawn from the aquifer for beneficial use; however, the potential beneficial use of the groundwater is as a drinking water source. Consistent with the beneficial-use classifications of Washington State and the EPA, the goal for remediating 100-FR-3 OU groundwater is to reduce contamination to levels that will allow its use as a future drinking water source.

Accordingly, the RAOs applicable to the 100-FR-3 OU, as stated in the ROD ([EPA 2014](#)), are as follows:

- RAO 1. Prevent unacceptable risk to human health from ingestion of and incidental exposure to groundwater containing contaminant concentrations above federal and state standards and risk-based thresholds.
- RAO 2. Prevent unacceptable risk to human health and ecological receptors from groundwater discharges to surface water containing contaminant concentrations above federal and state standards and risk-based thresholds.
- RAO 7. Restore groundwater impacted from 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 releases to cleanup levels, which include DWSs, within a timeframe that is reasonable given the particular circumstances of the site.

Remedy Components. The final action ROD ([EPA 2014](#)), as signed in 2014, provided the following summary-level descriptions of the major components of the selected remedy (i.e., monitored natural attenuation and ICs); the italicized text in the following box is a direct quote from the ROD ([EPA 2014](#)). As noted in the ROD, the remedies selected may change somewhat as a result of the remedial design and

construction process. Any changes to the remedies described in the ROD will be documented using a technical memorandum in the administrative record, an ESD, or a ROD amendment, as appropriate.

Excerpt from ROD (EPA 2014):

Monitored Natural Attenuation (MNA) of Groundwater. MNA will be used for all COCs in 100-FR-3 to reduce groundwater concentrations to concentrations less than the cleanup levels shown in Table 7 [referring to Table 7 within the ROD]. Overall plume behavior is controlled by a combination of the source strength (flux of contaminants into the groundwater) and the rate and capacity of attenuation in the groundwater. Without a continuing source, the net plume response will be to diminish over time. The primary natural attenuation processes for COCs present in 100-FR-3 include biodegradation and abiotic degradation, radioactive decay, dispersion, volatilization, and sorption. The required performance monitoring component includes installation of new wells, periodic sampling, laboratory analysis, and data evaluation needed to assess and confirm the natural attenuation processes, rates of attenuation, and overall protectiveness. The monitoring will continue until cleanup levels are achieved.

Institutional Controls Component Common to All OUs. ICs are required before, during and after the active phase of remedial action implementation where ICs are needed to protect human health and the environment. ICs are used to control access to residual contamination in soil and groundwater above standards for unlimited use and unrestricted exposure. DOE shall be responsible for implementing, maintaining, reporting on and enforcing ICs. Although the DOE may later transfer these procedural responsibilities to another party by contract, property transfer agreement or through other means, the DOE shall retain ultimate responsibility for remedy integrity and ICs. In the event that land is transferred out of federal ownership, deed restrictions (proprietary controls such as easements and covenants) are required that are legally enforceable against subsequent property owners.

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

The following institutional control performance objectives are required to be met as part of this remedial action. Land-use controls will be maintained until cleanup levels are achieved and the concentrations of hazardous substances are at such levels to allow for unlimited use and unrestricted exposure and EPA authorizes the removal of restrictions. ICs to be implemented by DOE to support achievement of the RAOs include the following:

In the event that land is transferred out of federal ownership, deed restrictions (proprietary controls such as easements and covenants) are required that are legally enforceable against subsequent property owners.

In the event of any unauthorized access (e.g. trespassing), DOE shall report such incidents to the Benton County Sheriff's Office for investigation and evaluation of possible prosecution.

Activities that would disrupt or lessen the performance of any component of the remedies are prohibited. Signage and access control to waste sites with contamination above cleanup levels will be provided. Maintain the integrity of any current or future remedial or monitoring system such as monitoring wells. Prohibit the development and use of property for residential housing, elementary and secondary schools, child care facilities and playgrounds until cleanup levels are met.

DOE shall employ and maintain an excavation permit program for protection of human health against unacceptable exposure, and protection of environmental and cultural resources.

The DOE shall report on the effectiveness of ICs for all OUs that are the subject of this ROD in an annual report, or on an alternative reporting frequency specified by the lead regulatory agency. Such reporting may be for OUs individually or may be part of the Hanford Site-wide ICs report.

Measures that are necessary to ensure continuation of ICs shall be taken before any lease or transfer of any land subject to ICs. DOE will provide notice to Ecology and EPA at least 6 months before any transfer or sale of land subject to ICs so that the lead regulatory agency can be involved in discussions to ensure that appropriate provisions are included in the transfer terms or conveyance documents to maintain effective ICs. If it is not possible for DOE to notify Ecology and EPA at least 6 months before any transfer or sale, DOE will notify Ecology and EPA as soon as possible, but no later than 60 days before the transfer or sale of any property subject to ICs. In addition to the land transfer notice and discussion provisions, DOE further agrees to provide Ecology and EPA with similar notice, within the same time frames, as to federal-to-federal transfer of property. DOE shall provide a copy of the executed deed or transfer assembly to Ecology and EPA. DOE shall notify EPA and Ecology immediately upon discovery of any activity inconsistent with the specific ICs.

Institutional Controls Component Unique to 100-FR-3: The following institutional control performance objectives are required to be met as part of this remedial action for 100-FR-3. Land-use controls will be maintained until cleanup levels are achieved and the concentrations of hazardous substances are at such levels to allow for unlimited use and unrestricted exposure and EPA authorizes the removal of restrictions. ICs to be implemented by DOE to support achievement of the RAOs include the following:

DOE shall employ and maintain an excavation permit program limiting 100-FR-3 groundwater access and use to research purposes and for monitoring and treatment in areas where groundwater is above cleanup levels (see Figure 8 [from the 2014 ROD; the figure shows the 2012 locations of contaminant plumes for nitrate, tritium and uranium within the 100-FR-3 OU.]).

Prevent access or use of the groundwater for drinking water purposes until cleanup levels are met.

Remedy Implementation Progress Prior to this Review Period ([DOE/RL-2016-01](#)). Upon issuance of the ROD in 2014, the IC component of the 100-FR-3 groundwater remedy was incorporated into [DOE/RL-2001-41](#). Implementation of the monitored natural attenuation (MNA) remedy component began after the August 2015 publication of the RDR/RAWP ([DOE/RL-2014-44](#)). Performance monitoring for groundwater MNA began in the fall of 2015 and preparations were underway for construction of additional monitoring wells.

Issues/Corrective Actions from the Previous (2011-2015) 5-Year Review. No previous issues or actions were noted for the 100-FR-3 groundwater OU in the 2011-2015 [CERCLA](#) 5-year review ([DOE/RL-2016-01](#)).

Protectiveness Statement from the Previous (2011-2015) 5-Year Review Report ([DOE/RL-2016-01](#)). The protectiveness statement from the previous (2011-2015) 5-year review report for the 100-FR-3 groundwater OUs was as follows:

100-FR-3 Groundwater OU – Will Be Protective. *The remedy at the 100-FR-3 groundwater OU is expected to be protective upon completion of construction. ICs are in place and are protecting human exposure to contaminated groundwater. Construction of additional wells to enhance the remedy component involving monitored natural attenuation began in early 2016 and is expected to be completed by 2019. In the interim, the remedial activities completed to date have addressed the exposure pathways that could result in unacceptable risks in these areas.*

Progress Since 2011-2015 Review

Accomplishments. The primary remedial action accomplishments for the 100-FR-3 groundwater OU during the past 5 years (2016-2020) can be summarized as follows:

- Effectively managed, assessed, and maintained ICs for the 100-FR-3 OU.
- Implemented [DOE/RL-2014-44-ADD2](#), *Remedial Design Report/Remedial Action Work Plan Addendum for the 100-F/IU Groundwater* (hereinafter referred to as the 100-FR-3 groundwater addendum), which addresses the work elements, performance measurements, construction management and oversight, and schedule specific to MNA at the 100-FR-3 OU.
- Installed 12 new monitoring wells (six in 2016 and six in 2019).
- Conducted groundwater monitoring in accordance with the sampling and analysis plan (Appendix A of [DOE/RL-2014-44-ADD2](#), as modified by TPA Change Notices [TPA-CN-708](#), [TPA-CN-0736](#), [TPA-CN-0814](#), and [TPA-CN-0874](#)).
- Issued a report evaluating Phase 1 of the monitoring program and making recommendations for Phase 2 monitoring wells ([SGW-61298](#), *Evaluation of 100-FR-3 Groundwater Monitoring Results from Phase 1 Wells*).
- Prepared a performance evaluation report in 2021 with results from 2015 to 2020 ([DOE/RL-2020-47](#), *Performance Monitoring Report for 100-FR-3 Monitored Natural Attenuation, 2015 to 2020*).
- Reported groundwater monitoring results annually in Hanford Site groundwater reports.

Remedy Implementation. Implementation of the 100-FR-3 remedy, as outlined in the final action ROD ([EPA 2014](#)), is being performed in phases in accordance with the 100-FR-3 groundwater addendum ([DOE/RL-2014-44-ADD2](#)). Both MNA and ICs for groundwater are expected to continue for approximately 150 years.

Upon issuance of the ROD in 2014, the IC component of the 100-FR-3 groundwater OU remedy was incorporated into [DOE/RL-2001-41](#).

Implementation of the 100-FR-3 groundwater OU MNA remedy began after the August 2015 publication of the integrated RDR/RAWP ([DOE/RL-2014-44](#)) and 100-FR-3 groundwater addendum ([DOE/RL-2014-44-ADD2](#)). Installation of the Phase 1 and Phase 2 monitoring wells was completed in 2016 and 2019, respectively.

A performance evaluation report ([DOE/RL-2020-47](#)) presented and evaluated results of the MNA performance monitoring for 2015 through 2020. The report includes the following elements, as required by the 100-FR-3 groundwater addendum ([DOE/RL-2014-44-ADD2](#)):

- Refine the conceptual site model
- Evaluate MNA processes and associated indicators
- Evaluate sampling frequency
- Adjust monitoring network, if needed
- Evaluate the need for continuing to collect automated water-level data
- Conduct statistical analyses on monitoring data
- Evaluate data from aquifer tubes and a riverbank seep

- Evaluate trace metals
- Update the flow and transport model and predictive simulations.

Table 2-7 lists the estimated duration of MNA performance monitoring for each COC to achieve its cleanup level. Preliminary results of an updated model prepared for the 2021 performance evaluation report indicate the remedy remains on target to meet the initial time estimates.

Table 2-7. Estimated Times for 100-FR-3 Groundwater to Achieve Cleanup Levels.

Contaminant (cleanup level)	Time Estimate (years) ^a
Hexavalent chromium (48 µg/L /10 µg/L) ^b	Upland (48 µg/L): 20 At river (10 µg/L): 35
Trichloroethene (4 µg/L)	50
Nitrate (45 mg/L)	80
Strontium-90 (8 pCi/L)	150

^a Based on 2011 model estimates (DOE/RL-2010-98)

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

DOE/RL-2010-98, 2014, *Remedial Investigation/Feasibility Study for the 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and 100-IU-6 Operable Units*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <https://pdw.hanford.gov/document/0085341H>.

Based on future performance monitoring reports, estimated timeframes for natural attenuation will continue to be refined and updated every 5 years. Once the cleanup level for each COC is achieved, 5 years of attainment monitoring will be performed at each well. The 5-year attainment monitoring period is not included in the timeframe estimates for cleanup level attainment.

Table 2-8 is an overview of primary components of the 100-FR-3 remedy and implementation status.

Table 2-8. Overview of 100-FR-3 Remedy Implementation. (2 Pages)

Document Type	Date	Title
Final Action ROD	09/2014	<i>Record of Decision, Hanford 100 Area Superfund Site, 100-FR-1, 100-FR-3, 100-IU-2, 100-FR-3, 100-IU-2, and 100-IU-6 Operable Units</i> (EPA 2014)
RDR/RAWP	08/2015	DOE/RL-2014-44, <i>Integrated Remedial Design Report/Remedial Action Work Plan for 100-F/IU</i> , Rev. 0 DOE/RL-2014-44-ADD2, <i>Integrated Remedial Design Report/Remedial Action Work Plan Addendum for the 100-F/IU Groundwater</i> , Rev. 0
RAO (brief description)		1. Prevent unacceptable risk to human health from ingestion of and incidental exposure to groundwater containing contaminant concentrations above federal and state standards and risk-based thresholds of human exposure to groundwater containing COC concentrations above cleanup levels. 2. Prevent unacceptable risk to human health and ecological receptors from groundwater discharges to surface water containing contaminant concentrations above federal and state standards and risk-based thresholds. 7. Restore groundwater impacted from 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 releases to cleanup levels, which include DWSs, within a timeframe that is reasonable, given the particular circumstances of the site.
COCs		Nitrate, hexavalent chromium, strontium-90, and trichloroethene

Table 2-8. Overview of 100-FR-3 Remedy Implementation. (2 Pages)

Remedy Component	Status (approximate percentage complete for implementing the remedy component as of December 2020) ^a						Duration of O&M (~years) ^b	Finish ^c (Est'd year)
	0	1-25	26-50	51-75	76-99	100%		
Monitored Natural Attenuation							155	2169
Institutional Controls							155	2169

^a Percentages reflect implementation status of the remedy component; post-startup remedial process optimization is considered part of O&M. 100% = fully implemented and now in O&M mode.

^b Approximate number of years to operate remedy component as estimated in ROD (shorter durations for certain COCs, and longest for attenuation of strontium-90); duration estimate is based on 150 years for attenuation of strontium-90 and 5 years for post-attainment monitoring.

^c Estimated year when remedy component will be completed.

DOE/RL-2014-44, 2015, *Integrated Remedial Design Report/Remedial Action Work Plan for 100-F/IU*, Rev. 0, U.S.

Department of Energy, Richland Operations Office, Richland Washington. Available online at

<http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0080174H>.

DOE/RL-2014-44-ADD2, 2015, *Integrated Remedial Design Report/Remedial Action Work Plan Addendum for the 100-F/IU*

Groundwater, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at

<https://pdw.hanford.gov/document/0080174H>.

EPA, 2014, *Record of Decision, Hanford 100 Area Superfund Site 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and 100-IU-6*

Operable Units, U.S. Environmental Protection Agency, Washington, D.C. Available online at

<http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0082927H>.

COC = contaminant of concern

DWS = Drinking Water Standard

O&M = operation and maintenance

RAWP = remedial action work plan

RAO = remedial action objectives

RDR = remedial design report

ROD = record of decision

Technical Assessments

Is the remedy functioning as intended by the decision documents?

The monitoring well network for the 100-FR-3 MNA remedy is now complete (supporting achievement of RAO 2 and RAO 7) and ICs have been implemented (supporting RAO 1 and RAO 2). Performance monitoring began at existing wells and aquifer tubes in fall 2015 and at new wells following their installation in 2016 and 2019. A report detailing an initial evaluation of the monitoring program was published in 2018 ([SGW-61298](#)) and the first comprehensive 5-year performance monitoring report was prepared in 2021 ([DOE/RL-2020-47](#)).

Concentrations of some COCs have not declined in the first 5 years of monitoring. Some areas of potential concern include the following:

- Nitrate, hexavalent chromium, and strontium-90 concentrations in several wells in the 100-F Area tend to increase with periods of higher water table elevations, which may suggest the presence of residual contamination in the lower vadose zone.
- Nitrate concentrations increased sharply in one of the new wells south of the 100-F Area. The well is not located near a known nitrate source.
- The TCE plume is interpreted to extend farther south than previously known, based on data from new wells.

As detailed in Section 6.3 of the 100-FR-3 groundwater RDR/RAWP addendum ([DOE/RL-2014-44-ADD2](#)), it is expected that some performance evaluations may indicate variable attenuation rates and plume extents, particularly in the early years of monitoring, which include data from new monitoring wells. Some of this variation may be attributable to sampling variability and seasonal fluctuation. A consequence of this expectation is that it may require several 5-year review cycles for conclusive identification of trends at some locations and for some COCs throughout the groundwater OU.

Also, as recently documented in *Performance Monitoring Report for 100-FR-3 Monitored Natural Attenuation, 2015 to 2020* ([DOE/RL-2020-47](#)), published in 2021:

- Trend analysis of monitoring data, contamination plume mapping, and groundwater modeling indicate that the remedy is progressing as expected.
- The estimated period (from 2020) to reach cleanup levels is 15 years for hexavalent chromium (10 µg/L at the shoreline), 55 years for nitrate, 85 years for strontium-90, and 50 years trichloroethene.
- The selected remedy remains appropriate based on statistical evaluation of monitoring data through 2020 and updated groundwater model simulations. Although concentrations are not yet declining in all wells, variability is to be expected during the early years of the remedy.

As another indicator of recent trends, Table 2-9 provides an overview of 100-FR-3 groundwater OU contaminant plume areas and associated changes to the areas during this past 5-year review period. Wells monitored during 2020 are shown in Figure 2-5. Plume maps in Figure 2-6 compare plume extents in 2015 and 2020. Figure 2-7 depicts the estimated annual changes in contaminant plume areas since 2003.

More detailed information on the 100-FR-3 groundwater OU well locations, distribution of contaminant concentrations within each plume, and historic trends associated with each 100-FR-3 COC, is included in the first performance evaluation report published in 2021 ([DOE/RL-2020-47](#)). Annual updates are provided in the *Hanford Site Groundwater Monitoring Report* (published each summer for the previous calendar year): <http://www.hanford.gov/page.cfm/SoilGroundwaterAnnualReports>.

Table 2-9. Overview of 100-FR-3 Groundwater Contaminant Plumes.^a

Groundwater Contaminant	Cleanup Level (EPA 2014) ^b	Maximum Concentration (2020)	Plume Area ^c (km ²)			Shoreline Intersection ^d (m)		
			2015	2020	Change	2015	2020	Change
Nitrate	45 mg/L ^e	230 mg/L	9.7	5.5	-4.2	0	0	0
Hexavalent Chromium	48 µg/L ^f	40 µg/L	0.01	0.0	-0.01	0	0	0
	10 µg/L ^f		0.21	0.26	+0.05	0	108	108
Strontium-90	8 pCi/L	90.7 pCi/L	0.13	0.11	-0.02	0	0	0
Trichloroethene	4 µg/L	22.2 µg/L	1.4	2.4	+1.0	0	0	0

^a Sources are from Hanford Annual Groundwater Monitoring Reports for 2015 and 2020

<http://www.hanford.gov/page.cfm/SoilGroundwaterAnnualReports>

^b Source: *Record of Decision, Hanford 100 Area, Superfund Site, 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2 and 100-IU-6 Operable Units* (EPA 2014). The groundwater cleanup levels, as presented in the ROD, are included in Appendix C of this report.

^c Estimated area at a concentration greater than the listed cleanup level

^d Length of Columbia River shoreline intersected by contaminant plume

^e 45 mg/L as nitrate is equivalent to the drinking water standard of 10 mg/L as nitrogen

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

EPA, 2014, *Record of Decision, Hanford 100 Area Superfund Site 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and 100-IU-6 Operable Units*, U.S. Environmental Protection Agency, Washington, D.C. Available online at <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0082927H>.

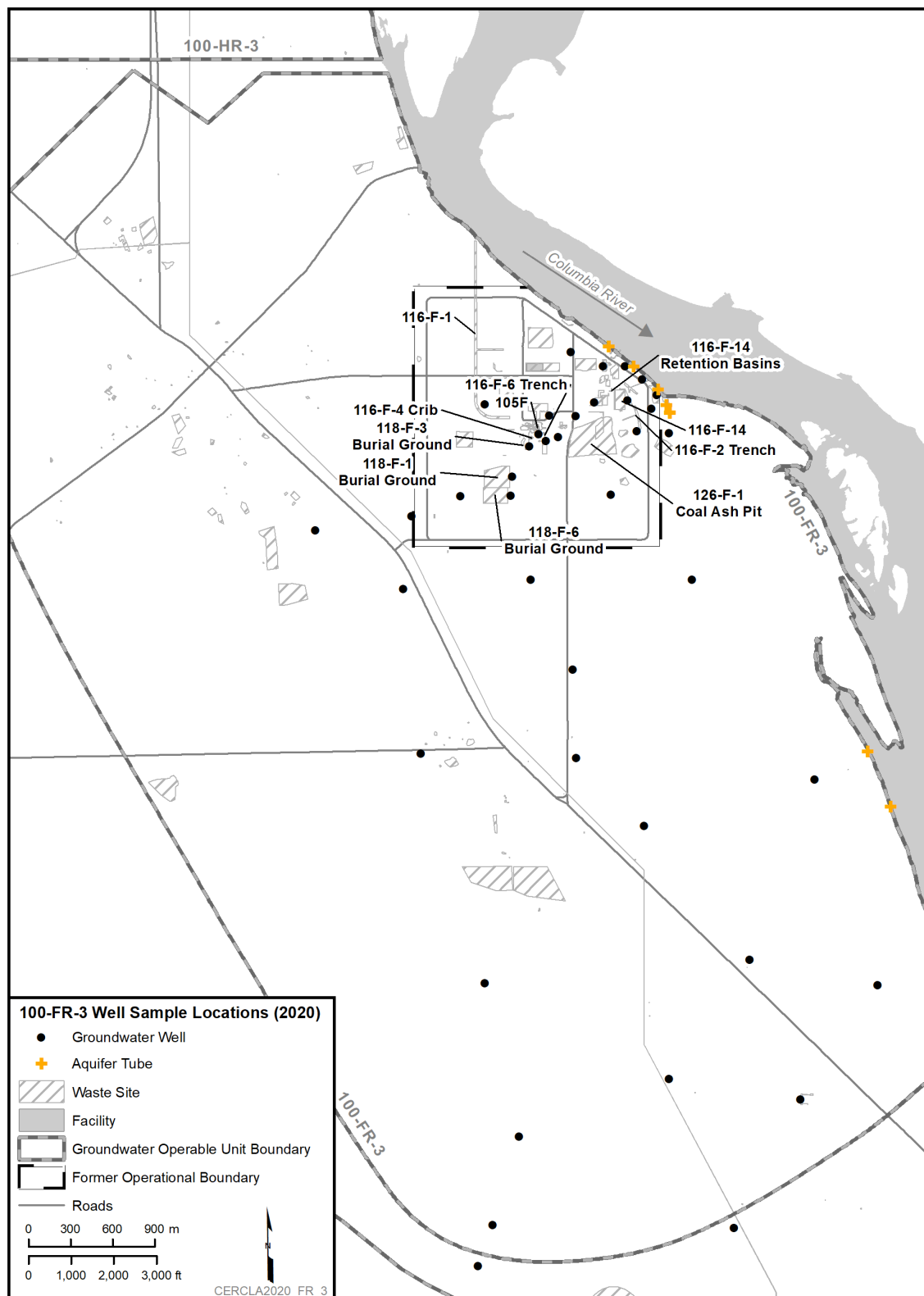


Figure 2-5. 100-FR-3 Well and Aquifer Tube Locations (2020).

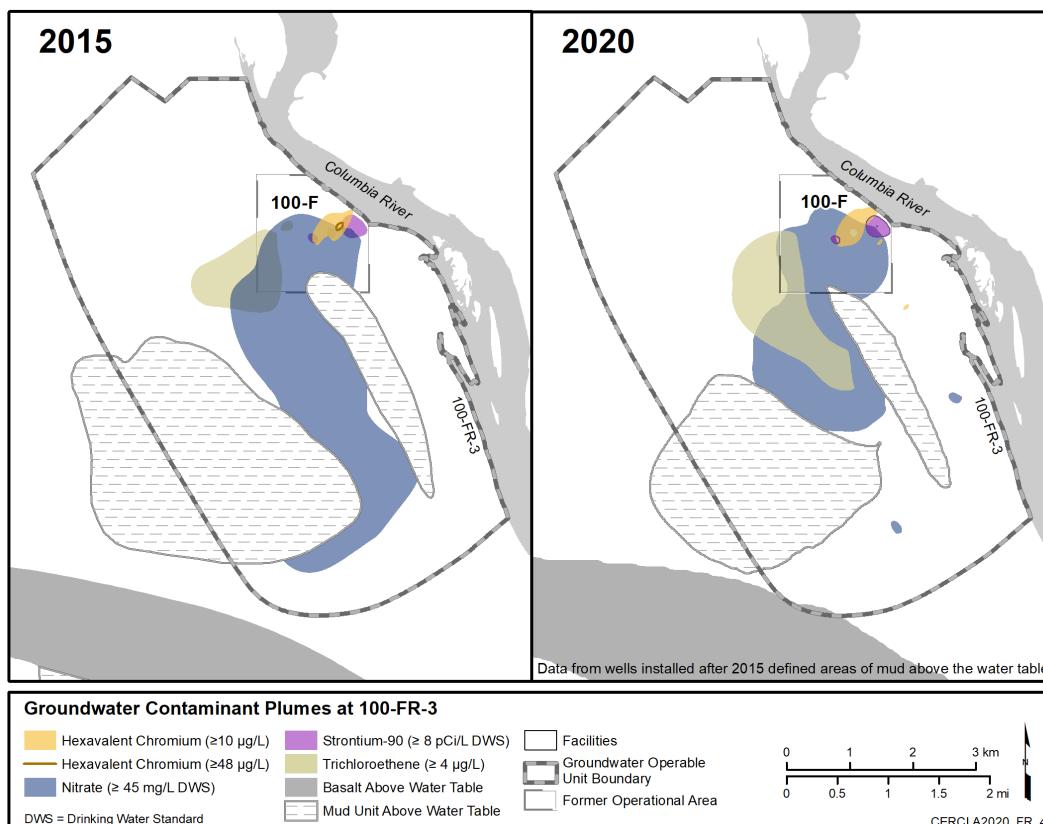
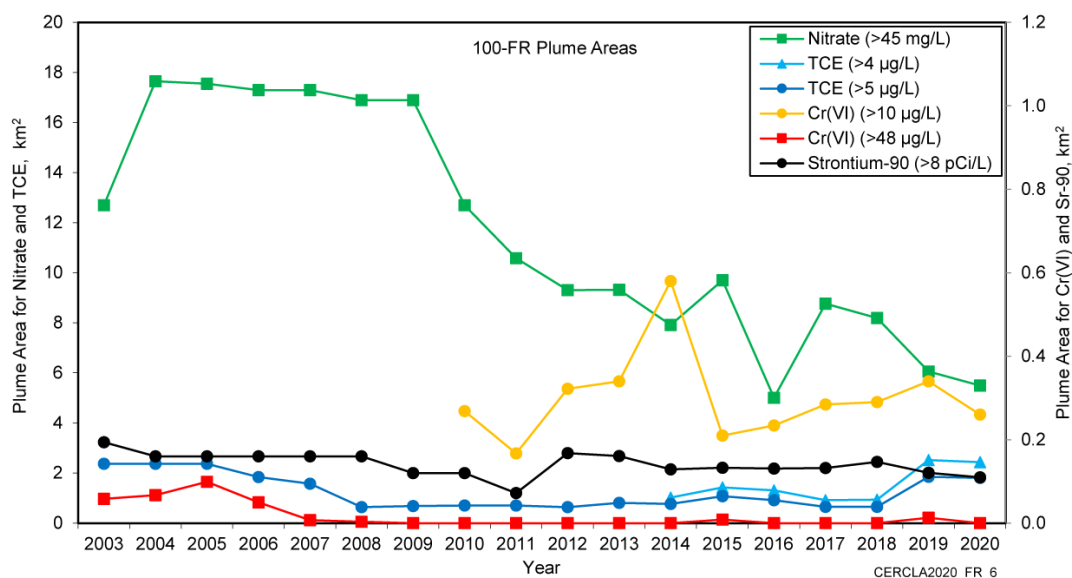


Figure 2-6. 100-FR-3 Groundwater OU Plumes in 2015 (left) and 2020 (right).



This figure shows the plume area for pre-record of decision target cleanup level for trichloroethene at the Drinking Water Standard of 5 µg/L, as well as the 2014 through 2020 plume areas for the post-record of decision (EPA 2014, Table 7) risk-based target cleanup level of 4 µg/L from WAC-173-340, “Model Toxics Control Act – Cleanup.”

Figure 2-7. 100-FR-3 Trend Plots of Contaminant Plume Areas (2003-2020).

ICs for the 100-FR-3 groundwater OU, as required by the ROD (EPA 2014), are described in the latest version of the RDR/RAWP (DOE/RL-2014-44) and are actively managed. Specific details associated with each applicable IC have been incorporated into *Sitewide Institutional Controls Plan for the Hanford CERCLA Response Actions and RCRA Corrective Actions* (DOE/RL-2001-41); this report is routinely updated within 180 days after publication of each decision document that addresses ICs. The ICs for the 100-FR-3 groundwater OU include access control (entry restrictions), land-use management (e.g., land use and excavation permits), groundwater-use management, and miscellaneous provisions. The land-use controls will be maintained until cleanup levels are achieved and the concentrations of hazardous substances are at levels that allow for unlimited use and unrestricted exposure and EPA authorizes removal of the restrictions. The ICs are assessed annually and DOE presents a summary including any noted issues or actions to the Site regulators each fall at the unit managers' meeting. The presentation is documented in the meeting minutes, which are archived in the Hanford Site Administrative Record (see examples in Attachment 4 at the following link: <https://pdw.hanford.gov/document/AR-04230>). During the 5-year review period of 2016 through 2020, no deficiencies related to the 100-FR-3 groundwater OU were specifically noted.

Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of remedy selection still valid?

Yes, the exposure assumptions, toxicity data, and RAOs used at the time of remedy selection (2014) are still valid for the OU. Since the time of the remedy decision, Ecology has clarified application of groundwater cleanup standards under WAC 173-340-720. Under this clarification, the state surface water quality standard for hexavalent chromium (10 ug/L) would be considered in selecting the cleanup level throughout the aquifer for the 100-FR-3 OU. Because the state surface water quality standard was already considered as a cleanup level for groundwater entering the river, this change would not affect remedy protectiveness. However, a change in the cleanup level for the aquifer could affect overall timeframe for cleanup level attainment throughout the OU.

Has any other information come to light that could call into question the protectiveness of the remedy?

Concentrations of groundwater COCs have not declined in the first 5 years of monitoring in all monitoring wells. Variable attenuation rates and plume extents are expected, particularly in the early years of monitoring. If future monitoring shows that the conditions persist, then DOE and the regulators will re-evaluate the protectiveness of the remedy.

Similar to the remedy for the 100-FR-3 OU, the remedy for 100-BC-5 OU includes MNA for hexavalent chromium with near-term concentrations at the river interface exceeding the state surface water quality standard. While there are differences between the 100-BC-5 and 100-FR-3 OUs in existing data and contaminant plume fate and transport, studies to evaluate benthic communities at the 100-BC-5 OU may have future relevance to increased understanding of benthic communities at the 100-FR-3 OU.

Issues/Corrective Actions During this Review Period

Issue FR3-1. The 100-BC ROD (EPA 2021a) clarified that the State water quality standard of 10 µg/L should be considered throughout the aquifer, not only at the shoreline.

Recommendation FR3-1. Evaluate the 100-FR-3 groundwater OU cleanup timeframe relative to application of the 10 µg/L hexavalent chromium State surface water quality standard as a groundwater cleanup level (Milestone Date: September 30, 2024).

Does this issue/action currently affect the protectiveness of the remedy? – NO.

Will this issue/action affect the protectiveness of the remedy in the future? – NO.

Protectiveness Statement

100-FR-3 Groundwater OU – Protective. The remedy at the 100-FR-3 groundwater OU is protective of human health and the environment. The RAOs for preventing human health and ecological receptors from exposure to contaminated groundwater are being met by the implementation and continued management of ICs, expansion of the monitoring well network, and continued monitoring. The RAO of restoring groundwater impacted by the associated source OUs is being met through monitored natural attenuation.

2.3.3 100-D/H Operable Units

The 100-D/H Area is located in the north-central region of the Hanford Site, adjacent to the Columbia River. The 100-D/H Area contains the 100-DR-1, 100-DR-2, 100-HR-1, and 100-HR-2 source OUs and the 100-HR-3 groundwater OU. Figure 2-8 shows all five 100-D/H area OUs. The 100-D/H Area includes the 100-D and 100-H Areas, and the region between them, which is commonly referred to as the “Horn.”

2.3.3.1 100-DR-1, 100-DR-2, 100-HR-1 and 100-HR-2 Source Operable Units

Background

The 105D Reactor operated from 1944 to 1967 and the 105DR Reactor operated from 1950 to 1964. The 105H Reactor operated from 1949 to 1965. Past operations associated with the two plutonium production reactors in the 100-D Area (105D and 105DR) and one reactor in the 100-H Area (105H) contributed to soil and groundwater contamination at the Hanford Site. Cleanup decisions for this region were initiated in the 1990s.

To effectively address waste site remediation efforts, the 100-D Area was divided into the 100-DR-1 source OU, associated with the 105D Reactor, and the 100-DR-2 source OU, associated with the 105DR Reactor.

The 100-H Area also has two source OUs. The 100-HR-1 source OU is located in the eastern portion of the 100-H Area, and includes liquid and sludge disposal sites (e.g., trenches, cribs, and septic tanks) associated with the operations of the reactor and related facilities. The 100-HR-2 source OU is located in the western and southern portions of the 100-H Area and primarily includes solid waste burial grounds, pits, trenches, and septic tanks associated with the operation of the 105H Reactor.

Chronology

Table 2-10 lists remedial action decision documents relevant to source OU response actions in the 100-D Area as of December 31, 2020.

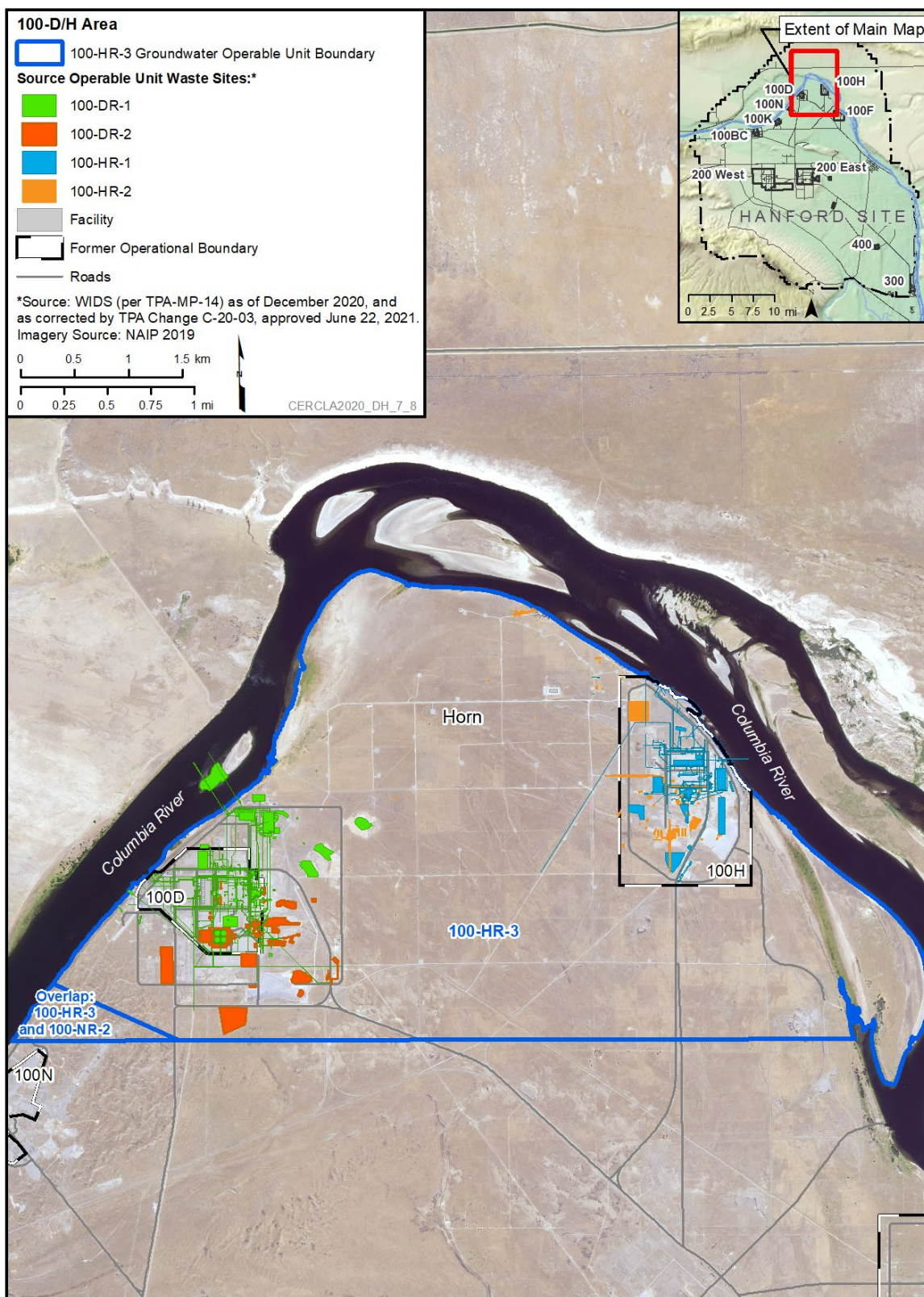


Figure 2-8. Location of 100-D and 100-H Area Operable Units.

Table 2-10. Decision Documents for the 100-DR-1, 100-DR-2, 100-HR-1 and 100-HR-2 Source Operable Units. (2 Pages)

Date	Location	Title
9/1995	EPA/ROD/R10-95/126	<i>Declaration of Record of Decision for the 100-BC-1, 100-DR-1, and 100-HR-1 Operable Units.</i> This interim action ROD requires removal of contaminated soil, structures, and debris using the Observational Approach; treatment by thermal desorption to remove organics and/or soil washing for volume reduction or as needed to meet waste disposal criteria; disposal of contaminated materials at ERDF; and backfill of excavated areas followed by revegetation.
4/1997	EPA/AMD/R10-97/044	<i>Amendment to the Interim Action Record of Decision for the 100-BC-1, 100-DR-1, and 100-HR-1 Operable Units.</i> This amendment to the interim action ROD incorporates 34 additional waste sites into the ROD; refines remedial cost estimate for the original 37 sites and additional 34 sites based on actual data, streamlining, and lessons learned; and eliminates the soil washing treatment option before disposal.
7/1999	EPA/ROD/R10-99/039	<i>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 Remaining Sites.</i> This interim action ROD requires RTD for 46 sites; adds the plug-in approach for the RTD remedy for both remaining 100 Area and 200 North sites and for newly identified 100 Area sites added by ESDs; disposal of debris from B, D, H, and K Reactors to ERDF; and provides decision framework for leaving waste in place, generally below 4.5-m (15-ft) depth.
9/2000	EPA/ROD/R10-00/121	<i>Interim Action Record of Decision: 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-2, 100-HR-2, 100-KR-2 Operable Units (100 Area Burial Grounds).</i> This interim action ROD requires removal of contaminated soil, structures, and debris; treatment as needed; disposal of waste at ERDF; backfilling; and revegetation. It applies to 45 burial grounds in the 100 Area.
2/2004	EPA 2004	<i>Explanation of Significant Difference for the 100 Area Remaining Sites Interim Remedial Action Record of Decision.</i> The ESD adds 28 sites to the ROD; adds 10 CFR 1022 and 40 CFR 6 , Appendix A as ARARs to the ROD; and revises annual ICs report date to coincide with the due date for the Sitewide IC Plan for Hanford CERCLA response actions.
8/2009	EPA et al. 2009	<i>Explanation of Significant Difference for the 100 Area Remaining Sites Interim Remedial Action Record of Decision:</i> This ESD authorizes adding 200-CW-3 OU waste sites, 99 newly discovered waste sites, and 87 candidate sites using the plug-in approach in the ROD and any newly discovered waste sites documented in the Administrative Record and an annual fact sheet.
3/2011	DOE et al. 2011	<i>Tri-Party Agreement Fact Sheet: 100 Area “Plug-In” and Candidate Waste Sites For Calendar Year 2010, Annual listing of waste sites plugged into the remove, treat and dispose remedy in the 1999 interim action Record of Decision for the 100 Area Remaining Sites.</i> This is the annual listing of candidate waste sites for confirmatory sampling and waste sites plugged into the RTD remedy in the 1999 interim action ROD for the 100 Area Remaining Sites.
2/2012	DOE et al. 2012	<i>Tri-Party Agreement Fact Sheet: 100 Area “Plug-In” and Candidate Waste Sites For Calendar Year 2011, Annual listing of waste sites plugged into the remove, treat and dispose remedy in the 1999 interim action Record of Decision for the 100 Area Remaining Sites.</i> This is the annual listing of candidate waste sites for confirmatory sampling and waste sites plugged into the RTD remedy in the 1999 interim action ROD for the 100 Area Remaining Sites.

Table 2-10. Decision Documents for the 100-DR-1, 100-DR-2, 100-HR-1 and 100-HR-2 Source Operable Units. (2 Pages)

Date	Location	Title
1/2013	DOE et al. 2013	Tri-Party Agreement Fact Sheet: 100 Area “Plug-In” and Candidate Waste Sites For Calendar Year 2012, Annual listing of waste sites plugged into the remove, treat and dispose remedy in the 1999 interim action Record of Decision for the 100 Area Remaining Sites. This is the annual listing of candidate waste sites for confirmatory sampling and waste sites plugged into the RTD remedy in the 1999 interim action ROD for the 100 Area Remaining Sites.
1/2014	DOE et al. 2015	Tri-Party Agreement Fact Sheet: 100 Area “Plug-In” and Candidate Waste Sites for Calendar Year 2014, Annual listing of waste sites plugged into the remove, treat and dispose remedy in the 1999 interim action Record of Decision for the 100 Area Remaining Sites. This is the annual listing of candidate waste sites for confirmatory sampling and waste sites plugged into the RTD remedy in the 1999 interim action ROD for the 100 Area Remaining Sites.
7/2018	EPA 2018	Record of Decision for Hanford 100 Area, 100-DR-1, 100-DR-2, 100-HR-1, 100-HR-2, and 100-HR-3 Operable Units, Hanford Superfund Site. This final-action ROD presents the selected remedies involving RTD at 45 waste sites, pipeline capping and ICs at one waste site, ICs at 43 other waste sites, no additional action at 150 waste sites as a result of interim remedial actions completed, pump-and-treat operations to remove hexavalent chromium and total chromium from 100-HR-3 OU groundwater, monitored natural attenuation to address nitrate and strontium-90 in 100-HR-3 OU groundwater, and groundwater ICs.

ARAR = applicable or relevant and appropriate requirement
 CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
 CFR = *Code of Federal Regulations*
 ERDF = Environmental Restoration Disposal Facility
 ESD = explanation of significant differences
 OU = operable unit
 ROD = record of decision
 RTD = removal, treatment (as required), and disposal

See Appendix B for a consolidated list of decision documents for Hanford Site OUs.

Remedial Action

Goals and Objectives. The final RAOs for the 100-DR-1, 100-DR-2, 100-HR-1, and 100-HR-2 source OUs, as specified in the 2018 ROD ([EPA 2018](#)), are RAOs 3 through 6:

- RAO 3: Prevent unacceptable risk from contaminants migrating and/or leaching through soil that will result in groundwater concentrations that exceed standards and risk-based thresholds for protection of surface water and groundwater.
- RAO 4: Prevent unacceptable risk to human health and ecological receptors from exposure to the upper 4.6 m (15 ft) of soil, structures, and debris contaminated with non-radiological constituent concentrations above the unrestricted land-use standards for human health (provided in MTCA Method B [[WAC 173-340](#)]) or soil contaminant levels protective of ecological receptors.
- RAO 5. Prevent unacceptable risk to human health and ecological receptors from exposure to the upper 4.6 m (15 ft) of soil, structures, and debris contaminated with radiological constituents. For human health and ecological receptors:

- Prevent exposure to radiological constituents at concentrations at or above a dose rate limit that causes an Excess Lifetime Cancer Risk threshold of 1×10^{-6} to 1×10^{-4} above background for the residential exposure scenario.
- Prevent ecological receptors based on a dose rate limit of 0.1 rad/day for terrestrial wildlife populations.
- RAO 6. Manage direct exposure to contaminated soils deeper than 4.6 m (15 ft) to prevent an unacceptable risk to human health and the environment.

Remedy Components. The final action ROD ([EPA 2018](#)), as signed in 2018, provided the following summary level descriptions of major components of the selected remedy for the 100-DR-1, 100-DR-2, 100-HR-1, and 100-HR-2 source OUs (i.e., RTD and ICs); the italicized text in the following box is a direct quote from the ROD ([EPA 2018](#)). As noted in the ROD, the remedies selected may change somewhat as a result of the remedial design and construction process. Any changes to the remedies described in the ROD may be documented using a technical memorandum in the administrative record, an ESD, or a ROD amendment, as appropriate.

Excerpt from ROD (EPA 2018)

RTD at Waste Sites for 100-DR-1, 100-DR-2, 100-HR-1, and 100-HR-2

RTD of 104 waste sites identified in Table 1 [referring to Table 1 in this ROD] to achieve RAOs and cleanup levels will be conducted as follows: (a) RTD the soil and debris with COCs exceeding cleanup levels identified in Table 4 as deep as 4.6 m (15 ft) bgs to protect human health and ecological receptors from direct exposure to contaminants, (b) RTD the soil and debris below 4.6 m (15 ft) bgs with COCs exceeding cleanup levels in Table 5 [referring to Table 5 in the ROD] for groundwater and river protection and (c) the excavated waste sites will be backfilled with clean borrow material and contoured to blend with the surrounding ground surface, after which native vegetation will be established. Contaminated soil and debris with concentrations above the cleanup levels will be excavated from the waste sites using shallow and deep excavation technology, treated as necessary to meet applicable LDRs and disposal facility requirements and sent to ERDF, which is considered onsite, or another facility approved by EPA or Ecology. The Selected Remedy for the 100-DR-1, 100-DR-2, 100-HR-1, and 100-HR-2 OUs requires treatment of RTD waste as necessary to meet applicable LDRs and the waste acceptance criteria of the disposal facility and as necessary to reduce air releases and worker exposure during excavation and waste management.

All remediated waste sites with closeout verification data as of November 2012 from the shallow vadose zone from 0 to 4.6 m (0 to 15 ft) bgs in the 100-DR-1, 100-DR-2, 100-HR-1, and 100-HR-2 source OUs were fully evaluated in the RI risk assessment. Between December 2012 and December 2015, interim remediation was completed at 101 waste sites in the 100-D/H source OUs. The results of the waste site data evaluation (CHPRC-02895 Evaluation of Remaining Site Verification Packages Approved after Transmittal of the Rev. 0 Remedial Investigation/Feasibility Study for the 100-DR-1, 100-DR-2, 100-HR-1, 100-HR-2, and 100-HR-3 Operable Units, DOE/RL-2010-95) conducted in 2016 indicate that contaminant concentrations at 99 of the 101 waste sites will likely not exceed the cleanup levels in Tables 4 and 5 of this ROD. Although the preliminary data evaluation indicates these 99 waste sites may not require RTD to meet cleanup levels, additional evaluation of these waste sites consistent with the evaluation conducted in the RI Risk Assessment will occur after issuance of this ROD. Table 1 identifies the waste sites for which the Selected Remedy is RTD. RTD is required unless the waste site meets cleanup levels in Tables 4 and 5 [referring to Tables 1, 4, and 5 in the ROD].

Pipeline Capping, Institutional Controls at Waste Site in 100-DR-1

Capping the end of the pipes in the 100-D-50:2 waste site is required, along with ICs to restrict entry and restrict excavation that will need to be maintained indefinitely.

Institutional Controls (deep zone) at Waste Sites in 100-DR-1, 100-DR-2, and 100-HR-1:

Institutional Controls Component Unique to ICs (deep zone) at waste sites in 100-DR-1, 100-DR-2, and 100-HR-1

ICs in the form of excavation restrictions are required for the 35 ICs (deep zone) waste sites identified in Table 1 and shown on Figures 9 and 10 [referring to Table 1 and Figures 9 and 10 in the ROD] to control access to residual contamination in soil below 4.6 m (15 ft) bgs that is above standards for UU/UE. Exposure to contamination deeper than 4.6 m (15 ft) bgs is not anticipated, however, ICs restricting excavation are required to ensure future activities do not bring contamination to the surface or otherwise result in exposure to contaminant concentrations that are above standards for UU/UE. These ICs will be maintained until the concentrations of hazardous substances are at such levels to allow for UU/UE and EPA or Ecology authorizes the removal of restrictions.

Institutional Controls (shallow zone) at waste sites in 100-DR-1, 100-DR-2, 100-HR-1, and 100-HR-2

Institutional Controls Component Unique to ICs (shallow zone) at waste sites in 100-DR-1, 100-DR-2, 100-HR-1, and 100-HR-2

ICs to control access, use, and to restrict excavation are required for the 8 shallow zone radiologically contaminated waste sites identified in Table 1 and shown on Figures 9 and 10 [referring to Table 1 and Figures 9 and 10 in the ROD] that exceed cleanup levels. The ICs to control access to residual contamination in soil above 4.6 m (15 ft) bgs and restricting excavation are required to ensure future activities do not bring contamination to the surface or otherwise result in exposure to contaminant concentrations that exceed the cleanup levels identified in Table 4 [referring to Table 4 in the ROD].

These ICs will be maintained until cleanup levels are achieved and the concentrations of hazardous substances are at such levels to allow for UU/UE and EPA or Ecology authorizes the removal of restrictions.

Institutional Controls Component Common to All OUs

ICs are required before, during and after the active phase of remedial action implementation where ICs are needed to protect HHE. ICs are used to control access to residual contamination in soil and groundwater above standards for UU/UE. DOE shall be responsible for implementing, maintaining, reporting on and enforcing ICs. Although the DOE may later transfer these procedural responsibilities to another party by contract, property transfer agreement or through other means, the DOE shall retain ultimate responsibility for remedy integrity and ICs. In the event that land is transferred out of federal ownership, deed restrictions (proprietary controls such as easements and covenants) are required that are legally enforceable against subsequent property owners.

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

The following IC performance objectives are required to be met as part of this remedial action. Land-use controls will be maintained until cleanup levels are achieved and the concentrations of hazardous substances are at such levels to allow for UU/UE and EPA or Ecology authorizes the removal of restrictions. Figure 8 [referring to Figure 8 in the ROD] shows the IC boundaries for 100-HR-3. Figure 9 [referring to Figure 9 in

the ROD] shows the IC boundaries for waste sites in the 100-DR-1 and 100-DR-2 OUs, and Figure 10 [referring to Figure 10 in the ROD] shows the IC boundaries for waste sites in the 100-HR-1 and 100-HR-2 OUs. ICs to be implemented by DOE to support achievement of the RAOs include the following:

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

Measures that are necessary to ensure continuation of ICs shall be taken before any lease or transfer of any land subject to ICs. DOE will provide notice to Ecology and EPA at least 6 months before any transfer or sale of land subject to ICs so that the lead regulatory agency can be involved in discussions to ensure that appropriate provisions are included in the transfer terms or conveyance documents to maintain effective ICs. If it is not possible for DOE to notify Ecology and EPA at least 6 months before any transfer or sale, DOE will notify Ecology and EPA as soon as possible, but no later than 60 days before the transfer or sale of any property subject to ICs. In addition to the land transfer notice and discussion provisions, DOE further agrees to provide Ecology and EPA with similar notice, within the same time frames, as to federal-to-federal transfer of property. DOE shall provide a copy of the executed deed or transfer assembly to Ecology and EPA. DOE shall notify EPA and Ecology immediately upon discovery of any activity inconsistent with the specific ICs.

Land Use Control Boundary

The land use control boundary for the 100-DR-1 and 100-DR-2 OUs is shown on Figure 9 [referring to Figure 9 in the ROD]. The land use control boundary for the 100-HR-1 and 100-HR-2 OUs is shown on Figure 10 [referring to Figure 10 in the ROD]. Figure 8 [referring to Figure 8 in the ROD] shows the IC boundaries for 100-HR-3.

Transition from Interim to Final Action for 100-DR-1, 100-DR-2, 100-HR-1, 100-HR-2, and 100-HR-3 OUs

In-progress interim action shall use the cleanup levels in this ROD immediately upon issuance of this ROD. All other aspects of the interim actions shall continue to be performed in accord with the existing RD/RAWPs. DOE shall develop, and submit for Ecology approval, a new RD/RAWP to implement the ROD, prepared in accordance with the TPA (Ecology et al., 1989). When the new RD/RAWP is approved, that document will direct future remedial actions and will replace all interim action ROD work plan requirements.

Remedy Implementation Progress Prior to this Review Period ([DOE/RL-2016-01](#)). Work on the interim remedy, involving RTD, backfilling, recontouring, revegetation, and implementing ICs had been ongoing since the mid-1990s. Prior to 2016, interim remedial actions had been completed at 192 of approximately 205 waste sites in the 100-DR-1, 100-DR-2, 100-HR-1, and 100-HR-2 source OUs.

Issues/Corrective Actions from the Previous (2011-2015) 5-Year Review Report ([DOE/RL-2016-01](#)). No issues or actions were noted for the 100-DR-1, 100-DR-2, 100-HR-1 OUs nor the 100-HR-2 OU in the previous (2011-2015) [CERCLA](#) 5-year review.

Protectiveness Statements from the Previous (2011-2015) 5-Year Review Report ([DOE/RL-2016-01](#)). The protectiveness statements from the previous (2011-2015) 5-year review report for the 100-DR-1, 100-DR-2, 100-HR-1, and 100-HR-2 OUs were as follows:

100-DR-1 Source OU – Will Be Protective. The remedy at the 100-DR-1 source OU is expected to be protective of human health and the environment upon completion of the final remedy. Implementation of the interim remedy (primarily involving RTD, backfilling, recontouring, revegetation, and ICs) at the 100-DR-1 OU has demonstrated that exposure pathways that could result in unacceptable risks are being controlled. DOE anticipates issuance of a final ROD for the 100-D and 100-H areas during the next (2016 – 2020) 5-year review period.

100-DR-2 Source OU – Will Be Protective. The remedy at the 100-DR-2 source OU is expected to be protective of human health and the environment upon completion of the final remedy. Implementation of the interim remedy (primarily involving RTD, backfilling, recontouring, revegetation, and ICs) at the 100-DR-2 OU has demonstrated that exposure pathways that could result in unacceptable risks are being controlled. DOE anticipates issuance of a final ROD for the 100-D and 100-H areas during the next (2016 – 2020) 5-year review period.

100-HR-1 Source OU – Will Be Protective. The remedy at the 100-HR-1 source OU is expected to be protective of human health and the environment upon completion of the final remedy. Implementation of the interim remedy (primarily involving RTD, backfilling, recontouring, revegetation, and ICs) at the 100-HR-1 source OU has demonstrated that exposure pathways that could result in unacceptable risks are being controlled. DOE anticipates issuance of a final ROD for the 100-D and 100-H areas during the next (2016 – 2020) 5-year review period.

100-HR-2 Source OU – Will Be Protective. The remedy at the 100-HR-2 source OU is expected to be protective of human health and the environment upon completion of the final remedy. Implementation of the interim remedy (primarily involving RTD, backfilling, recontouring, revegetation, and ICs) at the 100-HR-2 source OU has demonstrated that exposure pathways that could result in unacceptable risks are being controlled. DOE anticipates the issuance of a final ROD for the 100-D and 100-H areas during the next (2016 – 2020) 5-year review period.

Progress Since 2011-2015 Review

Accomplishments. Accomplishments for the 100-DR-1, 100-DR-2, 100-HR-1, and 100-HR-2 source OUs during the past 5 years (2016-2020) can be summarized as follows:

- Published 100-D/H Interim Remedial Action Report ([DOE/RL-2018-47](#)).

- Published the final action ROD for the 100-DR-1, 100-DR-2, 100-HR-1, and 100-HR-2 source OUs and the 100-HR-3 groundwater OU in 2018 ([EPA 2018](#)).
- Published [DOE/RL-2017-13](#), *Remedial Design/Remedial Action Work Plan for the 100-DR-1, 100-DR-2, 100-HR-1, 100-HR-3 Operable Units* (RD/RAWP) in 2020.
- Achieved an interim closed or final no-action reclassification status in WIDS for three waste sites in accordance with the guideline [TPA-MP-14](#), *Maintenance of Waste Information Data System (WIDS)*. The waste sites that achieved interim reclassification status in WIDS during this review period include 100-D-98 (100-DR-1 OU, interim closed out), 116-H-4 (100-HR-1 OU, interim no-action), and 600-385 (100-HR-2 OU, interim closed out). These sites were reclassified prior to the publication of the final action ROD and will ultimately be reclassified to a final reclassification status.
- Achieved a final closed or final no-action reclassification status in WIDS for more than 140 waste sites in accordance with the guideline [TPA-MP-14](#), *Maintenance of Waste Information Data System (WIDS)*. See listing below. This accomplishment required completion of an evaluation of the final ROD RAOs for waste sites previously closed under interim action RODs. Cleanup verification data (including sampling data and other technical information) to support the reclassification to final closed or final no-action are included in the Hanford Site Administrative Record for the 100-DR-1, 100-DR-2, 100-HR-1, and 100-HR-2 source OUs. Cleanup levels for these source OUs are published in Tables 4 and 5 in the ROD ([EPA 2018](#)). The waste sites that achieved the final closed or final no-action reclassification status in WIDS during this review period are listed below. While most of these waste sites had previously been dispositioned under an interim decision, five sites were reclassified directly to a final status – 100-D-10, 100-D-59, and 100-D-60 in the 100-DR-1 OU, and 100-H-34 and 100-H-36 in the 100-HR-1 OU.

– 100-DR-1 Operable Unit

• 100-D-1, Process Sewer	• 100-D-9, Storage Tank
• 100-D-10, Depression/Pit (nonspecific)	• 100-D-90, Unplanned Release
• 100-D-18, Trench	• 116-D-10, Pond
• 100-D-19, Trench	• 116-D-1A, Trench
• 100-D-2, Foundation	• 116-D-1B, Trench
• 100-D-20, Trench	• 116-D-2, Crib
• 100-D-21, Trench	• 116-D-3, Crib
• 100-D-22, Trench	• 116-D-4, Crib
• 100-D-24, French Drain	• 116-D-5, Outfall
• 100-D-25, Unplanned Release	• 116-D-6, French Drain
• 100-D-29, Unplanned Release	• 116-D-7, Retention Basin
• 100-D-3, Burial Ground	• 116-D-9, Crib
• 100-D-32, Burial Ground	• 116-DR-1&2, Trench
• 100-D-4, Trench	• 116-DR-5, Outfall
• 100-D-42, Burial Ground	• 116-DR-9, Retention Basin
• 100-D-45, Burial Ground	• 118-D-6, Reactor
• 100-D-48, Radioactive Process Sewer	• 120-D-2, Surface Impoundment
• 100-D-49, Radioactive Process Sewer	• 126-D-2, Inert/Demolition Landfill
• 100-D-5, Burial Ground	• 128-D-2, Burn Pit
• 100-D-56, Product Piping	• 130-D-1, Storage Tank
• 100-D-59, French Drain	• 132-D-1, Process Unit/Plant

- 100-D-6, Burial Ground
 - 100-D-60, Radioactive Process Sewer
 - 100-D-61, Dumping Area
 - 100-D-63, Product Piping
 - 100-D-67, Unplanned Release
 - 100-D-7, Dumping Area
 - 100-D-70, French Drain
 - 100-D-74, French Drain
 - 100-D-82, Dumping Area
 - 100-D-87, Dumping Area
 - 100-D-88, Product Piping
 - 132-D-2, Process Unit/Plant
 - 132-D-3, Pump Station
 - 132-D-4, Stack
 - 1607-D4, Septic Tank
 - 1607-D5, Septic Tank
 - 628-3, Burn Pit
 - UPR-100-D-1, Unplanned Release
 - UPR-100-D-2, Unplanned Release
 - UPR-100-D-3, Unplanned Release
 - UPR-100-D-4, Unplanned Release
 - UPR-100-D-5, Unplanned Release
- 100-DR-2 Operable Unit
- 100-D-12, Pump Station
 - 100-D-13, Septic Tank
 - 100-D-15, Dumping Area
 - 100-D-23, French Drain
 - 100-D-28, Septic Tank
 - 100-D-43, Burial Ground
 - 100-D-46, Burial Ground
 - 100-D-47, Burial Ground
 - 100-D-53, Process Unit/Plant
 - 100-D-54, French Drain
 - 100-D-64, Laboratory
 - 100-D-68, Process Unit/Plant
 - 100-D-94, Depression/Pit (nonspecific)
 - 116-D-8, Storage
 - 116-DR-10, Pond
 - 116-DR-4, Crib
 - 116-DR-6, Trench
 - 116-DR-7, Crib
 - 116-DR-8, Crib
 - 118-D-1, Burial Ground
 - 118-D-4, Burial Ground
 - 118-D-5, Burial Ground
 - 118-DR-1, Burial Ground
 - 128-D-1, Burn Pit
 - 132-DR-1, Pump Station
 - 132-DR-2, Stack
 - 1607-D1, Septic Tank
 - 600-30, Dumping Area
- 100-HR-1 Operable Unit
- 100-H-1, Storage
 - 100-H-10, French Drain
 - 100-H-11, French Drain
 - 100-H-12, French Drain
 - 100-H-13, French Drain
 - 100-H-14, Unplanned Release
 - 100-H-17, Unplanned Release
 - 100-H-21, Radioactive Process Sewer
 - 100-H-22, Unplanned Release
 - 100-H-24, Electrical Substation
 - 100-H-3, Storage Tank
 - 100-H-30, Trench
 - 100-H-31, Unplanned Release
 - 100-H-33, Retention Basin
 - 100-H-34, Radioactive Process Sewer
 - 100-H-35, Product Piping
 - 100-H-36, Outfall
 - 100-H-4, Maintenance Shop
 - 100-H-40, Trench
 - 100-H-41, Unplanned Release
 - 100-H-45, Storage Tank
 - 100-H-50, French Drain
 - 100-H-53, Process Sewer
 - 100-H-7, French Drain
 - 100-H-8, French Drain
 - 100-H-9, French Drain
 - 116-H-1, Trench
 - 116-H-2, Trench
 - 116-H-3, French Drain
 - 116-H-4, Crib
 - 116-H-5, Outfall
 - 116-H-7, Retention Basin
 - 116-H-9, Crib
 - 118-H-6, Reactor
 - 132-H-1, Burial Ground
 - 1607-H2, Septic Tank
 - 1607-H3, Septic Tank
 - 1607-H4, Septic Tank

– 100-HR-2 Operable Unit

- 100-H-2, Burial Ground
- 100-H-37, Contamination Migration
- 118-H-1, Burial Ground
- 118-H-2, Burial Ground
- 118-H-3, Burial Ground
- 118-H-4, Burial Ground
- 118-H-5, Burial Ground
- 128-H-1, Burn Pit
- 128-H-2, Burn Pit
- 128-H-3, Burn Pit
- 132-H-2, Burial Ground
- 1607-H1, Septic Tank
- 600-151, Dumping Area
- 600-152, Septic Tank

Table 2-11 summarizes the waste site cleanup status for the 100-DR-1, 100-DR-2, 100-HR-1, and 100-HR-2 source OU waste sites, including metrics on work accomplished prior to 2016 as well as those addressed during this past 5-year period (2016-2020). Figure 2-9 shows the general locations and closure status as of December 2020 of waste sites in the 100-DR-1 and 100-DR-2 source OUs. Figure 2-10 shows the locations and closure status as of December 2020 for waste sites in the 100-HR-1 and 100-HR-2 source OUs.

Table 2-11. 100-DR-1, 100-DR-2, 100-HR-1, and 100-HR-2 Source Operable Units Cleanup Status.

Source OU	Number of Waste Sites ^a	Sites Dispositioned ^b			
		Pre-2016	2016 – 2020	Total	Percent
100-DR-1	96	89	4	93	96
100-DR-2	39	39	0	39	100 ^c
100-HR-1	55	52	3	55	100 ^c
100-HR-2	21	19	1	20	95
Total	211	199	8	207	98%

^a Approximate number of waste sites within the OU, according to WIDS, as of December 2020 (and subsequently corrected per TPA Change C-20-03). Actual numbers can and do change if sites are added to or moved from a given OU in accordance with DOE and regulatory agency approvals.

^b Approximate number of sites dispositioned includes the number of sites that have been reclassified in WIDS, as of December 2020 (and subsequently corrected per TPA Change C-20-03), as either interim closed, final closed, interim no-action, or final no-action in accordance with the guideline TPA-MP-14.

^c The field remediation is complete at these sites; however, the closeout reports have yet to all be approved by Ecology.

TPA-MP-14, 2011, *Maintenance of the Waste Information Data System (WIDS)*, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1109271360>.

TPA Change C-20-03, 2021, *River Corridor Waste Site Updates in the Tri-Party Agreement, Appendix C*, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <https://pdw.hanford.gov/document/AR-14219>.

DOE = U.S. Department of Energy
OU = operable unit

WIDS = Waste Information Data System

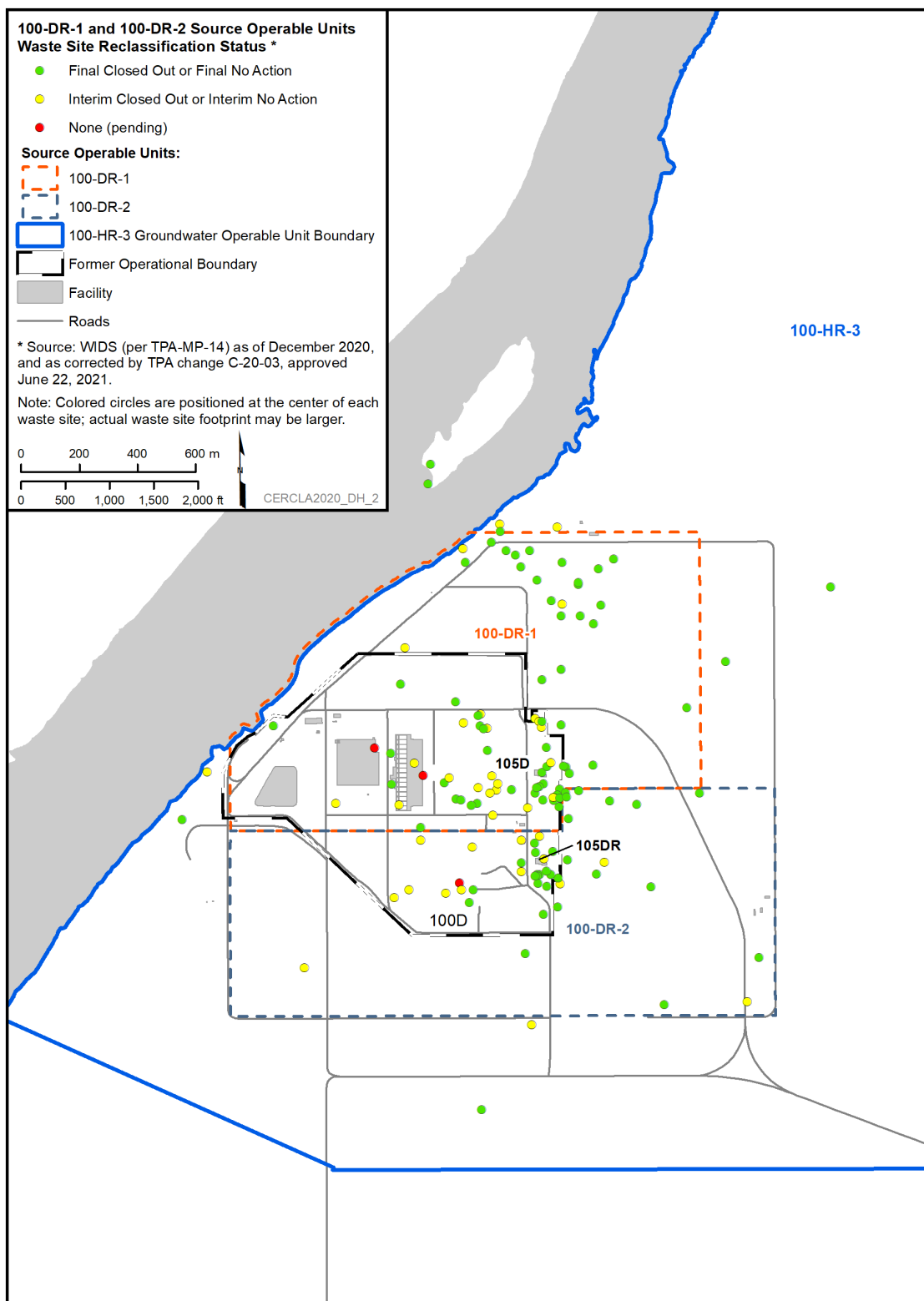


Figure 2-9. Geographic Distribution and WIDS Reclassification Status of the 100-DR-1 and 100-DR-2 Source Operable Unit Waste Sites as of December 2020.

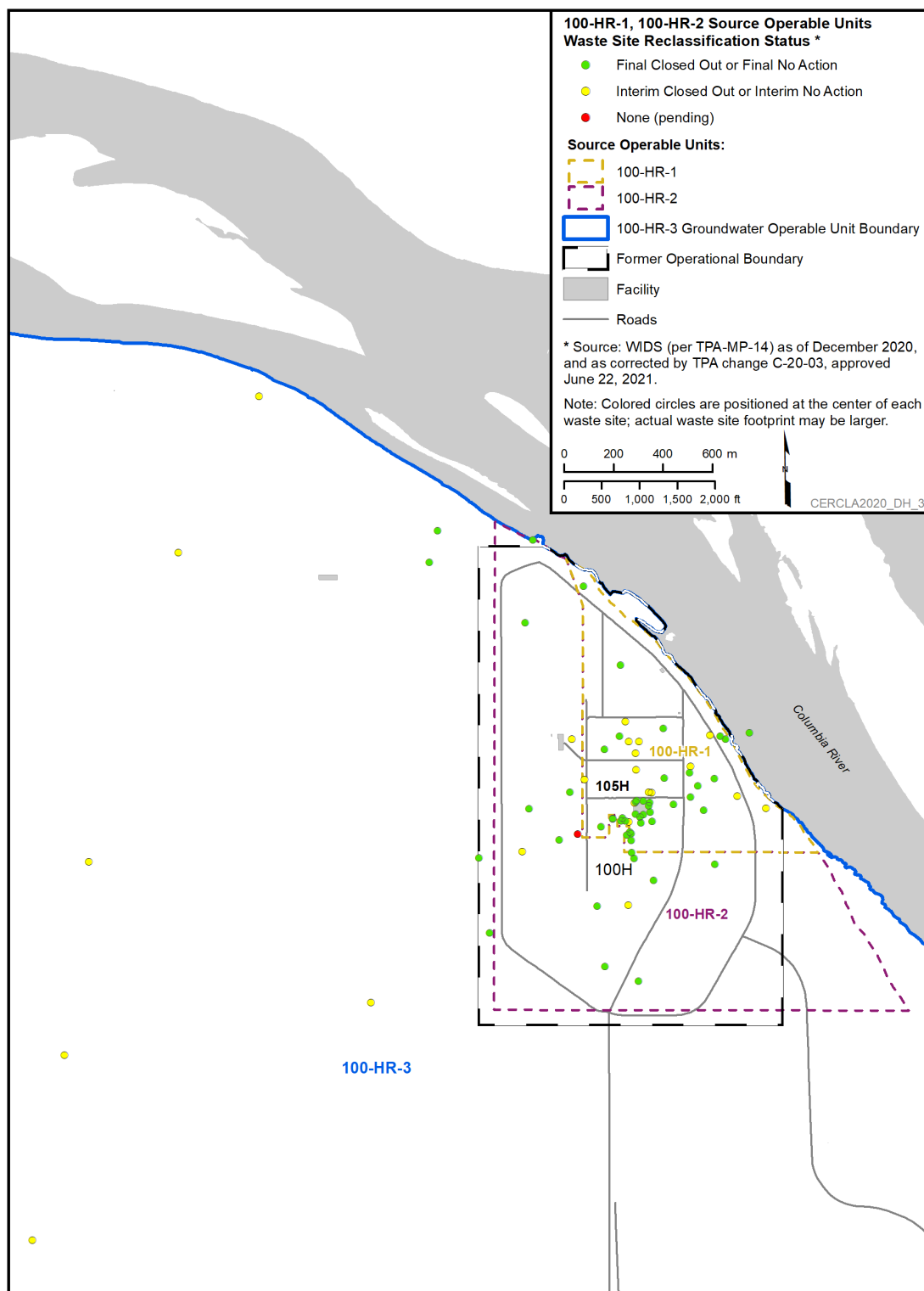


Figure 2-10. Geographic Distribution and WIDS Reclassification Status of the 100-HR-1 and 100-HR-2 Operable Unit Waste Sites as of December 2020.

Remedy Implementation. The 2016 through 2020 5-year review period involved transition of the 100-DR-1, 100-DR-2, 100-HR-1, and 100-HR-2 source OUs from an interim action ROD to final action ROD status. To support implementation of the final ROD ([EPA 2018](#)), the 100-D/H Area RD/RAWP ([DOE/RL-2017-13](#)), as previously noted in the Accomplishments section, was published in late 2020.

As of December 2020, approximately 207 out of 211 waste sites assigned to these four source OUs had been dispositioned. During the period of 2018 through 2020, approximately 140 of the waste sites that were previously classified in WIDS as interim closed or interim no-action, were reevaluated by DOE and regulators in accordance with the final ROD ([EPA 2018](#)) requirements and subsequently reclassified in WIDS as final closed out or final no-action. The status of other sites will remain as accepted, interim closed, or interim no-action until final waste site reclassification forms are prepared, reviewed/approved, and published. Appendix C of this 5-year review report identifies the soil cleanup levels for protection of human health, groundwater, and surface water as presented in Tables 4 and 5 of the 2018 ROD ([EPA 2018](#)).

ICs, including those required by the 2018 ROD ([EPA 2018](#)), have been incorporated into [DOE/RL-2001-41](#) and have been implemented and maintained during this 5-year review period to control access to residual contamination in soil and groundwater above standards for unlimited use and unrestricted exposure.

Technical Assessments

Is the remedy functioning as intended by the decision documents?

The remedies for the 100-DR-1, 100-DR-2, 100-HR-1, and 100-HR-2 waste sites are functioning as intended by the decision documents to the extent the actions have been completed. The remedy (primarily involving RTD, backfilling, revegetation, and ICs) is functioning as intended by the ROD ([EPA 2018](#)). As of December 2020, 207 of the 211 100-DR-1, 100-DR-2, 100-HR-1, and 100-HR-2 source OU waste sites had been dispositioned.

In accordance with [TPA-MP-14](#), *Maintenance of the Waste Information Data System (WIDS)*, the 100-DR-1, 100-DR-2, 100-HR-1, and 100-HR-2 remediated waste sites have been documented in WIDS as either interim closed out or interim no-action, or final closed out or final no-action. Cleanup verification packages (including sampling data and other technical information) to support the WIDS waste sites' reclassifications are included in the Hanford Site Administrative Record for the 100-DR-1, 100-DR-2, 100-HR-1, and 100-HR-2 source OUs. Additionally, in accordance with *EPA Guidance in Close Out Procedures for National Priorities List Sites* ([EPA 540-R-98-016](#)), the remedial actions were documented in *100-D/H Interim Remedial Action Report* ([DOE/RL-2018-47](#)).

The RAOs for 100-DR-1, 100-DR-2, 100-HR-1, and 100-HR-2 source OU remediated waste sites, and the compliance methods used for achieving the RAOs through the interim remedial actions are described in [DOE/RL-2018-47](#). The final RAOs for the 100-DR-1, 100-DR-2, 100-HR-1, and 100-HR-2 source OUs, as specified in the 2018 ROD ([EPA 2018](#)), are RAOs 3 through 6:

- RAO 3. Prevent unacceptable risk from contaminants migrating and/or leaching through soil that will result in groundwater concentrations that exceed standards and risk-based thresholds for protection of surface water and groundwater.
- RAO 4. Prevent unacceptable risk to human health and ecological receptors from exposure to the upper 4.6 m (15 ft) of soil, structures, and debris contaminated with non-radiological constituent concentrations above the unrestricted land-use standards for human health (provided in MTCA Method B [[WAC 173-340](#)]) or soil contaminant levels protective of ecological receptors.

- RAO 5. Prevent unacceptable risk to human health and ecological receptors from exposure to the upper 4.6 m (15 ft) of soil, structures, and debris contaminated with radiological constituents. For human health and ecological receptors:
 - Prevent exposure to radiological constituents at concentrations at or above a dose rate limit that causes an Excess Lifetime Cancer Risk threshold of 1×10^{-6} to 1×10^{-4} above background for the residential exposure scenario.
 - Prevent ecological receptors based on a dose rate limit of 0.1 rad/day for terrestrial wildlife populations.
- RAO 6. Manage direct exposure to contaminated soils deeper than 4.6 m (15 ft) to prevent an unacceptable risk to human health and the environment.

Evaluations of the final ROD RAOs for sites interim-closed out under interim action RODs were completed during this 5-year review period and will continue. In accordance with [TPA-MP-14](#), the remediated sites that meet the final ROD RAOs are documented in WIDS as either final closed-out or final no-action. Cleanup verification packages (including sampling data or other information) to support the reclassification to final no-action or final closed-out are included for over 140 of these waste sites and are currently in the Hanford Site Administrative Record for the 100-DR-1, 100-DR-2, 100-HR-1, and 100-HR-2 source OUs. Cleanup levels for these source OUs are published in Tables 4 and 5 in the final ROD ([EPA 2018](#)).

ICs for the 100-DR-1, 100-DR-2, 100-HR-1, and 100-HR-2 source OUs, as required by the final action ROD ([EPA 2018](#)), are further described in the latest version of the 100-D/H Area RD/RAWP ([DOE/RL-2017-13](#)) and are actively managed. Specific details associated with each IC have also been incorporated into *Sitewide Institutional Controls Plan for the Hanford CERCLA Response Actions and RCRA Corrective Actions* ([DOE/RL-2001-41](#)); this report is routinely updated within 180 days after publication of each decision document that addresses ICs. The ICs implemented for the 100-DR-1, 100-DR-2, 100-HR-1, and 100-HR-2 source OUs include waste site-specific ICs (e.g., drilling and excavation restrictions for waste sites where residual contamination remains at depth, residential use restrictions, and access controls) and general area ICs including access control (warning notices and entry restrictions), land-use management (land use, excavation permits, and notice in deed), groundwater-use management, and miscellaneous provisions. These ICs are assessed annually and DOE presents a summary including any noted issues or actions to the Site regulators each fall at the unit managers' meeting. The presentation is documented in the meeting minutes (e.g., [CHPRC-2003813](#)), which are archived in the Hanford Site Administrative Record (see examples in Attachments 4 and 6 at the following link: <https://pdw.hanford.gov/document/AR-04230>). The annual IC assessments are also now captured in an annual report (e.g., *FY2020 Sitewide Institutional Control Assessment*, [HNF-65616](#)). A summary of observations noted during the annual assessments is presented in Appendix A of this report. The 100-DR-1, 100-DR-2, 100-HR-1, and 100-HR-2 source OU waste sites that were inspected during 2020 included:

- 100-D-18, 100-D-19, 100-D-25, 100-D-46, 100-D-48:1, 100-D-48:2, 100-D-48:3, 100-D-49:1, 100-D-49:2, 100-D-49:4, 100-D-5, 100-D-50:1, 100-D-50:2, 100-D-50:6, 100-D-6, 100-D-86:3, 116-D-1A, 116-D-1B, 116-D-7, 116-D-8, 116-DR-1&2, 116-DR-6, 116-DR-9, 118-D-2:1, 118-D-3:1, 118-D-6:3, 118-D-6:4, 122-DR-1:2, 122-DR-1:4, 122-DR-1:5, UPR-100-D-2, UPR-100-D-3 and UPR-100-D-4.
- 100-H-1, 100-H-11, 100-H-12, 100-H-14, 100-H-21, 100-H-22, 100-H-5, 100-H-54, 116-H-1, 116-H-3, 116-H-7, 118-H-6:3, 118-H-6:6 and 126-H-2.

During the 5-year review period of 2016 through 2020, four signage maintenance/repair issues were noted for the 100-DR-1, 100-DR-2, 100-HR-1, and 100-HR-2 source OUs. In fiscal year (FY) 2017, the warning sign near the west entrance of the 100-D Area was observed to have fallen and was repaired in FY 2018; in 2019, the English warning sign near the Columbia River in the 100-H Area had fallen over (due to high winds) and was repaired within 30 days; and in 2020, the same sign was observed to have fallen but was reattached to a new skid (as well as the Spanish sign) that was stabilized with cinder blocks. Also in 2020, the warning sign near the east entrance to the 105D Reactor area was observed to have fallen due to high winds and was placed in the upright position with added cinder blocks on the base of the skid. All other appropriate ICs for the 100-DR-1, 100-DR-2, 100-HR-1, and 100-HR-2 source OUs were found to be in place and maintained, and the objectives for the ICs are being met.

Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of remedy selection still valid?

The exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of remedy selection in the 2018 ROD are still valid.

Has any other information come to light that could call into question the protectiveness of the remedy?

No new information is known that could call into question the protectiveness of the remedy for these OUs.

Issues/Corrective Actions During this Review Period

Issues. No issues specific to the 100-DR-1, 100-DR-2, 100-HR-1, and 100-HR-2 source OUs were identified during this 5-year review.

Recommendations. No corrective actions are recommended.

Protectiveness Statements

100-DR-1 Source OU – Will Be Protective. The final remedy at the 100-DR-1 source OU is expected to be protective of human health and the environment upon completion. Implementation of the final remedy (primarily involving RTD, backfilling, recontouring, revegetation, pipeline end-capping, and ICs) at the 100-DR-1 OU is ongoing. The remedial activities completed to date and the ongoing management of ICs address unacceptable risks from exposure pathways in the 100-DR-1 OU.

100-DR-2 Source OU – Will Be Protective. The final remedy at the 100-DR-2 source OU is expected to be protective of human health and the environment upon completion. Implementation of the final remedy (primarily involving RTD, backfilling, recontouring, revegetation, and ICs) at the 100-DR-2 OU is ongoing. The remedial activities completed to date and the ongoing management of ICs address unacceptable risks from exposure pathways in the 100-DR-2 OU.

100-HR-1 Source OU – Will Be Protective. The final remedy at the 100-HR-1 source OU is expected to be protective of human health and the environment upon completion. Implementation of the final remedy (primarily involving RTD, backfilling, recontouring, revegetation, and ICs) at the 100-HR-1 OU is ongoing. The remedial activities completed to date and the ongoing management of ICs address unacceptable risks from exposure pathways in the 100-HR-1 OU.

100-HR-2 Source OU – Will Be Protective. The final remedy at the 100-HR-2 source OU is expected to be protective of human health and the environment upon completion. Implementation of the final remedy (primarily involving RTD, backfilling, recontouring, revegetation, and ICs) at the 100-HR-2 OU is ongoing. The remedial activities completed to date and the ongoing management of ICs address unacceptable risks from exposure pathways in the 100-HR-2 OU.

2.3.3.2 100-HR-3 Groundwater Operable Unit

Background

The 100-HR-3 groundwater OU (shown in Figure 2-8) is 1 of 10 groundwater OUs on the Hanford Site, and 1 of 6 located in the River Corridor. The 100-HR-3 groundwater OU consists of the groundwater contaminated by releases from the 100-D and 100-H Area facilities and the associated waste sites in the 100-DR-1, 100-DR-2, 100-HR-1, and 100-HR-2 source OUs.

The 100-D Area is the site of two deactivated reactors: the 105D Reactor (operated from 1944 to 1967) and the 105DR Reactor (operated from 1950 to 1964). The 100-H Area is the site of one deactivated reactor (the 105H Reactor operated from 1949 to 1965). During the years of reactor operations, large volumes of reactor coolant water were discharged to retention basins for ultimate disposal in the Columbia River through outfall pipelines. Liquid wastes containing significant quantities of chromium from reactor operations were discharged to the soil column at cribs, trenches, and French drains. Contaminant plumes in groundwater resulted from these waste disposal practices.

COCs for the 100-HR-3 groundwater OU include hexavalent chromium, total chromium, strontium-90, and nitrate. Other contaminants that exceeded the DWS include uranium and technetium-99.

Groundwater in the 100-HR-3 OU flows generally to the northeast from the 100-D Area, across the Horn to the 100-H Area. Groundwater flow in the 100-H Area is to the east and southeast, generally toward the Columbia River. Groundwater flow in the southern and central portions of the 100-D Area is northwest toward the Columbia River. Operation of pump-and-treat systems at the 100-HR-3 OU changes groundwater flow direction and velocity throughout 100-HR-3, primarily in the reactor areas. These changes are expressed as depressions and mounds in the water table, which are often localized and influence local flow and gradient. Daily and seasonal fluctuations in the river stage also affect groundwater levels, gradients, and flow directions.

Contaminant concentrations in 100-HR-3 groundwater are above cleanup levels and withdrawal for purposes other than research, monitoring, or treatment is prohibited. Under current site-use conditions and controls, the only complete human exposure pathway to groundwater is the potential for limited exposure from intermittent seeps along the Columbia River or during remediation, research, and monitoring activities. The 100-HR-3 groundwater is not being used for drinking water.

A summary of the 100-HR-3 groundwater OU condition, as of 2020, is included in [DOE/RL-2020-60](#), *2020 Hanford Site Groundwater Monitoring Report*, as well in [DOE/RL-2020-61](#), *Calendar Year 2020 Annual Summary Report for the 100-HR-3 and 100-KR-4 P&T Operations and 100-NR-2 Groundwater Remediation*. Additionally, these annual reports and similar reports for calendar years prior to 2020 can be accessed online as noted below:

- *Hanford Site Groundwater Monitoring Report* (published annually to address the previous calendar year): <http://www.hanford.gov/page.cfm/SoilGroundwaterAnnualReports>
- *Annual Summary Report for the 100-HR-3 and 100-KR-4 P&T Operations and 100-NR-2 Groundwater Remediation* for each calendar year can also be accessed online at <http://www.hanford.gov/page.cfm/SoilGroundwaterAnnualReports>.

Chronology

Table 2-12 lists the remedial action decision documents associated with the 100-HR-3 groundwater OU as of December 31, 2020.

Table 2-12. Decision Documents for the 100-HR-3 Groundwater Operable Unit.

Date	Location	Title
3/1996	EPA/ROD/R10-96/134	<i>Declaration of the Record of Decision for the 100-HR-3 and 100-KR-4 Operable Units, Hanford Site, Benton County, Washington.</i> This interim action ROD requires pump-and-treat removal of hexavalent chromium from groundwater extraction wells, ion exchange treatment, reinjection of treated effluent, monitoring, and institutional controls.
10/1999	EPA/AMD/R10-00/122	<i>U.S. Department of Energy Hanford Site – 100 Area, Benton County, Washington, Amended Record of Decision, Decision Summary and Responsiveness Summary.</i> This amendment to the interim action ROD implements the ISRM barrier for the second chromium plume in the 100-HR-3 OU and incorporates Ecology’s 1997 change in chronic ambient water quality standard from 11 µg/L to 10 µg/L; existing pump-and-treats remain in operation. (WAC 173-201A)
4/2003	EPA/ESD/R10-03/606	<i>Explanation of Significant Difference for the 100-HR-3 Operable Unit Record of Decision.</i> This ESD provides notice of revisions to the project schedule and cost estimate associated with the ISRM groundwater remedial action at 100-HR-3 and explains that the addition of an evaporation pond invokes an additional ARAR.
8/2009	EPA 2009	<i>Explanation of Significant Differences for the 100-HR-3 and 100-KR-4 Operable Units Interim Action Record of Decision, Hanford Site, Benton County, Washington.</i> This ESD provides notice of an increase in projected costs for pump-and-treat operations for both OUs, changes reinjection location requirements for treated water to other than upgradient locations to help contain the hexavalent chromium plumes and prevent the plume from expanding, and changes the treatment and discharge standards for wells not upgradient of extraction wells to meet the aquatic river protection criterion of 10 µg/L for hexavalent chromium.
10/2010	11-AMCP-0002	<i>Non-Significant Change for the 100-HR-3 and 100-KR-4 Operable Units Interim Action Record of Decision.</i> This notice of non-significant change indicates that the ISRM barrier would no longer be actively maintained; this shifted the groundwater remedy at the ISRM barrier to the pump-and-treat system.
7/2018	EPA 2018	<i>Record of Decision for Hanford 100 Area, 100-DR-1, 100-DR-2, 100-HR-1, 100-HR-2, and 100-HR-3 Operable Units, Hanford Superfund Site.</i> This final-action ROD presents the selected remedies involving RTD at 45 waste sites, pipeline capping and ICs at one waste site, ICs at 43 other waste sites, no additional action at 150 waste sites as a result of interim remedial actions completed, pump-and-treat operations to remove hexavalent chromium and total chromium from 100-HR-3 OU groundwater, monitored natural attenuation to address nitrate and strontium-90 in 100-HR-3 OU groundwater, and groundwater ICs.

ARAR = applicable or relevant and appropriate requirement
Ecology = Washington State Department of Ecology
ESD = explanation of significant differences

ISRM = in situ reduction-oxidation manipulation
OU = operable unit
ROD = record of decision

See Appendix B for a consolidated list of decision documents for Hanford Site OUs.

Remedial Actions

Goals and Objectives. In accordance with the NCP, “EPA expects to return useable ground waters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site” ([40 CFR 300.430](#)[a][1][iii][F]). EPA generally defers to state definitions of

groundwater classification provided under EPA-endorsed Comprehensive State Groundwater Protection Programs (*Guidance on Remedial Actions for Contaminated Ground Water at Superfund Sites EPA/540/G-88/003*).

Groundwater from the 100-HR-3 OU is contaminated and is not currently withdrawn from the aquifer for beneficial use; however, the highest potential beneficial use of groundwater is as a drinking water source. Consistent with the beneficial-use classifications of Washington State and the EPA, the goal for remediating 100-HR-3 OU groundwater is to reduce contaminants to levels that will allow its use as a future drinking water source.

Based on the expectations for 100-HR-3 groundwater restoration, the RAOs, as stated in the 2018 final action ROD ([EPA 2018](#)), are as follows:

- RAO 1. Prevent unacceptable risk to human health from ingestion of and incidental exposure to groundwater containing contaminant concentrations above federal and state standards and risk-based thresholds.
- RAO 2. Prevent unacceptable risk to human health and ecological receptors from groundwater discharges to surface water containing contaminant concentrations above federal and state standards and risk-based thresholds.
- RAO 7. Restore groundwater in 100-HR-3 to cleanup levels, which include DWSs, within a timeframe that is reasonable given the particular circumstances of the site.

These RAOs reflect the potential use of groundwater as a drinking water source. Note: The current cleanup level for hexavalent chromium in the surface water at the point of groundwater discharge is 10 µg/L. The groundwater remediation is implemented to ensure that this requirement is met.

Remedy Components. The ROD, as signed in 2018, provided the following summary-level descriptions of the major components of the selected remedy (i.e., pump-and-treat system, monitored natural attenuation, ICs, and groundwater performance monitoring) for the 100-HR-3 groundwater OU; the italicized text in the following box is a direct quote from the original ROD ([EPA 2018](#)). The selected remedy may change somewhat as a result of the remedial design and construction process. Any changes to the remedy described in the ROD will be documented using a technical memorandum in the administrative record, an ESD, or a ROD amendment in accordance with the NCP.

Excerpt from ROD (EPA 2018):

The Selected Remedy may change somewhat as a result of the remedial design and construction process. Any changes to the remedy described in the ROD will be documented using a technical memorandum in the AR, an ESD, or a ROD amendment, in accordance with the NCP.

Pump and Treat System for 100-HR-3

The Selected Remedy requires an expansion and optimization of the existing pump and treat system designed to reduce concentrations of Cr(VI) and total chromium to meet cleanup levels in Table 6 [referring to Table 6 within the ROD] 12 years after implementation and hydraulic plume capture to reduce contamination levels and prevent discharge to the Columbia River above state surface water quality standards. Total chromium, strontium-90 and nitrate are collocated with Cr(VI). Nitrate and strontium-90 will be co-extracted with the Cr(VI) during pump and treat. Cr(VI), total chromium, nitrate and strontium-90 will meet cleanup standards in Table 6 [referring to Table 6 within the ROD] upon reinjection.

O&M activities for this remedy include inspection, maintenance, and periodic replacement of monitoring wells; routine and preventive maintenance and replacement of pump and treat system parts at the end of their design life for groundwater pump and treat components; and operations and performance monitoring. A geostatistical analysis will be conducted to determine the optimum spatial distribution for the performance monitoring network. The performance monitoring component includes installation of new wells, periodic sampling, laboratory analysis, and data evaluation to assess the natural attenuation processes, rates of attenuation, and overall protectiveness.

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

MNA for 100-HR-3

MNA will be used for nitrate and strontium-90 in the 100-HR-3 OU to reduce groundwater contamination to concentrations less than the cleanup levels shown in Table 6 [referring to Table 6 within the ROD]. The primary natural attenuation processes for nitrate and strontium-90 present in 100-HR-3 include biodegradation and abiotic degradation, radioactive decay, dispersion, and sorption. The required performance monitoring component includes installation of new wells, periodic sampling, laboratory analysis, and data evaluation needed to assess and confirm the natural attenuation processes, rates of attenuation consistent with natural attenuation model estimates, and overall protectiveness. The MNA processes are expected to achieve cleanup standards for nitrate in 6 years and strontium-90 in 44 years. The monitoring will continue until cleanup levels are achieved.

O&M activities for this remedy include inspection, maintenance, and periodic replacement of monitoring wells, and operations and performance monitoring. A geostatistical analysis will be conducted to determine the optimum spatial distribution for the performance monitoring network. The performance monitoring component includes installation of new wells, periodic sampling, laboratory analysis, and data evaluation to assess the natural attenuation processes, rates of attenuation, and overall protectiveness.

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

Institutional Controls Component Unique to 100-HR-3

The following IC performance objectives are required to be met as part of this remedial action for 100-HR-3. Land-use controls will be maintained until cleanup levels are achieved and the concentrations of hazardous substances are at such levels to allow for UU/UE and EPA or Ecology authorizes the removal of restrictions. ICs to be implemented by DOE to support achievement of the RAOs include the following:

- DOE shall employ and maintain a permit program limiting 100-HR-3 groundwater access and use to research purposes and for monitoring and treatment in areas where groundwater is above cleanup levels (Figure 8) [referring to Figure 8 within the ROD].*
- Prevent access or use of the groundwater for drinking water purposes until cleanup levels are met (Figure 8) [referring to Figure 8 within the ROD].*

Institutional Controls Component Common to All OUs

ICs are required before, during and after the active phase of remedial action implementation where ICs are needed to protect HHE. ICs are used to control access to residual contamination in soil and groundwater above standards for UU/UE. DOE shall be responsible for implementing, maintaining, reporting on and enforcing ICs. Although the DOE may later transfer these procedural responsibilities to another party by contract, property transfer agreement or through other means, the DOE shall retain ultimate responsibility for remedy integrity and ICs. In the event that land is transferred out of federal ownership, deed restrictions (proprietary controls such as easements and covenants) are required that are legally enforceable against subsequent property owners.

The current implementation, maintenance and periodic inspection requirements for ICs at the Hanford

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

The following IC performance objectives are required to be met as part of this remedial action. Land-use controls will be maintained until cleanup levels are achieved and the concentrations of hazardous substances are at such levels to allow for UU/UE and EPA or Ecology authorizes the removal of restrictions. Figure 8 [referring to Figure 8 within the ROD] shows the IC boundaries for 100-HR-3. Figure 9 [referring to Figure 9 within the ROD] shows the IC boundaries for waste sites in the 100-DR-1 and 100-DR-2 OUs, and Figure 10 [referring to Figure 10 within the ROD] shows the IC boundaries for waste sites in the 100-HR-1 and 100-HR-2 OUs. ICs to be implemented by DOE to support achievement of the RAOs include the following:

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

Measures that are necessary to ensure continuation of ICs shall be taken before any lease or transfer of any land subject to ICs. DOE will provide notice to Ecology and EPA at least 6 months before any transfer or sale of land subject to ICs so that the lead regulatory agency can be involved in discussions to ensure that appropriate provisions are included in the transfer terms or conveyance documents to maintain effective ICs. If it is not possible for DOE to notify Ecology and EPA at least 6 months before any transfer or sale, DOE will notify Ecology and EPA as soon as possible, but no later than 60 days before the transfer or sale of any property subject to ICs. In addition to the land transfer notice and discussion provisions, DOE further agrees to provide Ecology and EPA with similar notice, within the same time frames, as to federal-to-federal transfer of property. DOE shall provide a copy of the executed deed or transfer assembly to Ecology and EPA. DOE shall notify EPA and Ecology immediately upon discovery of any activity inconsistent with the specific ICs.

Land Use Control Boundary

The land use control boundary for the 100-DR-1 and 100-DR-2 OUs is shown on Figure 9 [referring to Figure 9 within the ROD]. The land use control boundary for the 100-HR-1 and 100-HR-2 OUs is shown on Figure 10 [referring to Figure 10 within the ROD]. Figure 8 [referring to Figure 8 within the ROD] shows the IC boundaries for 100-HR-3.

Groundwater Performance Monitoring for 100-HR-3

Groundwater performance monitoring will be integrated into the sampling and analysis portion of the RD/RA WP. Sampling will be sufficient to document changes in contaminant plumes for all groundwater COCs. As part of monitoring the lateral extents of plumes, groundwater will be monitored in the near vicinity of the Columbia River throughout 100-HR-3 to ensure the lateral extent of the plumes are defined. Monitoring will continue until COCs have met cleanup levels and are expected to continue to meet cleanup levels and EPA or Ecology approves termination of the monitoring. Groundwater monitoring will be performed to evaluate the effectiveness of the selected 100-HR-3 remedy to achieve cleanup levels. The monitoring will be for groundwater COCs (Cr(VI), total chromium, nitrate, and strontium-90).

Miscellaneous solid waste generated by groundwater monitoring activities may be transferred to the CGWSA and accumulated or stored there before being transferred to ERDF or another facility approved by EPA or Ecology, where it will be treated as necessary to meet applicable LDRs and disposal facility requirements and disposed.

Transition from Interim to Final Action/or 100-DR-1, 100-DR-2, 100-HR-1, 100-HR-2, and 100-HR-3 OUs

In-progress interim action shall use the cleanup levels in this ROD immediately upon issuance of this ROD. All other aspects of the interim actions shall continue to be performed in accord with the existing RD/RA WPs. DOE shall develop, and submit for Ecology approval, a new RD/RA WP to implement the ROD, prepared in accordance with the TP A (Ecology et al., 1989). When the new RD/RA WP is approved, that document will direct future remedial actions and will replace all interim action ROD work plan requirements.

Remedy Implementation Progress Prior to this Review Period. Prior to this review period (i.e., before 2016), five [CERCLA](#) interim action remedies had operated in the 100-HR-3 groundwater OU. These remedies included the original 100-HR-3 OU Pump and Treat System, which treated groundwater from both the 100-D and 100-H Areas, the 100-DR-5 Pump and Treat System, and the in situ reduction-oxidation manipulation (ISRM) barrier in the 100-D Area. These original pump-and-treat systems were then enhanced with two new systems; the DX and HX Pump and Treat Systems. [DOE/RL-2016-19, Calendar Year 2015 Annual Summary Report for the 100-HR-3 and 100-KR-4 Pump and Treat Operations, and 100-NR-2 Groundwater Remediation](#), (Rev. 0) reports the total hexavalent chromium removed by the systems through the end of 2015. Since startup of the 100-HR-3 OU Pump and Treat Systems, the cumulative volume of groundwater treated (prior to 2016) was approximately 15,542 million L (4,103 million gal), with 2,349 kg (5,168 lb) of hexavalent chromium removed.

Based on treatability study demonstrations, in situ treatment of hexavalent chromium was another remedy component added to the 100-HR-3 groundwater OU by the October 1999 ROD amendment (see Table 2-10). This additional remedy component involved installing an ISRM barrier to reduce the mobility and toxicity of chromium in groundwater. This component was deemed necessary because sampling from additional wells installed determined that the hexavalent chromium plume was not being captured by the pump-and-treat systems. Details on the elements of the ISRM barrier are provided in *EPA Superfund Record of Decision Amendment: Hanford 100-Area (USDOE), EPA ID: WA3890090076, OU 02, Benton County WA, 10/24/1999* ([EPA/AMD/R10-00/122](#)) to *EPA Superfund Record of Decision: Hanford 100-Area (USDOE), EPA ID: WA3890090076, OU 02, Benton County, WA, 03/26/1996* ([EPA/ROD/R10-96/134](#)). The ISRM barrier, which operated from 1997 to 2012, is described in more detail in the upcoming Remedy Implementation section. Due to hexavalent chromium breakthrough at the ISRM barrier, a notice of nonsignificant change to the interim action ROD was issued in 2010, indicating that the barrier would no longer be actively maintained. Under the interim action remedy, the ISRM barrier continued to be monitored for hexavalent chromium and dissolved oxygen. Once the final ROD was signed in 2018, the ISRM monitoring requirement was removed. Further details are described in the previous 5-year review report ([DOE/RL-2016-01](#)).

Issues/Corrective Actions from the Previous (2011-2015) 5-Year Review. In the previous [CERCLA](#) 5-Year Review report ([DOE/RL-2016-01](#)) for the period of 2011 through 2015, the following single issue and its recommended action were noted in the 100-HR-3 groundwater OU assessment:

***Issue HR3-1.** Hexavalent chromium exceeds the aquatic water quality standard at several small areas along the Columbia River shoreline.*

***Corrective Action HR3-1.** Install additional wells and/or convert existing wells to remove contaminant mass and impose hydraulic containment necessary to protect aquatic receptors in the Columbia River. (Action Due Date: September 30, 2020).*

Does this issue/action currently affect the protectiveness of the remedy? – YES

Will this issue/action affect the protectiveness of the remedy in the future? – YES

In support of Issue/Corrective Action HR3-1, a total of 40 new wells were installed (15 new wells installed in 2016, 6 wells in 2017, 0 wells in 2018, 10 new wells in 2019, and 9 new wells in 2020) during the period of 2016 to 2020 to expand and optimize the 100-HR-3 groundwater OU network of injection, extraction, and monitoring wells. One new extraction well and two new injection wells in the 100-D Area were installed in 2016 for river protection and plume control in that area. Four extraction wells were installed north of the 100-H Area in 2016 and 2017 as part of the remedial optimization for plume containment near the river shore. Farther north, one new injection well was installed in 2019 to mitigate the Horn plume migration to the river. In 2019, one new well was connected to the extraction system near the 107H Retention Basin in the 100-H Area to improve river protection and increase mass removal in that area. One extraction well south of the 100-H Area was converted to an injection well in 2020 to prevent hexavalent chromium plume migration to the river. Further details are described in each of the respective annual groundwater monitoring reports and the annual pump-and-treat reports (<http://www.hanford.gov/page.cfm/SoilGroundwaterAnnualReports>).

Protectiveness Statement from the Previous (2011-2015) 5-Year Review Report ([DOE/RL-2016-01](#)).

The protectiveness statement from the previous (2011-2015) 5-year review report for the 100-HR-3 groundwater OU was as follows:

***100-HR-3 Groundwater OU – Will Be Protective.** The remedy at the 100 HR-3 groundwater OU is expected to be protective of human health and the environment upon completion of the final remedy. Implementation of the interim remedy at 100-HR-3 (primarily involving groundwater P&T system operations focused on hexavalent chromium contamination, flow-path control, and ICs) has demonstrated that exposure pathways that could result in unacceptable risks are being controlled. DOE anticipates issuance of a final ROD for the 100-D and 100-H Areas during the next (2016 – 2020) 5-year review period.*

Progress Since the 2011-2015 Review

Accomplishments. The primary remedial action accomplishments for the 100-HR-3 groundwater OU during the past 5 years (2016-2020) is summarized as follows:

- Continued [CERCLA](#) groundwater sampling and analysis at monitoring well locations
- Continued operation of groundwater pump-and-treat systems and removed over 2,600 kg (5,732 lb) of hexavalent chromium:

- HR-3 Pump and Treat: Operated from 1997 to 2011 and removed 406 kg (895 lb) of hexavalent chromium
 - DR-5 Pump and Treat: Operated from 2007 to 2011 and removed 338 kg (745.2 lb) of hexavalent chromium
 - DX Pump and Treat: Operating since 2010 and removed 1,650 kg (3,637.6 lb) of hexavalent chromium as of 2020
 - HX Pump and Treat: Operating since 2011 and removed 265 kg (584.2 lb) of hexavalent chromium as of 2020.
- Published the final action ROD for the 100-DR-1, 100-DR-2, 100-HR-1 and 100-HR-2 source OUs and the 100-HR-3 groundwater OU in 2018 ([EPA 2018](#)).
 - Published *Remedial Design/Remedial Action Work Plan for the 100-DR-1, 100-DR-2, 100-HR-1, 100-HR-3 Operable Units* ([DOE/RL-2017-13](#)) in 2020.
 - Published *100-D/H Continuing Hexavalent Chromium Source Evaluation* ([SGW-64372](#)), a continuing source evaluation, which identified six sites at the 100-HR-3 OU where the vadose zone is acting as a continuing source to groundwater contamination.
 - Increased emphasis on characterizing, monitoring, and remediating the uppermost water-bearing unit within the Ringold upper mud (RUM).
 - Installed 40 new wells to expand and optimize the 100-HR-3 groundwater OU network of injection, extraction, and monitoring wells:
 - 21 new wells installed in the unconfined aquifer
 - 19 new wells installed in the underlying RUM aquifer.

Additional narrative on 100-HR-3 groundwater OU accomplishments relative to each RAO (as of 2020) can be viewed in [DOE/RL-2020-61](#), *Calendar Year 2020 Annual Summary Report for the 100-HR-3 and 100-KR-4 Pump and Treat Operations and 100-NR-2 Groundwater Remediation*.

Remedy Implementation. Primary documents that have influenced field implementation of the interim action ROD for 100-HR-3 ([EPA/ROD/R10-96/134](#), as amended) include [DOE/RL-96-84](#), *Remedial Design Report and Remedial Action Work Plan for the 100-HR-3 and 100-KR-4 Groundwater Operable Unit's Interim Action*, Rev. 0 and Rev. 0A, and [DOE/RL-2013-31](#), *100-HR-3 Groundwater Operable Unit Remedial Design/Remedial Action Work Plan*. Later in this 5-year review period of 2016-2020, remedy implementation has been influenced by the final remedy ROD ([EPA 2018](#)) and the RD/RAWP ([DOE/RL-2017-13](#)). The work plans include the design and operational requirements for the original and updated 100-HR-3 OU Pump and Treat Systems. Associated with each pump-and-treat system are additional supporting documents that address such topics as operations, performance monitoring, and sampling requirements.

To mitigate risks associated with hexavalent chromium contamination in groundwater discharging to the river, multiple [CERCLA](#) interim action ion exchange pump-and-treat systems have been installed in the 100-HR-3 OU since 1997. The original pump-and-treat system (HR-3) operated from 1997 to 2011 and the DR-5 Pump and Treat System operated from 2007 to 2011. Two replacement pump-and-treat

systems, DX and HX, were installed and have been operating since 2010 and 2011, respectively. In 2012, several areas along the river were identified in [DOE/RL-2013-13](#), *Calendar Year 2012 Annual Summary Report for the 100-HR-3 and 100-KR-4 Pump-and-Treat Operations, and 100-NR-2 Groundwater Remediation*, as having the potential to be affected by hexavalent chromium. As a result, refinement of the pump-and-treat systems was targeted and, in 2013, initiated in those areas. In the 100-D Area, additional wells were drilled to increase capture and mass removal of the northern plume; these wells were connected to the pump-and-treat system in 2015. Wells also were installed in 100-D south to improve contaminant mass recovery near the 100-D-100 waste site. Realignment in the 100-D Area also included connecting existing wells along the ISRM barrier as extraction wells.

In 2000, an in situ chemical treatment technology was added to the existing pump-and-treat remedy in the form of an ISRM barrier to reduce hexavalent chromium to trivalent chromium. Use of this new technology was approved by the 1999 interim ROD amendment ([EPA/AMD/R10-00/122](#)). Contaminant breakthrough at the ISRM barrier triggered issuance of a notice of nonsignificant change to the ROD in 2010, which indicated that the barrier would no longer be actively maintained ([11-AMCP-0002](#)). The notice of nonsignificant change shifted the groundwater remedy at the ISRM barrier to the pump-and-treat system. However, groundwater at the ISRM site is still monitored for hexavalent chromium.

Other final remedy activities performed during the 2016-2020 5-year review period included groundwater monitoring to track plumes, plume areas, and concentration trends; operation and optimization of the pump-and-treat systems for hexavalent chromium (including adding new wells and realigning existing wells); and finalizing the RD/RAWP document ([DOE/RL-2017-13](#)). ICs to prevent human exposure to contaminated groundwater also were managed throughout the review period.

With respect to [RCRA](#) monitoring, the former 183-H Solar Evaporation Basins (116-H-6 waste site) are now in post-closure corrective action status. Corrective action is being accomplished through the [CERCLA](#) remedial action for groundwater. 100-D Pond (120-D-1 waste site) is a closed site and no longer in the “Hanford Site-Wide RCRA Permit” ([WA7890008967](#)). The final status groundwater monitoring plan for the 183-H Solar Evaporation Basins was incorporated into the Hanford Permit on May 24, 2017. The 183-H Basins and underlying soils were remediated in 1996; the unit was closed in place in 1997 under the modified closure provisions of the Hanford Permit, with respect to specified measures for post-closure care. DOE submits semiannual reports to Ecology, as required under [RCRA](#) corrective action monitoring for the 183-H Solar Evaporation Basins. [SGW-65236](#), *Post-Closure Corrective Action Groundwater Monitoring Report for the 183-H Solar Evaporation Basins: January – June 2020*, covers the monitoring period from January through June 2020. [SGW-65857](#), *Post-Closure Corrective Action Groundwater Monitoring Report for the 183-H Solar Evaporation Basins: July – December 2020*, covers the rest of 2020. The [RCRA](#) post-closure corrective action groundwater monitoring period for the 183-H Solar Evaporation Basins, initiated in 1997, is 25 years. At the end of this compliance period, monitoring will continue until it can be demonstrated that the concentration limit has not been exceeded for a period of three consecutive years. When the compliance period is complete, the 183-H Solar Evaporation Basins will be removed from the Hanford Facility [RCRA](#) Permit.

Table 2-13 presents an overview of primary components of the remedy and implementation status for the 100-HR-3 final action ROD.

Technical Assessment

Is the remedy functioning as intended by the decision documents?

Yes, the remedy identified in the final action ROD ([EPA 2018](#)) involving extraction and treatment of hexavalent chromium-contaminated groundwater from the 100-HR-3 area, reinjection of treated water, MNA for nitrate and strontium-90, ICs, and performance monitoring is functioning as intended. In support of remedial process optimization, the pump-and-treat system is routinely evaluated to identify

modifications to improve performance. These modifications include construction of additional wells, well realignments, and system modifications. Continued optimization is planned for this next review period.

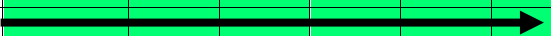
Operation of the DX and HX Pump and Treat Systems is effectively removing hexavalent chromium and providing hydraulic capture for river protection progress toward achieving interim RAOs 2 and 7, as described in [EPA \(2018\)](#). From 1997 through 2020, pump-and-treat systems (HR-3, DR-5, DX, and HX), collectively, have removed over 2,600 kg (5,732 lb) of hexavalent chromium. Table 2-14 summarizes the 100-HR-3 groundwater OU contaminants removed by the DX and HX Pump and Treat Systems during this 5-year review period and cumulatively since system startup. Concentrations and distribution of strontium-90 have shown consistent, gradual declines in both the 100-D and 100-H Areas. In 2015, for the first time, strontium-90 was not detected above the DWS in any aquifer tube in the 100-HR-3 OU. For the period 2016-2020, strontium-90 was detected above the DWS in only one aquifer tube in the 100-HR-3 OU.

Groundwater extraction, reinjection, monitoring, and optimization are conducted through a series of wells, as shown for 2020 in Figures 2-11 and 2-12 for the DX and HX systems, respectively. Specific details on the performance and optimization of each pump-and-treat system in the River Corridor are updated and published each year in the *Annual Summary Report for the 100-HR-3 and 100-KR-4 P&T Operations and 100-NR-2 Groundwater Remediation*, which is available at <http://www.hanford.gov/page.cfm/SoilGroundwaterAnnualReports>.

Hexavalent chromium is the primary contaminant in 100-HR-3 groundwater; however, smaller plumes of strontium-90 and nitrate also are present. The collective hexavalent chromium plume area above 10 µg/L in the unconfined aquifer is calculated to have decreased from 4.8 km² in 2015 to 2.5 km² in 2020, or a decrease of nearly 48%. The collective plume area in the unconfined aquifer above 48 µg/L decreased from 0.66 km² in 2015 to <0.01 km² in 2020, or a decrease of >98%. The length of shoreline that was interpreted to intersect the hexavalent chromium plume at concentrations above 10 µg/L varied during the 5-year period from 990 m in 2015 to 374 m in 2020. The maximum concentration of hexavalent chromium sampled in the unconfined aquifer was 640 µg/L in 2016 and 83.4 µg/L in 2020. The maximum hexavalent chromium concentration in the RUM aquifer was 130 µg/L in 2016 and 539 µg/L in 2020.

Table 2-15 provides an overview of 100-HR-3 contaminant plume areas in the unconfined aquifer and associated changes to the areas during this 5-year review period. The plume maps in Figure 2-13 show the changes in plume shapes and areas during this 5-year review period. The Figure 2-14 trend plots depict the estimated annual changes in contaminant plume areas over the past several 5-year periods.

Table 2-13. Overview of 100-HR-3 Groundwater OU Remedy Implementation. (2 Pages)

Document Type	Date	Title						
Final Action ROD	07/2018	EPA, 2018, <i>Record of Decision for Hanford 100 Area, 100-DR-1, 100-DR-2, 100-HR-1, 100-HR-2, and 100-HR-3 Operable Units, Hanford Superfund Site.</i>						
RDR/RAWP	08/2003	DOE/RL-96-84, <i>Remedial Design Report and Remedial Action Work Plan for the 100-HR-3 and 100-KR-4 Groundwater Operable Units Interim Action, Rev. 0-A.</i>						
RD/RAWP	05/2016	DOE/RL-2013-31, <i>100-HR-3 Groundwater Operable Unit Remedial Design/Remedial Action Work Plan. Rev. 0.</i>						
RD/RAWP	12/2020	DOE/RL-2017-13, <i>Remedial Design/Remedial Action Work Plan for the 100-DR-1, 100-DR-2, 100-HR-1 and 100-HR-3 Operable Units, Rev. 0.</i>						
RAO (abbreviated description)	1. Prevent unacceptable risk to human health from ingestion of and incidental exposure to groundwater containing contaminant concentrations above federal and state standards and risk-based thresholds. 2. Prevent unacceptable risk to human health and ecological receptors from groundwater discharges to surface water containing contaminant concentrations above federal and state standards and risk-based thresholds. 7. Restore groundwater in 100-HR-3 to cleanup levels, which include DWSs, within a timeframe that is reasonable, given the particular circumstances of the site.							
COCs	Hexavalent chromium, total chromium, strontium-90, and nitrate							
Remedy Component (primary)	Status (approximate percentage complete for implementing the remedy component as of December 2020) ^a						Duration of O&M (~years) ^b	Finish ^c (Est'd year)
	0	1-25	26-50	51-75	76-99	100%		
Pump-and-Treat System (expansion and optimization of existing system, ~12 years from RD/RAWP issuance)							12	2032
Monitored Natural Attenuation (Nitrate: ~6 years from ROD issuance, strontium-90: ~44 years from ROD issuance)							44	2062
Institutional Controls							TBD	TBD
Groundwater Performance Monitoring							TBD	TBD

^a Percentages reflect implementation status of the remedy component; 100% = fully implemented and now in O&M mode.^b O&M and duration and completion timeframes are based on timelines in the ROD (EPA 2018) and RD/RAWP (DOE/RL-2017-13).^c Estimated year when remedy component will be completed.

DOE/RL-96-84, 1996, *Remedial Design Report and Remedial Action Work Plan for the 100-HR-3 and 100-KR-4 Groundwater Operable Unit's Interim Action*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at: <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D1348764>.

DOE/RL-2013-31, *100-HR-3 Groundwater Operable Unit Remedial Design/Remedial Action Work Plan*, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <https://pdw.hanford.gov/document/0076482H>.

DOE/RL-2017-13, Rev. 0, *Remedial Design/Remedial Action Work Plan for the 100-DR-1, 100-DR-2, 100-HR-1 and 100-HR-3 Operable Units*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <https://pdw.hanford.gov/document/AR-04759>.

EPA, 2018, *Record of Decision Hanford 100 Area Superfund Site 100-DR-1, 100-DR-2, 100-HR-1, 100-HR-2, 100-HR-3 Operable Units*, U.S. Environmental Protection Agency, Washington, D.C. Available online at <https://pdw.hanford.gov/document/0065047H>.

COC = contaminant of concern
 O&M = operation and maintenance

RD/RAWP = remedial design/remedial action work plan
 ROD = record of decision

Table 2-13. Overview of 100-HR-3 Groundwater OU Remedy Implementation. (2 Pages)

RAO = remedial action objectives TBD = to be determined

Table 2-14. Contaminant Mass Removed from 100-HR-3 Groundwater Extraction Systems.

System (Startup)	Constituent	Mass Removed (kg)					
		2016	2017	2018	2019	2020	Since Startup
DX (Dec 2010)	Hexavalent chromium	59	30.4	29.3	24.1	19.0	1,650
HX (Sept 2011)	Hexavalent chromium	25.7	25.9	26.6	30.6	38.4	265.3

Source: Annual pump-and-treat reports:

DOE/RL-2016-68, *Calendar Year 2016 Annual Summary Report for the 100-HR-3 and 100-KR-4 Pump-and-Treat Operations, and 199-NR-2 Groundwater Remediation*, Rev 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <https://pdw.hanford.gov/document/0067961H>.

DOE/RL-2017-67, *Calendar Year 2017 Annual Summary Report for the 100-HR-3 and 100-KR-4 Pump-and-Treat Operations, and 199-NR-2 Groundwater Remediation*, Rev 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <https://pdw.hanford.gov/document/0083709>.

DOE/RL-2018-67, 2019, *Calendar Year 2018 Annual Summary Report for the 100-HR-3 and 100-KR-4 Pump and Treat Operations, and 100-NR-2 Groundwater*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <https://pdw.hanford.gov/document/AR-03039>.

DOE/RL-2019-67, 2020, *Calendar Year 2019 Annual Summary Report for the 100-HR-3 and 100-KR-4 Pump and Treat Operations, and 100-NR-2 Groundwater Remediation*, Rev 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <https://pdw.hanford.gov/document/AR-04067>.

DOE/RL-2020-67, *Calendar Year 2020 Annual Summary Report for the 100-HR-3 and 100-KR-4 Pump and Treat Operations, and 100-NR-2 Groundwater*, Rev 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <https://www.hanford.gov/page.cfm/SoilGroundwaterAnnualReports>.

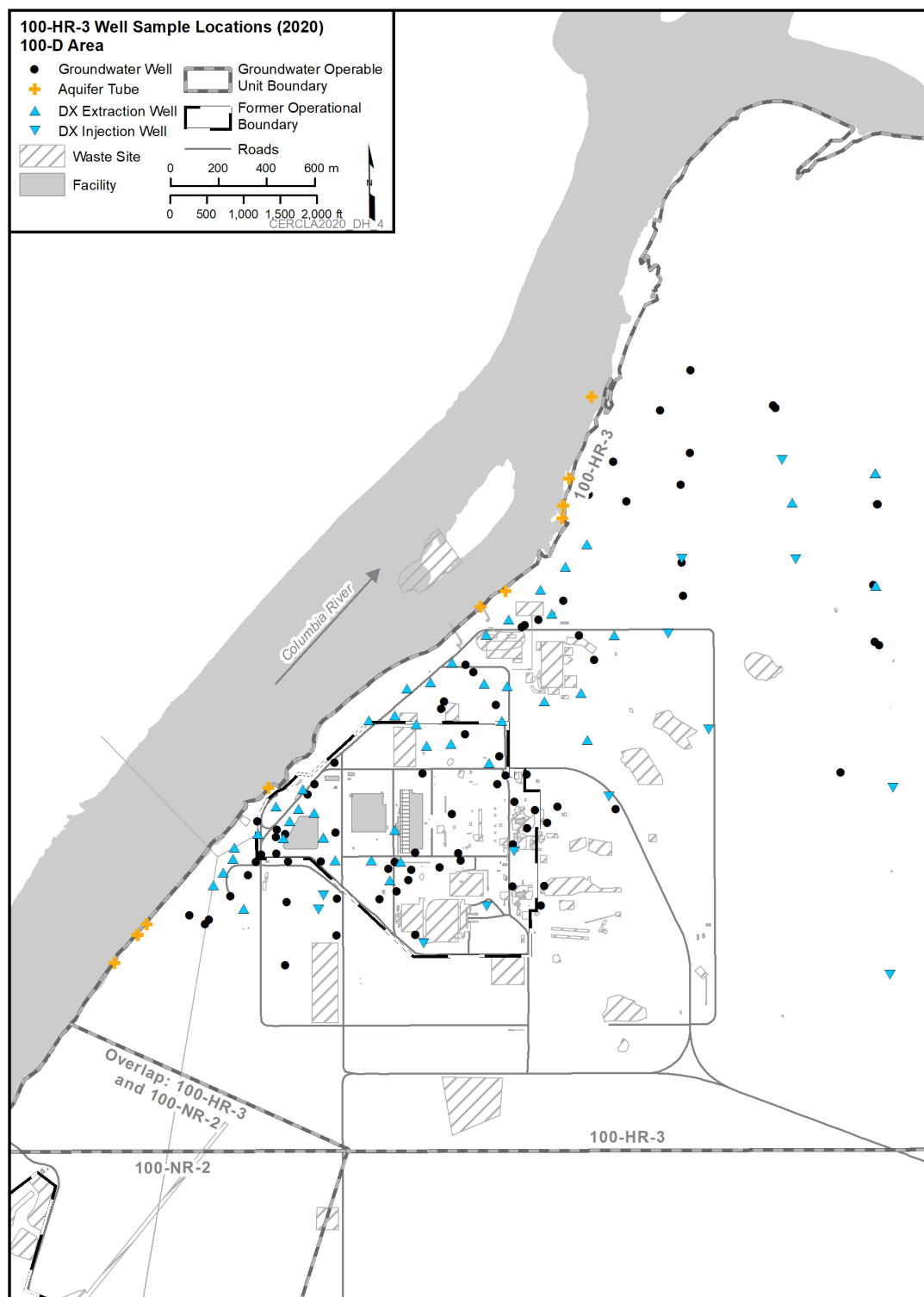


Figure 2-11. Locations of 100-HR-3 (100-D Area) Wells and Aquifer Tubes Sampled in 2020.

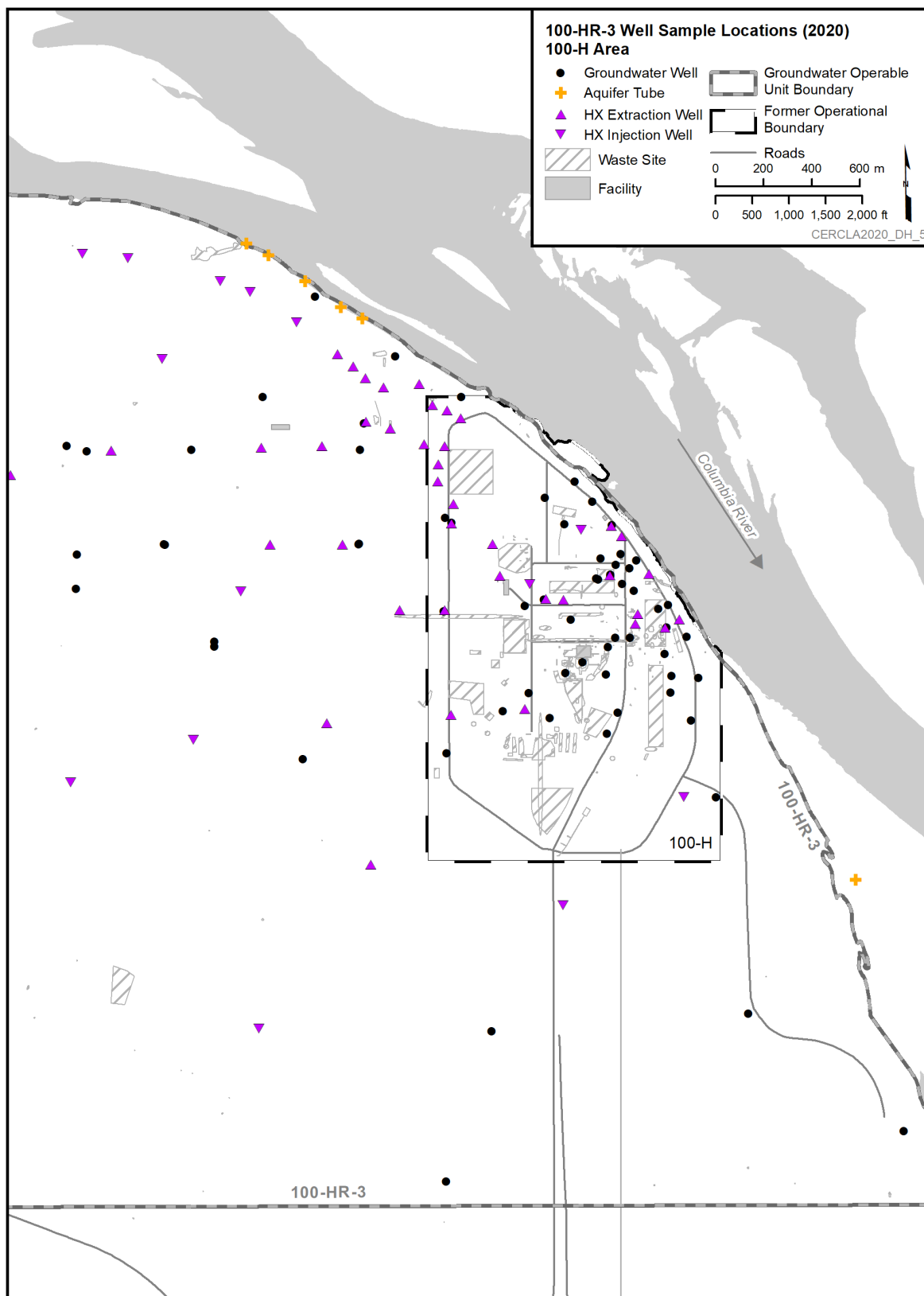


Figure 2-12. Locations of 100-HR-3 (100-H Area) Wells and Aquifer Tubes Sampled in 2020.

Table 2-15. Overview of 100-HR-3 Groundwater Contaminant Plumes.^a

100-HR-3 Groundwater Plume Summary								
Groundwater Contaminants of Concern	Cleanup Levels ^b	Maximum Concentration (2020)	Plume Area ^c (km ²)			Shoreline Intersection (m) ^d		
			2015	2020	Change	2015	2020	Change
Hexavalent Chromium	10 µg/L ^e	12.9 µg/L	4.8	2.5	-2.3	990	374	-616
Hexavalent Chromium	48 µg/L ^e	83.4 µg/L	0.66	<0.01	-0.65	0	0	0
Nitrate	45 mg/L ^f	159 mg/L	0.0	0.02	0.02	0	0	0
Strontium-90	8 pCi/L	15.9 pCi/L	0.02	<0.01	-0.01	0	0	0

^a Source: Hanford Annual Groundwater Monitoring Reports for 2015 and 2020

<http://www.hanford.gov/page.cfm/SoilGroundwaterAnnualReports>.

^b Drinking water standard for all but hexavalent chromium. The groundwater cleanup levels, as presented in the ROD (EPA 2018) are included in Appendix C of this report.

^c Estimated area in the unconfined aquifer at a concentration greater than the listed water quality standard.

^d Length of Columbia River shoreline intersected by plume above listed water quality standard.

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

^f 45 mg/L as nitrate is equivalent to the drinking water standard of 10 mg/L as nitrogen.

EPA, 2018, *Record of Decision Hanford 100 Area Superfund Site 100-DR-1, 100-DR-2, 100-HR-1, 100-HR-2, 100-HR-3 Operable Units*, U.S. Environmental Protection Agency, Washington, D.C. Available online at <https://pdw.hanford.gov/document/0065047H>.

N/A = not applicable

NC = not calculated

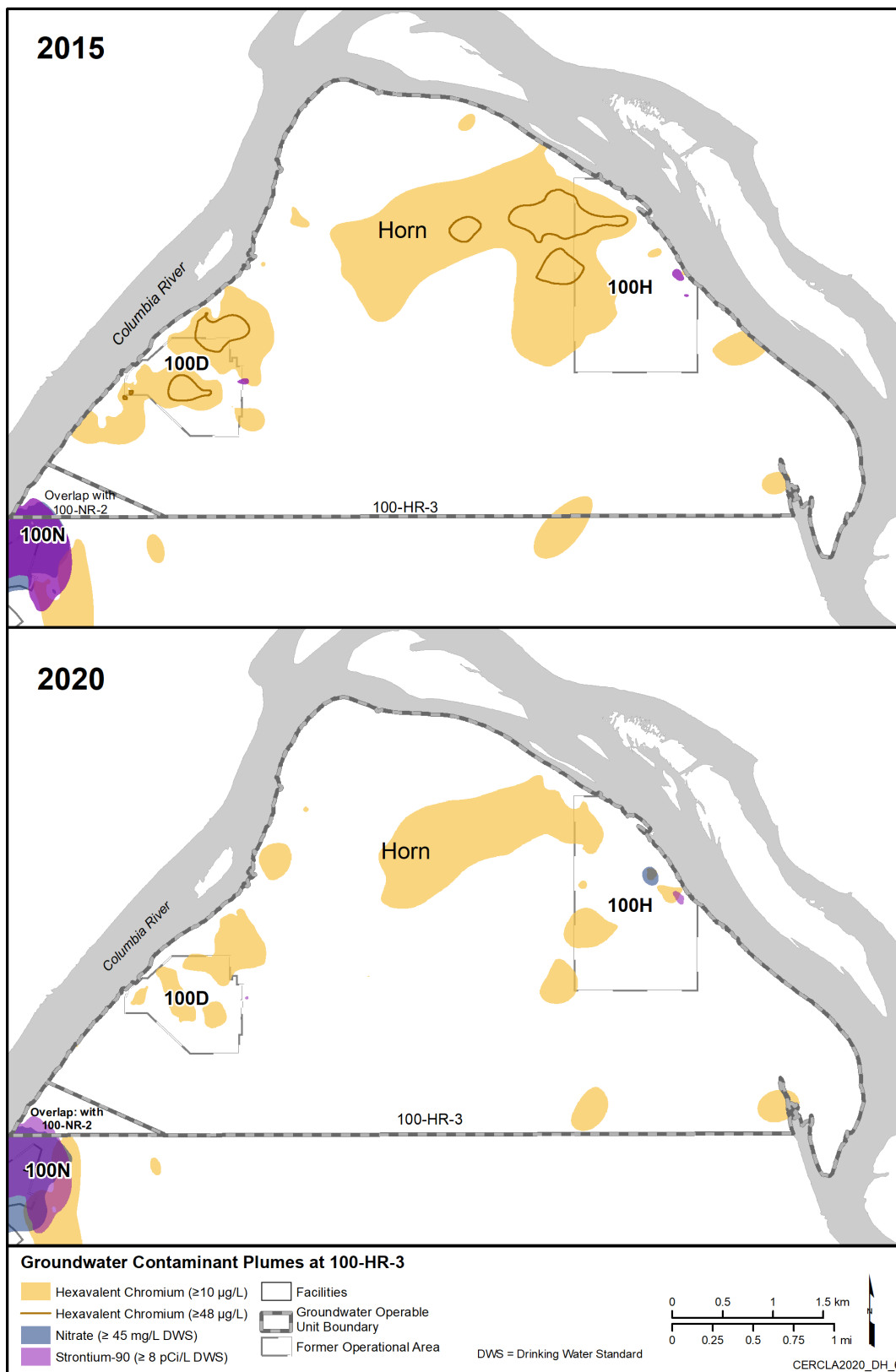


Figure 2-13. 100-HR-3 Groundwater Operable Unit Plumes in 2015 (top) and 2020 (bottom).

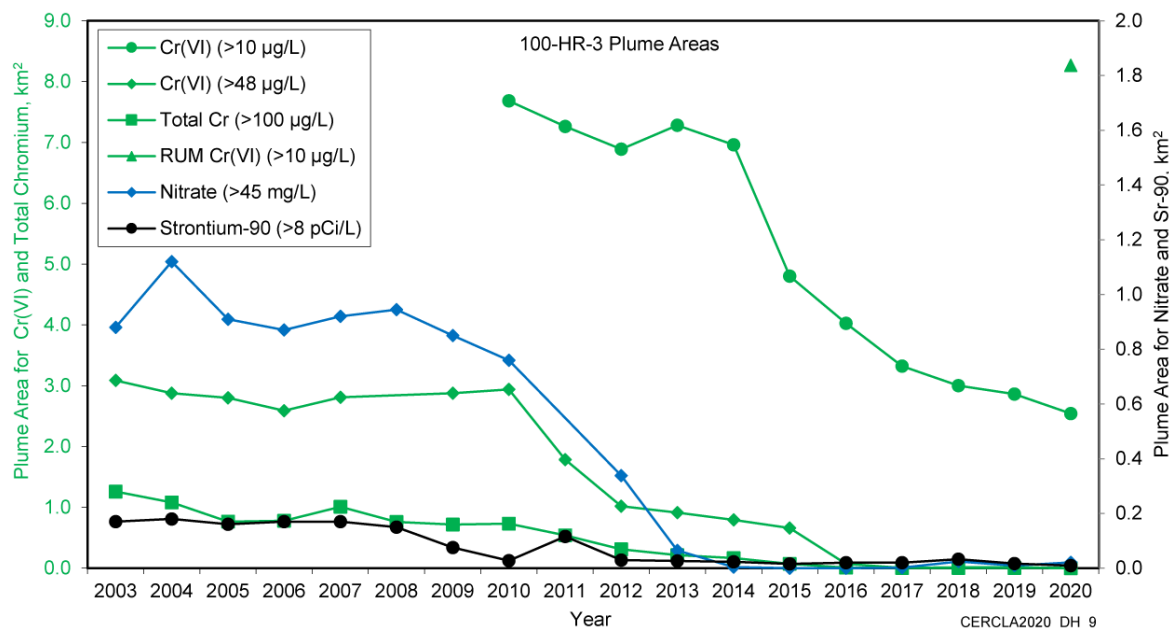


Figure 2-14. 100-HR-3 Trend Plots of Contaminant Plume Areas (2003-2020).

For more detailed information on the 100-HR-3 groundwater OU well locations, distribution of contaminant concentrations within each plume, and historic trends associated with each 100-HR-3 COC plume area, as well as for performance metrics associated with 100-HR-3 OU groundwater treatment, visit the following links:

- *Hanford Site Groundwater Monitoring Report* (published each summer for the previous calendar year): <http://www.hanford.gov/page.cfm/SoilGroundwaterAnnualReports>
- *Annual Summary Report for the 100-HR-3 and 100-KR-4 P&T Operations and 100-NR-2 Groundwater Remediation* (published for each prior calendar year): <http://www.hanford.gov/page.cfm/SoilGroundwaterAnnualReports>.

ICs for the 100-HR-3 groundwater OU, as initially required by the interim action ROD ([EPA/ROD/R10-96/134](#)), as amended, are described in [DOE/RL-96-84](#), *Remedial Design Report and Remedial Action Work Plan for the 100-HR-3 and 100-KR-4 Groundwater Operable Unit's Interim Action*, Rev. 0 and Rev. 0-A, and were actively managed in support of interim action RAO 2. Subsequently, ICs required by the final action ROD ([EPA 2018](#)) were in place to support final action remedy RAO 1, as described in [EPA \(2018\)](#) and in [DOE/RL-2017-13](#), *Remedial Design/Remedial Action Work Plan for the 100-DR-1, 100-DR-2, 100-HR-1, 100-HR-2, and 100-HR-3 Operable Units*. Specific details associated with each IC also have been incorporated into [DOE/RL-2001-41](#), *Sitewide Institutional Controls Plan for the Hanford CERCLA Response Actions and RCRA Corrective Actions*, and this report is routinely updated within 180 days after publication of each decision document that addresses ICs. The ICs implemented for the 100-HR-3 OU are required to prevent human exposure to contaminated groundwater and include warning notices, entry restrictions, land-use management (land use), groundwater-use management (excavation permits), and miscellaneous provisions. These ICs are assessed annually and DOE presents a summary including any noted issues or actions to the Site regulators each fall at the unit managers meeting. The presentation is documented in the meeting minutes (e.g., [CHPRC-2003813](#)), which are archived in the Hanford Site Administrative Record (see examples in Attachments 2 and 6 at the following link: <https://pdw.hanford.gov/document/AR-04230>). The annual IC assessments are also now captured in an annual report (e.g., [HNF-65616](#), *FY2020 Sitewide*

Institutional Control Assessment). During the 5-year review period of 2016 through 2020, no deficiencies were noted for the 100-HR-3 groundwater OU.

Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of remedy selection still valid?

The exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of remedy selection in 2018 ([EPA 2018](#)) are still valid. Since the time of the remedy decision, Ecology has clarified application of groundwater cleanup standards under [WAC 173-340-720](#). Under this clarification, the State surface water quality standard for hexavalent chromium (10 ug/L) would be considered in selecting the cleanup level throughout the aquifer for the 100-HR-3 OU. Because the state surface water quality standard was already considered as a cleanup level for groundwater entering the river, this change would not affect remedy protectiveness. However, a change in the cleanup level for the aquifer could affect overall timeframe for cleanup level attainment throughout the OU.

Has any other information come to light that could call into question the protectiveness of the remedy?

Information has come to light that would call into question the protectiveness of the final remedy based on evaluation factors involving source identification and plume delineation. As pump-and-treat remediation efforts have progressed in removing hexavalent chromium contamination from groundwater, hexavalent chromium concentrations in the unconfined aquifer have decreased to levels below the 48 µg/L cleanup level across most of the 100-HR-3 groundwater OU. Although many sources of hexavalent chromium have been removed through excavation activities, any sources of hexavalent chromium contamination remaining in the vadose zone may continue to impact groundwater. The RD/RAWP ([DOE/RL-2017-13](#)) identifies three potential secondary sources (100-D-56 pipeline, 116-H-6 [183-H Solar Evaporation Basins], 116-H-7 waste site [107H Retention Basin]) for confirmation and investigation. These three sources (also described in [SGW-58416](#), *Persistent Source Investigation at 100D Area*) and three additional persistent sources of hexavalent chromium are known or suspected to contribute to groundwater contamination were identified in the 100-D and 100-H Areas. Collectively, these six sources are more specifically noted as the 100-D-100 sidewall, 100-D-56:2 pipeline, and 100-D north plume in the 100-D Area and the 183-H Solar Evaporation Basins, 100-H-46 waste site, and 107H Retention Basin in the 100-H Area ([SGW-64372](#)). An investigation of these known or suspected continuing sources to estimate the mass and distribution of hexavalent chromium in the vadose zone was initiated in 2020. The investigation results will be used to identify whether remedy changes to address sources are needed to meet cleanup timeframes for hexavalent chromium.

Hexavalent chromium contamination has been known to occur in the uppermost water-bearing unit of the RUM at concentrations above the 48 µg/L cleanup level. This water-bearing unit, known as the RUM aquifer, is a semiconfined or leaky-confined aquifer that lies below the unconfined aquifer. The distribution of the contamination in the RUM aquifer has not been well defined and pump-and-treat extraction was limited to two locations in the 100-H Area when the HX Pump and Treat System began operating in 2011. Since 2016, 19 wells have been installed in the RUM aquifer to better define the spatial distribution of the contamination and to increase extraction volume and mass removal. The 2020 plume map of hexavalent chromium in the RUM aquifer indicates contamination at concentrations greater than the 48 µg/L cleanup level in the western part of the Horn, northeast of the 100-D Area and in the 100-H Area near the river shore. During 2020, the DX and HX Pump and Treat Systems removed 57.4 kg (126.5 lb) of hexavalent chromium from groundwater, 26.3 kg (58 lb) from the unconfined aquifer, and 31.1 kg (68.6 lb) from the RUM aquifer. Additional extraction wells are planned for the RUM aquifer.

Issues/Recommendations

Issue HR3-1: The 100-BC ROD ([EPA 2021a](#)) clarified that the State water quality standard of 10 µg/L should be considered throughout the aquifer, not only at the shoreline.

Recommendation HR3-1. Evaluate the 100-HR-3 groundwater OU cleanup timeframe relative to application of 10 µg/L hexavalent chromium State surface water quality standard as a groundwater cleanup level (Milestone Date: September 30, 2024).

Does this issue/action currently affect the protectiveness of the remedy? – NO.

Will this issue/action affect the protectiveness of the remedy in the future? – NO.

Protectiveness Statement

100-HR-3 Groundwater OU – Will Be Protective. The remedy at the 100-HR-3 groundwater OU is expected to be protective of human health and the environment upon completion of construction. ICs are in place and protecting human exposure to contaminated groundwater. Construction of additional wells to optimize the network of pump-and-treat extraction wells, injection wells, and monitoring wells is planned through FY 2026. Implementation of the final remedy at 100-HR-3 (primarily involving groundwater pump-and-treat system operations, monitored natural attenuation, ICs, and performance monitoring) has demonstrated that exposure pathways that could result in unacceptable risks are being controlled.

2.3.4 100-K Operable Units

The 100-K Area is located in the north-northwest region of the Hanford Site, adjacent to the Columbia River. The 100-K Area contains the 100-KR-1 and 100-KR-2 source OUs, and the 100-KR-4 groundwater OU. Figure 2-15 shows all three 100-K Area OUs.

To effectively address waste site remediation efforts, the 100-K Area was divided into two source OUs:

- 100-KR-1 OU principally contains soil sites contaminated by liquid discharges
- 100-KR-2 OU principally contains soil, structures, and landfills.

Current land use in the 100-K Area consists of facilities support and remediation activities. Facilities support includes maintaining existing structures, roads, and grounds. The principal structures include the two reactors, a new potable water treatment plant, parts of the water treatment infrastructure, groundwater treatment systems, and multiple support buildings. While most of these structures are planned to be removed, the two reactor buildings (105KE and 105KW) will be placed in interim safe storage for up to 75 years before the final remediation decision is implemented, allowing radionuclide activity levels to decrease through radioactive decay to levels suitable for final decommissioning. The Columbia River and north shoreline are used for recreational activities such as hunting, fishing, and boating and support a large variety of aquatic and riparian animals and plants.

2.3.4.1 100-KR-1 Source Operable Unit

Background

Past operations associated with the two plutonium production reactors (105KE and 105KW) in the 100-K Area contributed to soil and groundwater contamination at the Hanford Site. The 105KE Reactor operated from 1955 to 1971 and the 105KW Reactor operated from 1955 to 1970. Cleanup decisions for this region were initiated in the 1990s.

This section focuses on the 100-KR-1 source OU, which contains soil sites contaminated by liquid discharges. The 100-KR-1 OU comprises the north portion of the 100-K Area and is immediately adjacent to the Columbia River.

Chronology

Table 2-16 lists the remedial action decision documents relevant to the 100-KR-1 source OU as of December 31, 2020.

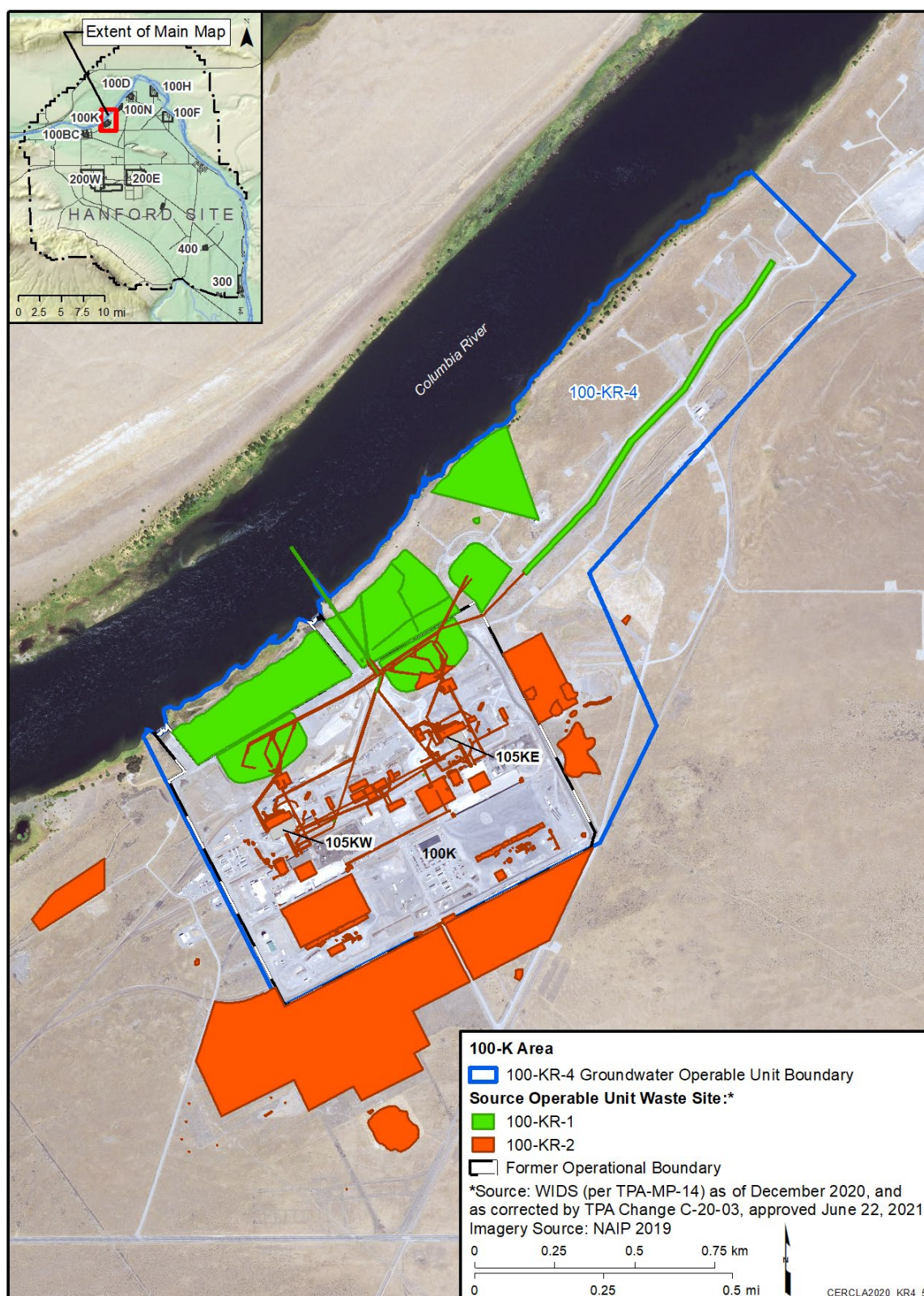


Figure 2-15. Location of 100-K Area Operable Units.

Table 2-16. Decision Documents for the 100-KR-1 Source Operable Unit.

Date	Location	Title
4/1997	EPA/AMD/R10-97/044	<i>Amendment to the Interim Action Record of Decision for the 100-BC-1, 100-DR-1, and 100-HR-1 Operable Units.</i> This amendment to the 1995 interim action ROD (EPA/ROD/R10-95/126) incorporates 34 additional waste sites (including 100-KR-1 and 100-KR-2 sites); refines the remedial cost estimate for the original 37 sites and additional 34 sites based on actual data, streamlining, and lessons learned; and eliminates the soil-washing treatment option before disposal. [Note: The 1995 interim action ROD did not originally include 100-K Area waste sites. The 1995 ROD requires removal of contaminated soil, structures, and debris using the observational approach treatment by thermal desorption to remove organics and/or soil washing for volume reduction or as needed to meet waste disposal criteria, disposal of materials at ERDF, and backfill of excavated areas followed by revegetation.]
7/1999	EPA/ROD/R10-99/039	<i>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 Remaining Sites.</i> This interim action ROD requires RTD for 46 sites; adds a plug-in approach for the RTD remedy of both remaining 100 and 200 North Area sites and newly identified 100 Area sites added by ESDs; and disposal of debris from B, D, H, and K Reactors to ERDF. It also provides a decision framework for leaving waste in place, generally below 4.6 m (15 ft) depth.
2/2004	EPA 2004	<i>Explanation of Significant Difference for the 100 Area Remaining Sites Interim Remedial Action Record of Decision.</i> The ESDs adds 28 sites to the ROD; adds 10 CFR 1022 and 40 CFR 6 , Appendix A, as ARARs to the ROD; and revises the annual ICs report date to coincide with the due date for the Sitewide IC Plan (DOE/RL-2001-41) for Hanford CERCLA response actions.
8/2009	EPA et al. 2009	<i>Explanation of Significant Difference for the 100 Area Remaining Sites Interim Remedial Action Record of Decision.</i> This ESD authorizes adding 200-CW-3 OU wastes sites, 99 newly discovered waste sites, and 87 candidate sites using the plug-in approach in the ROD and any newly discovered waste sites documented in the Administrative Record and an annual fact sheet.
3/2011	DOE et al. 2011	<i>Tri-Party Agreement Fact Sheet: 100 Area “Plug-In” and Candidate Waste Sites For Calendar Year 2010 Annual listing of waste sites plugged into the remove, treat and dispose remedy in the 1999 interim action Record of Decision for the 100 Area Remaining Sites.</i> This is the annual listing of candidate waste sites for confirmatory sampling and waste sites plugged into the RTD remedy in the 1999 interim action ROD for the 100 Area Remaining Sites.
2/2012	DOE et al. 2012	<i>Tri-Party Agreement Fact Sheet: 100 Area “Plug-In” and Candidate Waste Sites For Calendar Year 2011, Annual listing of waste sites plugged into the remove, treat and dispose remedy in the 1999 interim action Record of Decision for the 100 Area Remaining Sites.</i> This is the annual listing of candidate waste sites for confirmatory sampling and waste sites plugged into the RTD remedy in the 1999 interim action ROD for the 100 Area Remaining Sites.

ARAR = applicable or relevant and appropriate requirement
CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
ESD = explanation of significant differences
OU = operable unit
ROD = record of decision
RTD = removal, treatment (as required), and disposal

See Appendix B for a consolidated list of decision documents for Hanford Site OUs.

Remedial Action

Goals and Objectives. The RAOs set forth in the interim action RODs that are listed in Table 2-16 are narrative statements that define the extent to which the waste sites require cleanup to protect human health and the environment. The following RAOs identified in these interim action RODs apply to contaminants in soils, structures, and debris.

- RAO 1. Protect human and ecological receptors from exposure to contaminants in soil, structures, and debris by dermal exposure, inhalation, or ingestion of radionuclides, inorganics, or organics ([EPA/ROD/R10-95/126](#), page 25, and [EPA/ROD/R10-99/039](#), page 26).
- RAO 2. Control the sources of groundwater contamination to minimize the impacts to groundwater resources, protect the Columbia River from further adverse impacts, and reduce the degree of groundwater cleanup that may be required under future actions ([EPA/ROD/R10-95/126](#), page 25; and [EPA/ROD/R10-99/039](#), page 26).
- RAO 3. To the extent practicable, return soil concentrations to levels that allow for unlimited future use and exposure. Where it is not practicable to remediate to levels that will allow for unrestricted use in all areas, ICs and long-term monitoring will be required ([EPA/ROD/R10-95/126](#), page 26).

Remedy Components. The 1995 ROD ([EPA/ROD/R10-95/126](#)), as amended, and the 1999 ROD ([EPA/ROD/R10-99/039](#)), as amended, share the same basic interim action remedy components for the 100-KR-1 source OU waste sites. These components generally include the following steps:

- Remove contaminated soil, structures, and debris from 100 Area source waste sites using the observational approach, which uses field data and analytical screening during remediation to guide the extent of excavation. Remediation proceeds until it can be demonstrated through a combination of field screening and verification sampling that cleanup goals have been achieved.
- Treat the waste as required to meet applicable waste disposal criteria
- Dispose of contaminated materials at ERDF
- Backfill excavated areas and revegetate
- Implement ICs if unrestricted future use and exposure is not practicable.

Detailed descriptions of the remedy components are provided in the Selected Remedy section of each ROD, as amended.

Remedy Implementation Progress Prior to this Review Period ([DOE/RL-2016-01](#)). Work on the interim remedy began after issuance of the ROD amendment in 1997, with the first cleanup verification package approved in 2004. Before 2016, interim remedial actions had been completed at 6 of approximately 17 waste sites in the 100-KR-1 source OU.

Issues/Corrective Actions from the Previous (2011-2015) 5-Year Review ([DOE/RL-2016-01](#)). No previous issues or actions were noted for 100-KR-1 OU in the 2011-2015 [CERCLA](#) 5-year review.

Protectiveness Statement from the Previous (2011-2015) 5-Year Review Report ([DOE/RL-2016-01](#)). The protectiveness statement from the previous (2011-2015) 5-year review report for the 100-KR-1 source OU was as follows:

***100-KR-1 Source OU – Will Be Protective.** The remedy at the 100-KR-1 source OU is expected to be protective of human health and the environment upon completion of the final remedy. Implementation of the interim remedy (primarily involving RTD, backfilling, recontouring, and revegetation, and ICs) at the 100-KR-1 OU has demonstrated that exposure pathways that could result in unacceptable risks are being controlled.*

Progress Since 2011-2015 Review

Accomplishments. Since the 2011-2015 5-year review, interim remedial action was completed at one 100-KR-1 waste site and documented in a remaining sites verification package. The following waste site was reclassified to Interim Closed Out status during this 5-year review period:

- 100-K-94, French Drain.

Figure 2-16 shows the relative distribution (noted by geographic centers of waste site footprints) and reclassification/closure status (per WIDS) as of December 2020 for the waste sites in the 100-KR-1 and 100-KR-2 OUs. Table 2-17 summarizes the waste site cleanup status for the 100-KR-1 and 100-KR-2 waste sites, including metrics on work accomplished during this current 5-year period (2016-2020).

DOE submitted [DOE/RL-2010-97](#), *Remedial Investigation/Feasibility Study for the 100-KR-1, 100-KR-2, and 100-KR-4 Operable Units*, (Draft A RI/FS) and [DOE/RL-2011-82](#), *Proposed Plan for Remediation of 100-KR-1, 100-KR-2, and 100-KR-4 Operable Units*, Draft A, to EPA in 2011. EPA reviewed the documents in 2012. Additional characterization needs were identified (i.e., a subsurface soil contamination assessment in the vicinity of the 105KE SNF storage basin (hereafter referred to as 105KE Basin) as a result of EPA comments prior to completing the Draft A RI/FS ([DOE/RL-2010-97](#)). The additional characterization activities were completed in 2015 with the installation of two new monitoring wells in the vicinity of the 105KE Basin ([SGW-60149](#), *Report for Soil Borings and Well Installations in the UPR 100-K-1 and 116-KE-3 Waste Sites*). The results of supplemental source characterization activities were incorporated into the *Remedial Investigation for the 100-KR-1, 100-KR-2, and 100-KR-4 Operable Units*, Draft B ([DOE/RL-2010-97](#)), and transmitted to EPA for review in May 2019. A revised feasibility study ([DOE/RL-2018-22](#), *Feasibility Study for the 100-KR-1, 100-KR-2, and 100-KR-4 Operable Units*, Draft B) was transmitted to EPA for review in May 2020. Together, these reports present the results of remedial investigation (RI) studies and evaluates alternatives for cleaning up the vadose zone and groundwater.

Remedy Implementation. The primary remedial activities in the 100-KR-1 OU involved completing the interim remedial action at the seven sites listed in the previous section. This work was conducted under the 100 Area RDR/RAWP ([DOE/RL-96-17](#)), as amended.

ICs, as required by the interim action RODs (as amended), have been implemented and maintained during this 5-year review period to control access to residual contamination in soil and groundwater above standards for unlimited use and unrestricted exposure.

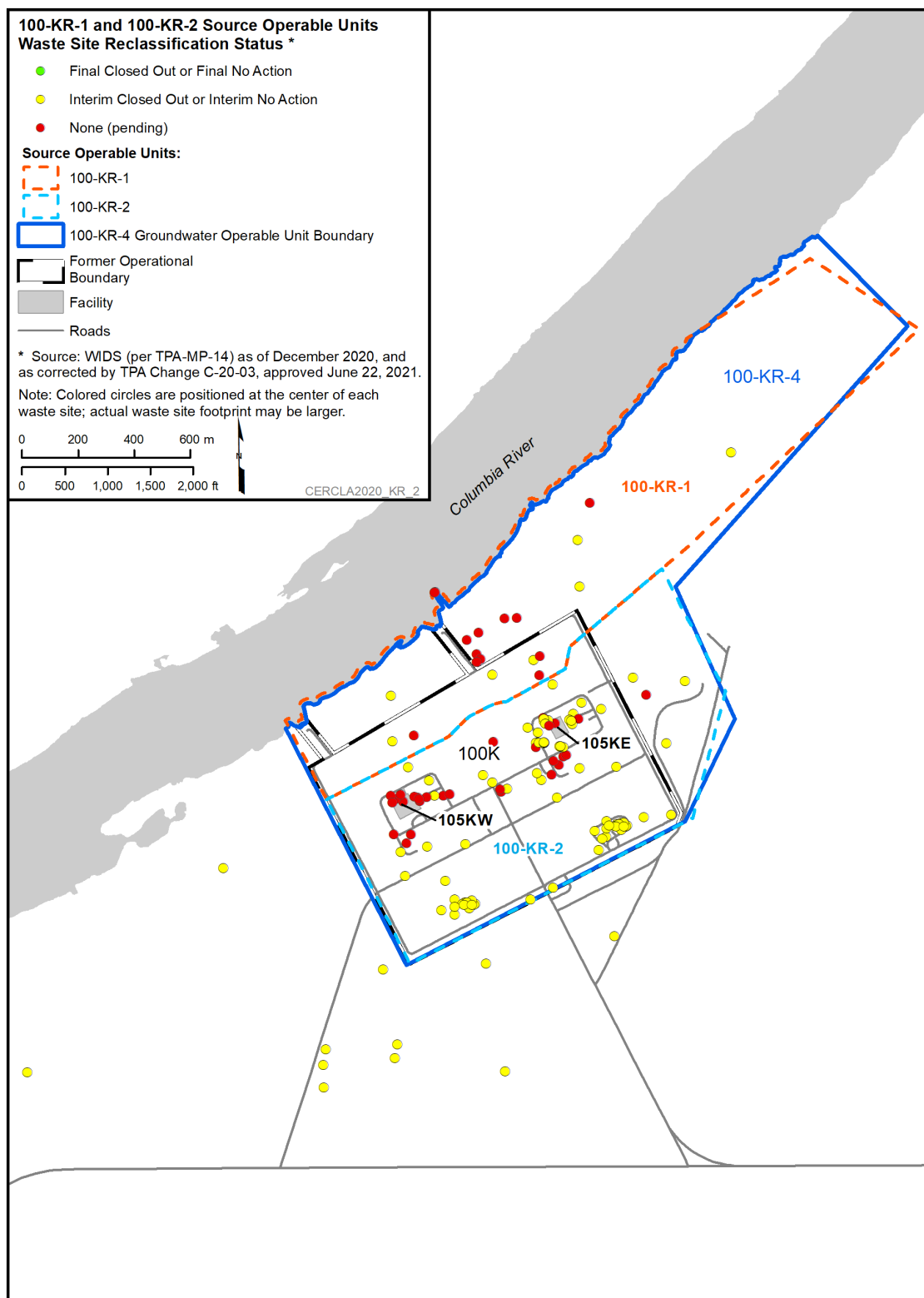


Figure 2-16. Geographic Distribution and WIDS Reclassification Status of the 100-KR-1 and 100-KR-2 Source Operable Unit Waste Sites as of December 2020.

Table 2-17. 100-KR-1 and 100-KR-2 Source Operable Units Cleanup Status.

Source OU	Number of Waste Sites ^a	Sites Dispositioned ^b			
		Pre-2016	2016 – 2020	Total	Percent
100-KR-1	17	6	1	7	41
100-KR-2	127	58	36	94	74
Total	144	64	37	101	70%

^a Number of waste sites within the OU, according to the Tri-Party Agreement (Ecology et al. 1989), Appendix C, as of December 2020 (and subsequent corrections per TPA Change C-20-03).

^b Sites with an interim closed out, final closed out, interim no-action, final no-action, or closed out reclassification status reflected in the WIDS as of December 2020 (and subsequently corrected per TPA Change C-20-03).

Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington. Available online at <https://www.hanford.gov/page.cfm/TriParty/TheAgreement>.

TPA Change C-20-03, 2021, *River Corridor Waste Site Updates in the Tri-Party Agreement, Appendix C*, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington. Available online at <https://pdw.hanford.gov/document/AR-14219>.

DOE = U.S. Department of Energy

OU = operable unit

Tri-Party Agreement = *Hanford Federal Facility Agreement and Consent Order*.

Technical Assessments

Is the remedy functioning as intended by the decision documents?

The interim remedy (primarily involving RTD, backfilling, revegetation, and ICs) is functioning as intended by the interim action ROD (as amended). As of December 2020, 7 of the 17 100-KR-1 OU waste sites had been remediated.

In accordance with [TPA-MP-14](#), *Maintenance of the Waste Information Data System (WIDS)*, the 100-KR-1 remediated waste sites have been documented in WIDS as either interim closed out or interim no-action. Cleanup verification packages (including sampling data and other technical information) to support the reclassification to interim closed out and/or no-action are included in the Hanford Site Administrative Record for the 100-KR-1 source OU. The RAGs are described in Chapter 2 of the 100 Area RDR/RAWP ([DOE/RL-96-17](#), Rev. 6). Additionally, in accordance with EPA guidance in *Close Out Procedures for National Priorities List Sites* ([EPA 540-R-98-016](#)), remedial actions completed for a number of the 100-KR-1 and 100-KR-2 OU waste sites are documented in [DOE/RL-2014-15](#), *100-K Area Interim Remedial Action Report*.

The RAOs for the 100-KR-1 remediated waste sites, and the methods used for achieving the RAOs through the interim remedial actions are summarized in the following list:

- RAO 1. Protect human and ecological receptors from exposure to contaminants in soil, structures, and debris by dermal exposure, inhalation, or ingestion of radionuclides, inorganics, or organics.
 - Will be achieved through excavation to MTCA levels for organic and inorganic chemical constituents in soil to support unrestricted (residential) use.
 - Will be achieved human health total radiological dose standards of less than 15 mrem/yr above background for radionuclides.

- RAO 2. Control the sources of groundwater contamination to minimize the impacts to groundwater resources, protect the Columbia River from further adverse impacts, and reduce the degree of groundwater cleanup that may be required under future actions.
 - Will be achieved through protection such that contaminant levels in soil after remediation do not result in an adverse impact to groundwater that exceeded any nonzero maximum contaminant level goals under the [Safe Drinking Water Act of 1974](#) or Method B cleanup levels under MTCA.
 - Levels of contaminants in the soil after remediation do not result in an impact to groundwater and the Columbia River that could exceed the ambient water quality criteria under the [Clean Water Act of 1977](#) for protection of fish or Method B cleanup levels under the [WAC 173-340-730](#), “Surface water cleanup standards.” Because no ambient water quality criteria have been established for radionuclides, maximum contaminant levels from national primary DWSs were used.
 - The protection of receptors (aquatic species, with emphasis on salmon) in surface waters will be achieved by reducing or eliminating further contaminant loadings to groundwater such that receptors at the groundwater discharge in the Columbia River are not subject to any additional adverse risks.
- RAO 3. To the extent practicable, return soil concentrations to levels that allow for unlimited future use and exposure. Where it is not practicable to remediate to levels that will allow for unrestricted use in all areas, ICs and long-term monitoring will be required.
 - Will be achieved by removing waste sites to the bottom of the engineered structure and providing ICs, as required. ICs (via use of excavation permits) prevent uncontrolled drilling or excavation into the deep vadose zone (i.e., greater than 15 ft [4.6 m] below the surface).

ICs for the 100-KR-1 source OU, as required by the interim action RODs (as amended), are further described in the latest version of the RDR/RAWP ([DOE/RL-96-17](#)) and are actively managed. Specific details associated with each IC have also been incorporated into [DOE/RL-2001-41](#), *Sitewide Institutional Controls Plan for the Hanford CERCLA Response Actions and RCRA Corrective Actions*, this report is routinely updated within 180 days after publication of each decision document that addresses ICs. The ICs for the 100-KR-1 source OU include waste site-specific ICs (e.g., drilling, irrigation, and excavation restrictions for waste sites where residual contamination remains at depth) and general areas ICs, including access control (i.e., warning notices and entry restrictions), land-use management (i.e., land use and excavation permits), and miscellaneous provisions. These ICs are assessed annually and DOE presents a summary including any noted issues or actions to the Site regulators each fall at the unit managers meeting. The presentation is documented in the meeting minutes, which are archived in the Hanford Site Administrative Record (see examples in Attachments 4 and 6 at the following link: <https://pdw.hanford.gov/document/AR-04230>). The annual IC assessments are also now captured in an annual report (e.g., [HNF-65616](#), *FY2020 Sitewide Institutional Control Assessment*). The 100-KR-1 operable unit waste sites that were inspected during 2020 were:

- 116-K-1 and 116-K-2.

During the 5-year review period of 2016 through 2020, appropriate ICs for the 100-KR-1 and 100-KR-2 source OUs were found to be in place and maintained, and the objectives for the ICs are being met.

Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of remedy selection still valid?

The exposure assumptions and the interim RAOs used at the time of remedy selection are still valid for most waste sites. However, cleanup levels for some contaminants (e.g., hexavalent chromium) that were developed for shallow soil remediation may not be adequately applicable for deep vadose and periodically rewetted-zone contamination conditions. RAOs for the interim action RODs broadly addressed protecting human and ecological receptors and controlling sources of potential contamination to groundwater and the Columbia River. Associated cleanup levels were developed based on unrestricted use. More recent remedial investigation evaluations ([DOE/RL-2010-97](#), Draft B) have typically determined that interim remedial actions remain protective considering updated guidance and parameters. A few exceptions arise when using risk-based instead of dose-based radionuclide values for a few radionuclides where radioactive decay will meet slightly lower values in a reasonable timeframe. These exceptions are specifically considered and addressed in the feasibility study ([DOE/RL-2018-22](#), Draft A) for a final ROD.

Has any other information come to light that could call into question the protectiveness of the remedy?

No new information is known that could call into question the protectiveness of the remedy.

Issues/Recommendations During this Review Period The interim RODs for the 100-KR-1 and 100-KR-2 source OUs only set cleanup levels based on protection of human health. Additionally, the human health protection standard was based on less than 15 mrem/yr above background (a dose-based value, not a risk-based number) for radionuclides. A full human-health and ecological risk assessment has been drafted by DOE (*Remedial Investigation for the 100-KR-1, 100-KR-2, and 100-KR-4 Operable Units*, [DOE/RL-2010-97](#), Draft B) and submitted to EPA for review.

Issue KR1/2/4-1. A full human health and ecological risk assessment for 100-KR-1 and 100-KR-2 source OUs and the 100-KR-4 groundwater OU has not been finalized.

Recommendation KR1/2/4-1. Finalize a full human health and ecological risk assessment for the 100-KR-1 and 100-KR-2 source OUs and the 100-KR-4 groundwater OU as part of the 100-K Area RI/FS (Milestone Date: September 30, 2022).

Does this issue/action currently affect the protectiveness of the remedy? – NO.

Will this issue/action affect the protectiveness of the remedy in the future? – YES.

Protectiveness Statement

100-KR-1 Source OU – Will Be Protective. The remedy at the 100-KR-1 source OU is expected to be protective of human health and the environment upon completion of the final remedy. Implementation of the interim remedy (primarily involving RTD, backfilling, recontouring, and revegetation) at the 100-KR-1 OU is ongoing. In the interim, remedial activities completed to date, including ICs, have adequately addressed all exposure pathways that could result in unacceptable risks in these areas.

2.3.4.2 100-KR-2 Source Operable Unit

Background

Past operations associated with the 105KE and 105KW Reactors in the 100-K Area contributed to soil and groundwater contamination at the Hanford Site. The 105KE Reactor operated from 1955 to 1971 and the 105KW Reactor operated from 1955 to 1970. Cleanup decisions for this region were initiated in the 1990s.

This section focuses on the 100-KR-2 source OU and is followed by the 100-KR-4 groundwater OU. The 100-KR-2 OU comprises the south portion of the 100-K Area as previously shown in Figure 2-15.

Hanford's K Basins Closure Project has been focused on removing the spent fuel that has been stored in the fuel storage basins in the 100-K Area for over 20 years. The project includes removing all the fuel, the baskets, the racks in which the fuel was stored, the sludge accumulated in the basins, and the water in the basins; it culminates with demolition and disposal of the basin structures. The 105KE Basin has been demolished. The other work in the 100-K Area involves the demolition and disposal of the ancillary buildings, placing the reactors in ISS, remediating soil waste sites, and remediating the groundwater (performed under the 100-KR-4 OU).

Chronology

Table 2-18 lists the remedial action decision documents relevant to the 100-KR-2 source OU as of December 31, 2020.

Table 2-18. Decision Documents for the 100-KR-2 Source Operable Unit. (3 Pages)

Date	Location	Title
4/1997	EPA/AMD/R10-97/044	<i>Amendment to the Interim Action Record of Decision for the 100-BC-1, 100-DR-1, and 100-HR-1 Operable Units.</i> This amendment to the 1995 interim action ROD (EPA/ROD/R10-95/126) incorporates 34 additional waste sites including the 100-KR-1 and 100-KR-2 sites, refines the remedial cost estimate for all 71 sites based on actual data, streamlining and lessons learned, and eliminates the soil washing option treatment prior to disposal. [Note: The 1995 interim action ROD did not originally include 100-K Area waste sites. The 1995 ROD requires removal of contaminated soil, structures, and debris using the observational approach treatment by thermal desorption to remove organics and/or soil washing for volume reduction or, as needed, to meet waste disposal criteria, disposal of materials at ERDF, and backfill of excavated areas followed by revegetation.]
7/1999	EPA/ROD/R10-99/039	<i>Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 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 Remaining Sites.</i> This interim action ROD requires RTD for 46 sites; adds the plug-in approach for the RTD remedy of both remaining 100 Area and 200 North sites and for newly identified 100 Area sites added by ESDs; and disposal of debris from the B, D, H, and K Reactors to ERDF. It also provides a decision framework for leaving waste in place, generally below the 4.6 m (15 ft) depth.
9/1999	EPA/ROD/R10-99/059	<i>Declaration of the Record of Decision for the 100-KR-2 Operable Unit, Hanford Site, Benton County, Washington.</i> This interim action ROD requires removing spent nuclear fuel from basins, removing sludge from basins, treating and removing water from the basins, removing debris from the basins, deactivating the basins, and instituting ICs.
9/2000	EPA/ROD/R10-00/121	<i>Interim Action Record of Decision: 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-2, 100-HR-2, 100-KR-2 Operable Units (100 Area Burial Grounds).</i> This interim action ROD requires removing contaminated soil, structures, and debris; treatment as needed; disposing of waste at ERDF; backfilling; and revegetation. It applies to 45 burial grounds in the 100 Area.
2/2004	EPA et al. 2004	<i>Explanation of Significant Difference for the 100 Area Remaining Sites Interim Remedial Action Record of Decision.</i> This ESD adds 28 sites to the ROD; adds 10 CFR 1022 and 40 CFR 6 , Appendix A, as ARARs to the ROD; and revises the annual ICs report date to coincide with the due date for the Site-wide IC Plan (DOE/RL-2001-41) for Hanford CERCLA response actions.

Table 2-18. Decision Documents for the 100-KR-2 Source Operable Unit. (3 Pages)

Date	Location	Title
6/2005	EPA 2005a	<i>Interim Remedial Action Record of Decision Amendment, U.S. Department of Energy; 100-K Area K Basins, Hanford Site – 100 Area, Benton County, Washington.</i> The amendment to the interim action ROD (EPA/ROD/R10-99/059) modifies the remedy for sludge by including sludge treatment prior to interim storage and shipment to a national repository and modifies the remedy for debris by including grouting in place for some of the basin debris followed by removal along with the basin removal.
11/2007	08-AMRC-0033	<i>Explanation of Significant Differences 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).</i> This ESD established the limit of RTD excavation at the 118-B-1 Burial Ground considering the balancing factors in the ROD, and required additional ICs to protect groundwater and the Columbia River.
8/2009	EPA et al. 2009	<i>Explanation of Significant Differences for the 100 Area Remaining Sites Interim Remedial Action Record of Decision.</i> This ESD authorizes adding 200-CW-3 OU wastes sites, 99 newly discovered waste sites, and 87 candidate sites using the plug-in approach in the ROD and any newly discovered waste sites documented in the Administrative Record and an annual fact sheet.
3/2011	DOE et al. 2011	<i>Tri-Party Agreement Fact Sheet: 100 Area “Plug-In” and Candidate Waste Sites For Calendar Year 2010 Annual listing of waste sites plugged into the remove, treat and dispose remedy in the 1999 interim action Record of Decision for the 100 Area Remaining Sites.</i> This is the annual listing of candidate waste sites for confirmatory sampling and waste sites plugged into the RTD remedy in the 1999 interim action ROD for the 100 Area Remaining Sites.
2/2012	DOE et al. 2012	<i>Tri-Party Agreement Fact Sheet: 100 Area “Plug-In” and Candidate Waste Sites For Calendar Year 2011, Annual listing of waste sites plugged into the remove, treat and dispose remedy in the 1999 interim action Record of Decision for the 100 Area Remaining Sites.</i> This is the annual listing of candidate waste sites for confirmatory sampling and waste sites plugged into the RTD remedy in the 1999 interim action ROD for the 100 Area Remaining Sites.
6/2016	16-AMRP-0173	<i>Explanation of Significant Differences for the 100 Area -K Basins Interim Remedial Action Record of Decision.</i> This ESD authorizes a change to the 2005 interim ROD by allowing for longer-term interim storage of untreated K Basin sludge at T-Plant prior to treatment.
9/2016	DOE et al. 2016	<i>Tri-Party Agreement Fact Sheet: 100 Area “Plug-In” and Candidate Waste Sites For Calendar Year 2016, Annual listing of waste sites plugged into the remove, treat and dispose remedy in the 1999 interim action Record of Decision for the 100 Area Remaining Sites.</i> This is the annual listing of candidate waste sites for confirmatory sampling and waste sites plugged into the RTD remedy in the 1999 interim action ROD for the 100 Area Remaining Sites.
3/2018	DOE et al. 2018	<i>Tri-Party Agreement Fact Sheet: 100 Area Plug-In Waste Sites For Calendar Year 2017, Annual listing of waste sites plugged into the remove, treat and dispose remedy in the 1999 interim action Record of Decision for the 100 Area Remaining Sites.</i> This is the annual listing of candidate waste sites for confirmatory sampling and waste sites plugged into the RTD remedy in the 1999 interim action ROD for the 100 Area Remaining Sites.

Table 2-18. Decision Documents for the 100-KR-2 Source Operable Unit. (3 Pages)

Date	Location	Title
ARAR		= applicable or relevant and appropriate requirement
CERCLA		= <i>Comprehensive Environmental Response, Compensation, and Liability Act of 1980</i>
CFR		= <i>Code of Federal Regulations</i>
ERDF		= Environmental Restoration Disposal Facility
ESD		= explanation of significant difference
IC		= institutional control
OU		= operable unit
ROD		= record of decision
RTD		= removal, treatment (as required, and disposal

See Appendix B for a consolidated list of decision documents for Hanford Site OUs.

Remedial Action

Goals and Objectives. Two sets of RAOs apply to the 100-KR-2 OU, one set applies to the 100-K Basins and the other applies to other waste sites. The RAOs set forth in the interim action RODs for waste sites, as listed, generally apply to 100-KR-2 contaminants in soils, structures, and debris. RAOs 1 and 2 are common to all three interim action RODs. RAOs 3 and 4 are not stated in all RODs, as amended, but are associated with future land use.

- RAO 1. Protect human and ecological receptors from exposure to contaminants in soil, structures, and debris by dermal exposure, inhalation, or ingestion of radionuclides, inorganics, or organics ([EPA/ROD/R10-95/126](#), page 25; [EPA/ROD/R10-99/039](#), page 26; and [EPA/ROD/R10-00/121](#), page 19).
- RAO 2. Control the sources of groundwater contamination to minimize the impacts to groundwater resources, protect the Columbia River from further adverse impacts, and reduce the degree of groundwater cleanup that may be required under future actions ([EPA/ROD/R10-95/126](#), page 25; [EPA/ROD/R10-99/039](#), page 26 :and [EPA/ROD/R10-00/121](#), page 22).
- RAO 3. To the extent practicable, return soil concentrations to levels that allow for unlimited future use and exposure. Where it is not practicable to remediate to levels that will allow for unrestricted use in all areas, ICs and long-term monitoring will be required. ([EPA/ROD/R10-95/126](#), page 26)
- RAO 4. Provide conditions suitable for future land use of the 100 Area ([EPA/ROD/R10-00/121](#), page 22).

The set of RAOs unique to the K Basins, in accordance with the September 1999 interim action ROD for the 100-KR-2 source OU, [EPA/ROD/R10-99/059](#), as amended, includes the following.

- RAO 1. Reduce the potential for future releases of hazardous substances from the K Basins to the environment.
 - Remove hazardous substances from the K Basins near the Columbia River in a safe and timely manner.
 - Provide for safe treatment, storage, and final disposal of the SNF, sludge, water, and debris removed from the K Basins.

- Prevent further deterioration of the SNF.
- RAO 2. Reduce occupational radiation exposure to workers at the basins.
- RAO 3. Address the sludge management concerns.
- RAO 4. Develop the most cost-effective site-wide approach, consistent with the [CERCLA](#) nine criteria for TSD of sludge.
- RAO 5. Treat, store, and/or dispose of sludge soon after removal.

Remedy Components. The 1995 ROD ([EPA/ROD/R10-95/126](#)), as amended, the 1999 ROD ([EPA/ROD/R10-99/039](#)) as amended, and the 2000 ROD ([EPA/ROD/R10-00/121](#)) as amended, share the same basic interim action remedy components for the 100-KR-2 OU waste sites. These components generally include the following steps:

- Remove contaminated soil, structures, and debris from 100 Area source waste sites using the observational approach, which uses field data and analytical screening during remediation to guide the extent of excavation. Remediation proceeds until it can be demonstrated through a combination of field screening and verification sampling that cleanup goals have been achieved.
- Treat the waste, as required, to meet applicable waste disposal criteria.
- Dispose of contaminated materials at ERDF.
- Backfill excavated areas and revegetate.
- Implement ICs if unrestricted future use and exposure is not practicable.

Detailed descriptions of the remedy components are provided in the Selected Remedy section of each ROD, as amended.

Major components of the remedy for the two 100-K Area SNF storage basins, 100-K-42 (K-East Basin) and 100-K-43 (K-West Basin), are specified in the September 1999 interim remedial action ROD ([EPA/ROD/R10-99/059](#)), as amended, include the following:

- Remove the SNF from the K Basins
- Remove sludge from the K Basins
- Treat and remove water from the K Basins
- Remove debris from the K Basins
- Deactivate the basins
- ICs.

Here again, further description of the remedy components is provided in the Selected Remedy section of the 1999 ROD ([EPA/ROD/R10-99/059](#)), as amended.

Remedy Implementation Progress Prior to this (2016-2020) Review Period ([DOE/RL-2016-01](#), Rev. 0). Work on the interim remedy began after issuance of the ROD amendment in 1997, with the first cleanup verification package approved in 2004. Before 2016, interim remedial actions had been completed at 63 of approximately 164 waste sites in the 100-KR-2 OU.

Issues/Corrective Actions from the Previous (2011-2015) 5-Year Review. The previous [CERCLA](#) 5-Year Review report ([DOE/RL-2016-01](#)) for the period of 2011 through 2015 included the following issue and corrective action in the 100-KR-2 source OU and the 100-KR-4 groundwater OU assessments:

Issue KR-2-1. *Several 100-KR-2 OU waste sites near the 105-KE and 105-KW Reactors likely serve as continuing sources of 100-KR-4 OU groundwater contamination.*

Corrective Action KR-2-1. *Incorporate supplemental characterization data and risk evaluation information in a revised draft RI/FS report and transmit for regulator review. (Corrective Action Due Date: December 31, 2018).*

Corrective Action KR-2-1 was completed on May 1, 2019, with the submittal of [DOE/RL-2010-97](#), Draft B, which included the supplemental characterization data. The document was sent to EPA for review and EPA provided comments on the draft RI on October 16, 2019 ([EPA 2019d](#)).

Protectiveness Statement from the Previous (2011-2015) 5-Year Review Report ([DOE/RL-2016-01](#)). The protectiveness statement from the previous (2011-2015) 5-year review report for the 100-KR-2 OU was as follows:

100-KR-2 Source OU – Will Be Protective. *The remedy at the 100-KR-2 OU is expected to be protective of human health and the environment upon completion of the final remedy. Implementation of the interim remedy (primarily involving RTD, backfilling, recontouring and revegetation, ICs, and deactivation of the SNF basins) at the 100-KR-2 OU has demonstrated that exposure pathways that could result in unacceptable risks are being controlled.*

Progress Since 2011-2015 Review

Accomplishments. Since the 2011-2015 5-year review, interim remedial actions were completed at the following waste sites and documented in waste site cleanup verification packages or remaining sites verification packages. The following waste sites and subsites were reclassified to an interim closed out or interim no action status during this 5-year review period:

- 100-KR-2 Operable Unit
 - 100-K-13, French Drain
 - 100-K-14, French Drain
 - 100-K-25, Sump
 - 100-K-27, Foundation
 - 100-K-35, Sump
 - 100-K-50, 1, Sanitary Sewer Holding Storage Tank
 - 100-K-50:2, Sanitary Sewer Holding Tank
 - 100-K-79:3, Pipeline
 - 100-K-79:4, Pipeline
 - 100-K-79:9, Pipeline
 - 100-K-98, French Drain
 - 100-K-101, French Drain
 - 100-K-103, Settling Tank
 - 100-K-105, Depression/Pit (nonspecific)
 - 100-K-107, Drain/Tile Field
 - 100-K-123, Dumping Area
 - 100-K-124, Dumping Area
 - 100-K-125, Dumping Area
 - 100-K-126, Dumping Area
 - 100-K-127, Dumping Area
 - 100-K-128, Dumping Area
 - 100-K-129, Dumping Area
 - 100-K-131, Dumping Area
 - 120-KE-1, Sump
 - 120-KE-2, French Drain
 - 120-KE-3, Trench
 - 120-KE-4, Storage Tank
 - 120-KE-5, Storage Tank
 - 120-KE-6, Foundation
 - 120-KE-9, Sump

- 100-K-108, Septic Tank	- 126-KE-2, Storage Tank
- 100-K-110, Unplanned Release	- 1607-K1, Septic Tank
- 100-K-115, Dumping Area	- 1607-K2, Septic Tank
- 100-K-116, Dumping Area	- 1607-K5, Septic Tank
- 100-K-119, Dumping Area	

Table 2-17 and Figure 2-16, as previously shown in Section 2.3.4.1, summarize the waste site cleanup status for both the 100-KR-1 and 100-KR-2 waste sites, including metrics on work accomplished during the current 5-year period (2016-2020).

Remediation of the 105KW Basin continued through this 5-year review period. Previously, fuel had been removed and transferred to the 200-East Area for storage. Following the purchase and testing of tools and equipment, sludge removal was initiated in 2018 and completed in 2019 including transport of the sludge to T-Plant. In 2021 the final phase of preparations will begin to allow the basin to be drained, filled with grout, and prepared for demolition.

DOE submitted [DOE/RL-2010-97](#), *Remedial Investigation/Feasibility Study for the 100-KR-1, 100-KR-2, and 100-KR-4 Operable Units*, Draft A, and [DOE/RL-2011-82](#), *Proposed Plan for Remediation of 100-KR-1, 100-KR-2, and 100-KR-4 Operable Units*, Draft A to EPA in 2011. EPA reviewed the documents in 2012. Additional characterization needs were identified (i.e., a subsurface soil contamination assessment in the vicinity of the 105KE Basin) as a result of EPA comments prior to completing the Draft A RI/FS ([DOE/RL-2010-97](#)). The additional characterization activities were completed in 2015 with the installation of two new monitoring wells in the vicinity of the 105KE Basin ([SGW-60149](#), *Report for Soil Borings and Well Installations in the UPR 100-K-1 and 116-KE-3 Waste Sites*). The results of supplemental source characterization activities were incorporated into the *Remedial Investigation for the 100-KR-1, 100-KR-2, and 100-KR-4 Operable Units*, Draft B ([DOE/RL-2010-97](#)) and transmitted to EPA for review in May 2019. A revised feasibility study ([DOE/RL-2018-22](#), *Feasibility Study for the 100-KR-1, 100-KR-2, and 100-KR-4 Operable Units*, Draft B) was transmitted to EPA for review in May 2020. Together, these reports present the results of RI studies and evaluates alternatives for cleaning up the vadose zone and groundwater.

Remedy Implementation. Remedial activities in the 100-KR-2 source OU involved completing the interim remedial action at the more than 30 waste sites listed in the accomplishments discussion. This work was conducted under the 100 Area RDR/RAWP ([DOE/RL-96-17](#)), as amended. Cleanup of the 100-KR-2 OU waste sites will continue into the next 5-year review period.

Remediation at the 105KW Basin is ongoing and will continue into the next 5-year review period. This work is conducted under [DOE/RL-2010-53](#), *Remedial Design/Remedial Action Work Plan for the 100 Area Remaining Sites Interim Remedial Action: 105-K West Basin Demolition and Removal*. A series of other work plans applicable to various elements of K Basin deactivation and demolition scope are included in the Hanford Site Administrative Record (<http://pdw.hanford.gov/arpir/>) for the 100-KR-2 OU.

Removing SNF from both K Basins satisfied one of the RAOs. The 105KE Basin has been decommissioned and demolished. Sludge removal from 105KW Basin was completed in 2019. In 2021 the final phase of preparations will begin to allow the basin to be drained, filled with grout, and prepared for demolition. This work is conducted under [DOE/RL-2010-53](#).

ICs, as required by the interim action RODs (as amended), have been implemented and maintained during this 5-year review period in order to control access to residual contamination in soil and groundwater above standards for unlimited use and unrestricted exposure.

Technical Assessments

Is the remedy functioning as intended by the decision documents?

The interim remedy (primarily involving RTD, backfilling, revegetation, and ICs) is functioning as intended by the interim action ROD ([EPA/ROD/R10-95/126](#)), as amended. As of December 2020, 94 of 127 100-KR-2 waste sites had been remediated.

In accordance with [TPA-MP-14](#), the 100-KR-2 remediated waste sites have been documented in WIDS as either interim closed or interim no-action. Cleanup verification packages (including sampling data and other technical information) to support the reclassification to interim closed and/or no-action are included in the Hanford Site Administrative Record for the 100-KR-2 OU. The RAGs (contaminant-specific soil cleanup criteria developed to ensure that remedial actions implemented will meet the RAOs) are described in Chapter 2 of the 100 Area RDR/RAWP ([DOE/RL-96-17](#), Rev. 6). Additionally, in accordance with EPA guidance in *Close Out Procedures for National Priorities List Sites* ([EPA 540-R-98-016](#)), remedial actions completed for a number of the 100-KR-1 and 100-KR-2 source OU wastes sites are documented in [DOE/RL-2014-15](#), *100-K Area Interim Remedial Action Report*.

The RAOs for 100-KR-2 remediated waste sites and the methods used for achieving the RAOs through the interim remedial actions are summarized in the following list:

- RAO 1. Protect human and ecological receptors from exposure to contaminants in soil, structures, and debris by dermal exposure, inhalation, or ingestion of radionuclides, inorganics, or organics.
 - Will be achieved through excavation to MTCA levels for organic and inorganic chemical constituents in soil to support unrestricted (residential) use.
 - Will be achieved human health total radiological dose standards of less than 15 mrem/yr above background for radionuclides.
- RAO 2. Control the sources of groundwater contamination to minimize the impacts to groundwater resources, protect the Columbia River from further adverse impacts, and reduce the degree of groundwater cleanup that may be required under future actions.
 - Will be achieved through protection such that contaminant levels in soil after remediation do not result in an adverse impact to groundwater that exceeded any nonzero maximum contaminant level goals under the [Safe Drinking Water Act of 1974](#) or Method B cleanup levels under MTCA.
 - Levels of contaminants in the soil after remediation do not result in an impact to groundwater and the Columbia River that could exceed the ambient water quality criteria under the [Clean Water Act of 1977](#) for protection of fish or Method B cleanup levels under the [WAC 173-340-730](#), “Surface water cleanup standards.” Because no ambient water quality criteria have been established for radionuclides, maximum contaminant levels from national primary DWSs were used.
 - The protection of receptors (aquatic species, with emphasis on salmon) in surface waters will be achieved by reducing or eliminating further contaminant loadings to groundwater such that

receptors at the groundwater discharge in the Columbia River are not subject to any additional adverse risks.

- RAO 3. To the extent practicable, return soil concentrations to levels that allow for unlimited future use and exposure. Where it is not practicable to remediate to levels that will allow for unrestricted use in all areas, ICs and long-term monitoring will be required.
 - Will be achieved by removing waste sites to the bottom of the engineered structure and providing ICs, as required. ICs (via use of excavation permits) prevent uncontrolled drilling or excavation into the deep vadose zone (i.e., greater than 4.6 m [15 ft] below the surface).

In accordance with [DOE/RL-2010-53](#), the objective of the interim remedial action associated with the 105KW Basin involves basin structure and sludge transfer annex demolition. Soil remediation activities will be evaluated as part of a future remedial action to fully achieve RAOs 1 and 2 above. With respect to 105KW, RAO 1 will be met in part by removing the 105KW Basin structure to a depth below the leachate system and removal of the sludge transfer annex structure. The removal of the basin addresses protection of human and ecological receptors from exposure to contaminants in the structure and enables access to the waste underneath for soil remediation activities; these soil remediation activities will be limited to a depth that does not threaten the structural integrity/stability of the 105KW Reactor building. RAO 2 will be met through soil remediation activities under the 100 Area Remaining Sites ROD ([EPA/ROD/R10-99/039](#)) and [DOE/RL-96-17](#).

ICs for the 100-KR-2 source OU, as required by the interim action RODs (as amended), are described in the latest version of the 100 Area RDR/RAWP ([DOE/RL-96-17](#)) and are actively managed. Specific details associated with each IC have also been incorporated into *Sitewide Institutional Controls Plan for the Hanford CERCLA Response Actions and RCRA Corrective Actions* ([DOE/RL-2001-41](#)), this report is routinely updated within 180 days after publication of each decision document that addresses ICs. The ICs implemented for the 100-KR-2 OU include waste site-specific ICs (e.g., drilling and excavation restrictions for waste sites where residual contamination remains at depth) and general areas ICs including access control (e.g., warning notices, entry restrictions, and fencing), land-use management (e.g., land use and excavation permits), groundwater use management, and miscellaneous provisions. These ICs are assessed annually and DOE presents a summary including any noted issues or actions to the Site regulators each fall at the unit managers' meeting. The presentation is documented in the meeting minutes, which are archived in the Hanford Site Administrative Record (see examples in Attachments 4 and 6 at the following link: <https://pdw.hanford.gov/document/AR-04230>). The annual IC assessments are also now captured in an annual report (e.g., [HNF-65616](#), *FY2020 Sitewide Institutional Control Assessment*). During the 5-year review period of 2016 through 2020, appropriate ICs for the 100-KR-1 and 100-KR-2 source OUs were found to be in place and maintained, and the objectives for the ICs are being met.

Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of remedy selection still valid?

The exposure assumptions and interim RAOs used at the time of original remedy selection are still valid. RAOs for the interim action RODs broadly addressed protecting human and ecological receptors and controlling sources of potential contamination to groundwater and the Columbia River. Associated cleanup levels were developed based on unrestricted use. More recent remedial investigation evaluations ([DOE/RL-2010-97](#), Draft B) have typically determined that interim remedial actions remain protective considering updated guidance and parameters. A few exceptions arise when using risk-based instead of dose-based radionuclide values for a few radionuclides where radioactive decay will meet slightly lower values in a reasonable timeframe. These exceptions are specifically considered and addressed in the

feasibility study for a final ROD. This information will be reviewed and updated as needed to support final remedy selection.

Has any other information come to light that could call into question the protectiveness of the remedy?

The potential for continuing sources from mobile contaminants in the deep vadose zone may require additional protectiveness remedies. Suspect continuing source contribution effects noted in 100-KR-2 OU include the following:

- Ongoing groundwater monitoring of the wells installed near the 105KE Basin (UPR-100-K-1) and the 116-KE-3 crib in late 2015 continue to show strontium-90 entering the groundwater above the DWS of 8 pCi/L as reported in the Hanford annual groundwater report (e.g., [DOE/RL-2018-66](#)). These supplemental characterization data and groundwater monitoring results were incorporated into the revised draft RI ([DOE/RL-2010-97](#), Draft B) and feasibility study (FS) ([DOE/RL-2018-22](#)) reports between 2016 and 2020.
- Tritium at monitoring wells near the former 118-K-1 Burial Ground exceeds DWSs.
- Persistent areas of elevated hexavalent chromium in groundwater (e.g., near the 183-KE and 183-KW head houses) suggest the likelihood of continuing contaminant contributions from deep vadose soil contamination at these locations. The persistent area located near the 183-KW headhouse was confirmed as a result of the KW Rebound Study that occurred between 2016 and 2017 ([SGW-62061](#)).
- Persistent plumes of elevated carbon-14, tritium, and nitrate are observed downgradient of the 116-KE-1 and 116-KW-1 gas condensate cribs. These conditions suggest that deep vadose zone contamination is a continuing source of groundwater contamination at these locations. The persistent area located near the 116-KW-1 gas condensate crib was confirmed as a result of the KW Rebound Study that occurred between 2016 and 2017 ([SGW-62061](#)).

These continuing sources and potential remedial actions are identified in the 100-K FS ([DOE/RL-2018-22](#)). ICs and remedial actions implemented under interim actions currently provide protectiveness and will remain in place until final actions are implemented under an upcoming ROD.

Issues/Recommendations During this Review Period

The interim RODs for the 100-KR-1 and 100-KR-2 source OUs only set cleanup levels based on protection of human health. Additionally, the human health protection standard was based on less than 15 mrem/yr above background (a dose-based value, not a risk-based number) for radionuclides. A full human health and ecological risk assessment has been drafted by DOE (*Remedial Investigation for the 100-KR-1, 100-KR-2, and 100-KR-4 Operable Units*, [DOE/RL-2010-97](#), Draft B) and submitted to EPA for review.

Issue KR1/2/4-1. A full human health and ecological risk assessment for 100-KR-1 and 100-KR-2 source OUs and the 100-KR-4 groundwater OU has not been finalized.

Recommendation KR1/2/4-1. Finalize a full human-health and ecological risk assessment for the 100-KR-1 and 100-KR-2 source OUs and the 100-KR-4 groundwater OU as part of the 100-K Area RI/FS (Milestone Date: September 30, 2022).

Does this issue/action currently affect the protectiveness of the remedy? – NO.

Will this issue/action affect the protectiveness of the remedy in the future? – YES.

Protectiveness Statements

100-KR-2 Source OU – Will Be Protective. The remedy at the 100-KR-2 source OU is expected to be protective of human health and the environment upon completion of the final remedy. Implementation of the interim remedy (primarily involving RTD, backfilling, recontouring, and revegetation) at the 100-KR-2 OU is ongoing. In the interim, remedial activities completed to date, including ICs, have adequately addressed all exposure pathways that could result in unacceptable risks in these areas.

2.3.4.3 100-KR-4 Groundwater Operable Unit

Background

The 100-KR-4 groundwater OU (shown in Figure 2-15) is 1 of 10 groundwater OUs on the Hanford Site and 1 of 6 located in the River Corridor. The 100-KR-4 OU consists of the groundwater affected by contaminated releases from facilities and waste sites in the 100-KR-1 and 100-KR-2 source OUs.

The 100-K Area is the site of two deactivated reactors: the 105KE Reactor (operated from 1955 to 1971) and the 105KW Reactor (operated from 1955 to 1970).

The 105KE and 105KW Reactors were the largest single-pass cooling water reactors built on the Hanford Site, with 60% more fuel rods than earlier reactor designs, higher initial and final power ratings, and higher numbers of fuel elements. The reactors also used a larger amount of cooling water and inert cover gases (source of carbon-14) to dissipate reactor heat. Over 568,000 L/min (150,000 gal/min) of cooling water were used to cool each reactor. This flow rate increased to more than 757,000 L/min (200,000 gal/min) as the reactor power ratings increased. More than 80% of the cooling water used was discharged to the retention basins and then to the Columbia River via underwater pipelines.

The remainder was discharged to the soil column at liquid effluent waste sites; in some cases, valves and conveyance pipelines leaked effluent to the vadose zone. The 105KW and 105KE Reactors were shut down in 1970 and 1971, respectively. A subset of the liquid- and solid-waste disposal sites in the 100-KR-1 and 100-KR-2 source OU are known or suspected to have contributed to the 100-KR-4 groundwater contamination.

Per the 100-KR-4 interim action ROD ([EPA/ROD/R10-96/134](#)), hexavalent chromium is the primary contaminant in the 100-KR-4 groundwater OU that is currently targeted for treatment. Monitoring is also performed for tritium, nitrate, strontium-90, carbon-14, and TCE.

Groundwater flow in the 100-KR-4 OU generally ranges from the northwest to northeast, away from injection well network and toward the Columbia River, which forms a discharge boundary for the unconfined aquifer. Operation of pump-and-treat systems at the 100-KR-4 OU creates changes in groundwater flow direction and velocity. These changes are expressed as depressions and mounds in the water table that affect the flow direction. Daily and seasonal fluctuations in the river stage also affect groundwater flow in the 100-KR-4 OU. As would be expected, longer term changes in the river stage produce more extensive and longer-lived changes in the water levels, hydraulic gradient, and flow directions in the unconfined aquifer. Intrusion of river water into the aquifer during high river stage can lower contaminant concentrations in aquifer tubes and in some near-river wells.

Contaminant concentrations in 100-KR-4 groundwater are above cleanup levels and withdrawal for purposes other than research, monitoring, or treatment is prohibited. Under current site-use conditions and ICs, the only complete human exposure pathway to groundwater is the potential for limited exposure from intermittent seeps along the Columbia River or during remediation, research, and monitoring activities. The 100-KR-4 groundwater is not being used for drinking water.

A summary of the 100-KR-4 groundwater OU condition, as of 2020, is included in [DOE/RL-2020-60](#), *2020 Hanford Site Groundwater Monitoring Report*, as well as in [DOE/RL-2020-61](#), *Calendar Year 2020 Annual Summary Report for the 100-HR-3 and 100-KR-4 P&T Operations and 100-NR-2 Groundwater*

Remediation. Additionally, these annual reports and similar reports for calendar years prior to 2020 can be accessed online as noted below:

- *Hanford Site Groundwater Monitoring Report* (published annually to address the previous calendar year): <http://www.hanford.gov/page.cfm/SoilGroundwaterAnnualReports>
- *Annual Summary Report for the 100-HR-3 and 100-KR-4 Pump and Treat Operations and 100-NR-2 Groundwater Remediation* for each prior year can be accessed through the same link at <http://www.hanford.gov/page.cfm/SoilGroundwaterAnnualReports>.

Chronology

Table 2-19 lists the remedial action decision documents associated with the 100-KR-4 groundwater OU as of December 31, 2020.

Table 2-19. Decision Documents for the 100-KR-4 Groundwater Operable Unit.

Date	Location	Title
3/1996	EPA/ROD/R10-96/134	<i>Declaration of the Record of Decision for the 100-HR-3 and 100-KR-4 Operable Units, Hanford Site, Benton County, Washington.</i> This interim action ROD requires pump-and-treat removal of hexavalent chromium from groundwater extraction wells, ion exchange treatment, reinjection of treated effluent, monitoring, and institutional controls.
8/2009	EPA 2009	<i>Explanation of Significant Differences for the 100-HR-3 and 100-KR-4 Operable Units Interim Action Record of Decision, Hanford Site, Benton County, Washington:</i> This ESD provides notice of an increase in projected costs for pump-and-treat operations for both OUs, changes reinjection location requirements for treated water to other than upgradient locations to help contain the hexavalent chromium plumes and prevent the plume from expanding, and changes the treatment and discharge standards for wells not upgradient of extraction wells to meet the aquatic river protection criterion of 10 µg/L for hexavalent chromium.
6/2019	EPA 2019a	<i>Explanation of Significant Differences for the 100-HR-3 and 100-KR-4 Operable Units Interim Action Record of Decision, Hanford Site, Benton County, Washington:</i> This ESD allows for miscellaneous solid waste generated in support of the 100-KR-4 interim actions to be collected and stored at a Central Plateau storage facility prior to disposal.

ESD = explanation of significant difference

OU = operable unit

ROD = record of decision

See Appendix B for a consolidated list of decision documents for Hanford Site OUs.

Remedial Actions

Goals and Objectives. In accordance with the NCP, “EPA expects to return useable ground waters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site” (40 CFR 300.430[a][1][iii][F]). EPA generally defers to state definitions of groundwater classification provided under EPA-endorsed Comprehensive State Groundwater Protection Programs ([EPA/540/G-88/003](#)).

Groundwater within the 100-KR-4 OU is contaminated and is not currently withdrawn from the aquifer for beneficial use; however, the potential beneficial use of the groundwater is as a drinking water source.

Consistent with the beneficial-use classifications of Washington State and the EPA, the goal for remediating 100-KR-4 groundwater is to reduce contaminants to levels that will allow its use as a future drinking water source.

Based on the expectations for 100-KR-4 groundwater restoration, the interim RAOs, as stated in the 1996 interim action ROD ([EPA/ROD/R10-96/134](#)), are as follows:

- RAO 1. Protection of aquatic receptors in the river bottom substrate from contaminants in groundwater entering the Columbia River. The first RAO for the 100-KR-3 and 100-KR-4 OUs is to prevent the discharge of hexavalent chromium to the Columbia River substrate at concentrations exceeding those that are considered protective of aquatic life in the river and riverbed sediments.

Additional information will be obtained during the interim action before the development and implementation of a final action. [Note: The current RAG is 10 µg/L for hexavalent chromium in the surface water at the point of groundwater discharge. The groundwater remediation is implemented to ensure that this requirement is met.

- RAO 2. Protection of human health by preventing exposure to contaminants in the groundwater. A second RAO for these operable units is to continue to protect the public such that there is no exposure to contaminants above health-based levels.
- RAO 3. Provide information that will lead to the final remedy.

Remedy Components. The 1996 interim remedial action ROD provided the following summary-level descriptions of the primary components of the interim remedy for the 100-KR-4 groundwater OU (i.e., groundwater extraction and treatment, MNA, flow path control, and ICs). The original ROD narrative (in italicized text in the following box) is provided to give an historical perspective; some quantities and components have been modified through subsequent amendments to the interim remedial action ROD ([EPA/ROD/R10-96/134](#)) (as noted in Table 2-19) and incorporated in the OU's RDR/RAWP documentation. The RDR/RAWP documentation is discussed in the upcoming Remedy Implementation section.

Excerpt from ROD ([EPA/ROD/R10-96/134](#)) – original text that also included 100-D/H Area OUs is not shown:

Groundwater Extraction. Groundwater will be extracted from wells primarily located along the river in each of the three reactor areas. Extraction wells should be located at a sufficient distance inland from the river to minimize withdrawal of river water. Extraction wells shall be located such that the plume is captured to meet the remedial action objectives. Based on preliminary modeling accomplished for the operable unit focused feasibility studies, the following extraction well design was estimated as sufficient to capture the chromium plume to meet the chromium remedial action objectives:

- *100-K Area: Eleven extraction wells spaced approximately 240 m (786 ft) apart with a composite withdrawal rate of 220 gpm....*

During remedial design, estimates will be improved based on the incorporation of the results of ongoing river pore water sampling and shoreline drive point sampling, recent groundwater sampling data, and other pertinent data collected since the completion of the focused feasibility study. The groundwater extraction system shall be designed in accordance with the Remedial Design Report/Remedial Action Work Plan (RDR/RAWP) as approved by EPA and Ecology.

Groundwater Treatment and Discharge Standards – Hexavalent Chromium...100-K Areas. The groundwater treatment systems will reduce the effluent chromium concentrations to the maximum extent practicable. However, groundwater above 50 µg/L chromium will not be discharged to injection wells that are not located upgradient of the extraction wells. The average chromium concentrations in the treated effluent are expected to be at or below 20 µg/L. Treatment will be performed using ion exchange resins.

Groundwater Treatment – Other Contaminants. Because this interim action is designed to reduce levels of hexavalent chromium in the groundwater and the river substrate, there is a potential for other groundwater co-contaminants to be present in the reinjected effluent at concentrations above the drinking water standards set for those contaminants. Potential co-contaminants include nitrate, strontium-90, tritium, uranium, and technetium-99. The ion exchange system required to remove chromium will also reduce concentrations of other anionic contaminants such as nitrate, technetium-99, and uranium-238. Strontium-90 exists in groundwater as a cation and is not expected to be removed in the ion exchange system.

Tritium is also not expected to be removed by the treatment system. In addition to chromium at both operable units; other potential co-contaminants include:

- ...100-KR-4: tritium and strontium-90.

These other co-contaminants do not exceed the ecological risk criteria, and institutional controls (detailed elsewhere) limit human exposure.

Groundwater Reinjection. After treatment, water will be reinjected into the upper aquifer that will help contain the hexavalent chromium plumes and prevent the plumes from expanding in the ...100-KR-4 Operable Units respectively. Based on preliminary modeling accomplished for the operable unit Focused Feasibility Studies, the number of wells needed to accomplish this was estimated to be:

- ...100-K Area: Two injection wells.

During the remedial design process, more precise estimates are expected to be developed based on the collection and incorporation of well and site-specific data. The groundwater treatment and reinjection system shall be designed in accordance with the RDR/RAWP as approved by EPA and Ecology.

Compliance Monitoring – River Protection. The data analysis and evaluation procedures used to evaluate compliance with cleanup levels shall be defined in a compliance monitoring plan as part of the RDR/RAWP and prepared in accordance with WAC 173-340-720(8) and/or as approved by EPA and Ecology.

The aquatic receptor exposure point of concern is within the river substrate at depths up to 18 inches (46 centimeters), where embryonic salmon and fry could be present during parts of the year. Since it is impractical to routinely monitor the river substrate, groundwater will be monitored at near-river on-shore locations above the common high river mark. Monitoring shall be conducted at sufficient locations to evaluate the performance of the remedial action. The siting and design of the compliance monitoring system shall be in accordance with the RDR/RAWP as approved by EPA and Ecology. To account for dilution within the aquifer between the monitoring location on-shore and the aquatic receptor exposure point of concern within the river substrate, a preliminary dilution factor of 1:1 has been selected based on the available data (i.e., 22 µg/L hexavalent chromium in on-shore near-river well points is considered equivalent to 11 µg/L hexavalent chromium in the river substrate). It will take a period of time for the extraction system to have an effect on groundwater quality adjacent to the Columbia River. Concentrations in excess of 22 µg/L may be observed in the compliance wells during the early stages of operation.

Groundwater sampling will be conducted when dilution by river water at the compliance monitoring points is minimal. The details of the groundwater quality monitoring program will be described in the RDR/RAWP. Chromium compliance monitoring will be conducted at multiple depth intervals. Baseline sampling will be conducted prior to the start of the interim action.

Sampling will be conducted monthly for at least three months following start-up of the extraction system. Subsequently, there may be substantial reductions in frequency, number of stations, and depths sampled, if demonstrated to be appropriate, and approved by EPA and Ecology. A network of piezometers (or comparable

technique) will be installed and monitored such that the capture zone around the extraction wells can be estimated.

In the event of special conditions such as an unusual flood event or prolonged down time of the pump-and-treat system, extra monitoring, at the direction of EPA or Ecology shall be conducted.

The analyte list will be defined during remedial design; it shall include:

- *Hexavalent chromium (or total chromium assumed to be hexavalent). The method detection limit and quantitation limit of the selected test method shall be sufficiently low to allow comparison with the remedial action goals.*
- *Conductivity or comparable measurements adequate to indicate ratio of river-derived versus groundwater-derived water.*
- *On an infrequent basis, likely co-contaminants will be monitored as part of on-going Tri-Party Agreement activities to assess protectiveness of human health and the environment.*

Compliance monitoring will include analysis of results in a timely manner to support modifications to the treatment system in order to meet the remedial action objectives. Significant system modifications as identified in the RDR/RAWP are subject to EPA and Ecology approval.

Compliance Monitoring – Effluent for Reinjection. The data analysis and evaluation procedures used to evaluate compliance with cleanup levels shall be defined in the RDR/RAWP and prepared using WAC 173-340-720(8) and approved by EPA and Ecology.

Construction Requirements. Construction requirements shall be scoped as part of the RDR/RAWP with guidance provided by and as approved by EPA and Ecology. This Work Plan shall include at least the following elements:

- *Construction is expected to comply with appropriate worker safety requirements.*
- *In coordination with wildlife and other resource management agencies, activities should avoid or minimize disruption to local wildlife and other natural resources to the extent practicable.*
- *Design should provide for flexibility following startup to accommodate changes in plume characteristics, or different understandings of actual or perceived responses of the aquifer/plume to the pump-and-treat system. When the actual response of the aquifer is known, the pump and treat systems may be altered as needed, and approved by EPA and Ecology to meet the remedial action objectives.*
- *For areas that are disturbed during construction and operation, it is expected that the land will be revegetated following construction in those areas that are not needed for operation and maintenance of the treatment system and where the land is also not expected to be re-disturbed within the next few years by other site activities. Following completion of the interim action, it is expected that rectification of the habitat affected by this activity will be conducted and coordinated with activities in the source operable units (...100-KR-1, and 100-KR-2).*
- *To the extent practicable, facilities are expected to be designed and located in a manner that minimizes interference with and interference by remedial actions for the source waste sites.*
- *Sites with cultural resource significance should be avoided during remedial activities if avoidance is possible. Where avoidance is not possible, a data recovery/mitigation plan must be prepared in consultation with the affected resource trustee and carried out for each site impacted by remedial activities ...*

Resin Disposal. Waste generated during the remedial action, principally exhausted resins, will be disposed of at the Environmental Restoration Disposal Facility (ERDF) or at other on-site facilities as appropriate. Resins will be stabilized prior to disposal such that:

- *The chromium concentration in leachate generated using the Toxicity Characteristic Leachate Procedure (TCLP) is less than 5.0 mg/L.*
- *ERDF waste acceptance criteria are met for disposal at ERDF.*

In the event that some materials cannot be disposed to ERDF or other on-site facilities, and require disposal at an off-site facility, such a facility must be in compliance with EPA's Offsite Rule (40 CFR 300.440) concerning off-site disposal of wastes. If during the design or conduct of the remedial action it is determined that regeneration of resins is appropriate, that option may be implemented with any waste disposed as described for resins in this paragraph.

Human Access Institutional Controls. *Institutional controls are required to prevent human exposure to groundwater. The DOE is responsible for establishing and maintaining land use and access restrictions until MCLs and risk-based criteria are met or the final remedy is selected. Institutional controls include placing written notification of the remedial action in the facility land use master plan. The DOE will prohibit any activities that would interfere with the remedial activity without EPA and Ecology concurrence. In addition, measures necessary to ensure the continuation of these restrictions will be taken in the event of any transfer or lease of the property before a final remedy is selected. A copy of the notification will be given to any prospective purchaser/transferee before any transfer or lease. The DOE will provide EPA and Ecology with written verification that these restrictions have been put in place.*

Investigation-Derived Waste. *Remedial investigation at ...100-KR-4 generated investigation-derived waste consisting of soil and slurries from monitoring well installation, and purge water generated during development and monitoring of the wells. This waste is stored in the respective reactor areas in drums. Soil will be disposed to ERDF, as will slurries following dewatering in accordance with ERDF waste acceptance criteria. Water may be processed via the ion exchange treatment system installed for groundwater under this ROD.*

Operational Requirements. *The pump and treat portion of the interim remedial action will continue until the selection of a final action or it is demonstrated to EPA's and Ecology's satisfaction that termination (or intermittent operation) is appropriate because: (A) sampling indicates that hexavalent chromium is below the compliance value, and site data indicate it will remain below the compliance value; or (B) based on an evaluation of the following criteria:*

- *The effectiveness of the treatment technology does not justify further operation.*
- *An alternate treatment technique, such as in situ chemical reduction or other improved treatment technique is evaluated and proves to be more effective, and/or less costly, and is consistent with the remedial action objectives.*

Wetlands and Flood Plains. *The interim action will be implemented such that to the extent practicable disturbance to wetlands will be avoided and system components except monitoring points will be located away from wetlands. System components will be located such that they will not increase deleterious effects of flooding.*

Protectiveness. *The interim action is expected to provide adequate protection of human health and ecological receptors in the Columbia River until implementation of the final remedy for... and 100-KR-4 groundwater operable units, or until such time that the DOE demonstrates to Ecology and the EPA that no further interim action is required. Contaminated soil overlying these operable units are or will be addressed in separate remedial actions.*

Remedy Implementation Progress Prior to this Review Period. Before this review period (i.e., before 2015), three pump-and-treat systems were operating in the 100-KR-4 OU. These primarily included the original KR4 Pump and Treat System (beginning operation 1997), the KW Pump and Treat System (beginning in 2007), and the KX Pump and Treat System (beginning operations in 2009). As of 2015, more than 835 kg (1,840.8 lb) of hexavalent chromium had been removed by these systems

([DOE/RL-2016-01](#), Rev. 0). All three systems continued to operate through the previous reporting period and beyond. Further details can be found in the 2011-2015 5-year review report ([DOE/RL-2016-01](#), Rev. 0).

Issues/Corrective Actions from the Previous 5-Year Review. The previous [CERCLA](#) 5-Year Review report ([DOE/RL-2016-01](#)) for the period of 2011 through 2015 included the following issue and corrective action for the 100-KR-4 groundwater OU and the 100-KR-2 source OU assessments:

***Issue KR4-1.** Several 100-KR-2 OU waste sites likely serve as continuing sources of 100-KR-4 OU groundwater contamination by hexavalent chromium as well as other COCs.*

***Corrective Action KR4-1.** Incorporate supplemental characterization data and risk evaluation information in a revised draft RI/FS report and transmit for regulator review. (Corrective Action Due Date: December 31, 2018).*

Corrective Action KR4-1 was completed on May 1, 2019, with the submittal of [DOE/RL-2010-97](#), Draft B, which included the supplemental characterization data; the document was sent to EPA for review. EPA provided comments on the draft RI on October 16, 2019 ([EPA 2019d](#)).

Protectiveness Statement from the Previous (2011-2015) 5-Year Review Report. The 100-KR-4 groundwater OU protectiveness statement from the previous (2011-2015) 5-year-review report ([DOE/RL-2016-01](#)) was as follows:

***100-KR-4 Groundwater OU – Will Be Protective.** The remedy at the 100-KR-4 groundwater OU will be protective upon completion of the final remedy. The interim remedy for the 100-KR-4 groundwater OU focuses on hexavalent chromium contamination. The KR-4, KW, and KX groundwater treatment systems' operations and the flow-path-control components of the interim remedy are ongoing, and demonstrating effective progress in reducing contaminant plume sizes and concentrations. ICs have been implemented and continue to ensure that unacceptable risks to human health are being controlled. A revised RI/FS report that includes 100 KR-4 is in development, pending the results of supplemental field characterization.*

Progress Since the 2011-2015 Review

Accomplishments. The primary remedial action accomplishments for the 100-KR-4 groundwater OU during the past 5 years (2016-2020) can be summarized as follows:

- Continued [CERCLA](#) groundwater sampling and analysis at monitoring well locations and operation of three interim groundwater remediation systems focusing on removal of hexavalent chromium have achieved the following reductions in hexavalent chromium:
 - KR4 Pump and Treat: Operating since 1997 and removed 384 kg (847.6 lb) of hexavalent chromium as of 2020.
 - KW Pump and Treat: Operating since 2007 and removed 289.8 kg (638.9 lb) of hexavalent chromium as of 2020.
 - KX Pump and Treat: Operating since 2009 and removed 340.8 kg (751.3 lb) of hexavalent chromium as of 2020.

- In May 2016, the KW Pump and Treat System was shut down to initiate a hexavalent chromium rebound study ([DOE/RL-2016-42](#), *Sampling and Analysis Plan for KW Pump and Treat System Rebound Study*). The purpose of this study was to evaluate the potential for contaminant concentrations to remain below cleanup levels and determine if continuing secondary source material exists in the deep vadose zone by measuring the amount of rebound in hexavalent chromium concentrations in groundwater.
- In 2019, a soil flushing treatability test was implemented at the 183.1KW Headhouse area to address a continuing source of groundwater contamination ([DOE/RL-2017-30](#), *KW Soil Flushing/Infiltration Treatability Test Plan*). The goal of soil flushing was to flush hexavalent chromium from the deep portions of the vadose zone into the groundwater and then capture and treat the material with the active pump-and-treat system.
 - In 7 months of testing, between May 28, 2019, and December 31, 2019, a total of 17.3 kg (38.13 lb) of hexavalent chromium was removed from the groundwater during the treatability test; this was more than double the total of 7.6 kg (16.8 lb) removed by the KW Pump and Treat System in CY 2018 ([DOE/RL-2018-67](#)). The test continued in 2020 and removed an additional 7.2 kg (15.9 lb) of hexavalent chromium ([DOE/RL-2020-61](#)).
 - In May 2020, DOE and EPA began discussions to put together an explanation of significant difference (ESD) for [EPA/ROD/R10-96/134](#), *Record of Decision for the 100-HR-3 and 100-KR-4 Operable Units Interim Remedial Actions, Hanford Site, Benton County, Washington*, to add soil flushing for the 183.1KE Headhouse (the ESD was subsequently approved on September 28, 2021, but is not included in this 2016-2020 5-year review).
- DOE submitted the [DOE/RL-2010-97](#), *Remedial Investigation for the 100-KR-1, 100-KR-2, and 100-KR-4 Operable Units*, Draft B to EPA in May 2019 for regulatory agency review. The revision incorporates supplemental data associated with the 105KE Basin and 116-KE-3 Crib and reverse well, as well as data collected to support soil and groundwater interim remedial actions.
- DOE submitted the [DOE/RL-2018-22](#), *Feasibility Study for the 100-KR-1, 100-KR-2, and 100-KR-4 Operable Units*, Draft B to EPA in May 2020 for regulatory agency review. This revision presents alternatives based on the supplemental data as well as additional information from the 2019 treatability test ([DOE/RL-2017-30](#)).
- Groundwater monitoring results were reported annually in Hanford Site groundwater reports.

Additional narrative on 100-KR-4 OU accomplishments relative to each RAO (as of 2020) can be viewed in [DOE/RL-2020-61](#), *Calendar Year 2020 Annual Summary Report for the 100-HR-3 and 100-KR-4 Pump and Treat Operations and 100-NR-2 Groundwater Remediation*.

Remedy Implementation. The interim action ROD for the 100-HR-3 and 100-KR-4 OUs ([EPA/ROD/R10-96/134](#)), as modified, defined the hexavalent chromium cleanup goal in groundwater discharging to the Columbia River as the current ambient water quality criterion of 10 µg/L.

To mitigate risks associated with hexavalent chromium contamination in groundwater discharging to the river, three [CERCLA](#) interim action ion exchange pump-and-treat systems have been installed in the 100-KR-4 OU. All three systems were operational throughout this 5-year review period. The KR-4 system, the first system installed, began operation in 1997; it was designed to remediate groundwater around the 116-K-2 trench. The KW Pump and Treat System, the second system installed, began remediating hexavalent chromium in the 105KW Reactor area in January 2007. The newest pump-and-

treat system, KX, began operating in February 2009. The KX system is used primarily to treat hexavalent chromium in groundwater that migrated from the 116-K-2 trench area toward 105N Reactor and near the proximal end of the trench near the 105KE Reactor area.

A number of RDR/RAWP documents have influenced field implementation of the interim action ROD for 100-KR-4 ([EPA/ROD/R10-96/134](#)), as amended, for the three pump-and-treat systems. Higher level documents include the following:

- [DOE/RL-2013-33](#), Rev. 0, *Remedial Design/Remedial Action Work Plan for the 100-KR-4 Groundwater Operable Unit Interim Action*. This work plan supersedes the previous interim action work plans into a consolidated document (see Section 1.1 of [DOE/RL-2013-33](#) for a complete list).
- [TPA-CN-0858](#). This change notice incorporates the results of the KW Pump and Treat rebound study into the [DOE/RL-2013-33](#), Rev. 0, reflects changes in the pump-and-treat well network, and updates references.
- [DOE/RL-2013-48](#), Rev. 1, *Operations and Maintenance Plan for the 100-KR-4 Pump and Treat Systems*. This plan describes the operations and maintenance requirements of the 100-KR-4 Pump and Treat Systems to ensure the RAOs of the interim action ROD ([EPA/ROD/R10-96/134](#)) are met. The [TPA-CN-0894](#) change notice updates the well network associated with the 100-KR-4 Pump and Treat System and optimizes the in-process sampling frequency for the ion exchange resin vessels.

Associated with each pump-and-treat system are additional supporting documents that address such topics as operations, performance monitoring, and sampling requirements.

Table 2-20 presents an overview of primary components of the remedy and implementation status.

Technical Assessment

Is the remedy functioning as intended by the decision documents?

Yes, the interim remedy identified in the interim action ROD, as amended, ([EPA 2009](#)) involving extraction and treatment of hexavalent chromium-contaminated groundwater from the 100-KR-4 OU area, reinjection of treated water, and ICs is functioning as intended.

Operation of the three pump-and-treat systems is demonstrating progress toward meeting interim RAOs 1 and 3 as defined by the ROD (see Table 2-20). Table 2-21 summarizes 100-KR-4 groundwater OU contaminants removed from the groundwater extraction systems during this 5-year review period and cumulatively since system startup. Overall, the mass of hexavalent chromium removed annually by the 100-KR-4 Pump and Treat Systems has decreased over the past decade (e.g., [DOE/RL-2020-61](#)); this is the expected result of increased throughput of the systems and increased extraction of groundwater from areas of highest concentration, resulting in overall reduction of the maximum observed hexavalent chromium concentration in groundwater at 100-KR-4 OU. Between 2016 and 2020, the mass of hexavalent chromium removed at the KX and KW Pump and Treat Systems fluctuated as a result of extraction well placement targeting high concentration areas and through implementation of various groundwater remediation activities (e.g., the KW rebound study [[SGW-62061](#)]; soil flushing treatability test [[DOE/RL-2019-77](#)]).

Table 2-20. Overview of 100-KR-4 Interim Action Remedy Implementation.

Document Type	Date	Title							
Interim Action ROD, as amended	03/1996, 08/2009, 07/2019	EPA/ROD/R10-96/134, <i>Declaration of the Record of Decision for the 100-HR-3 and 100-KR-4 Operable Units, Hanford Site, Benton County, Washington</i>							
RD/RAWP	11/2016	DOE/RL-2013-33, <i>Remedial Design/Remedial Action Work Plan for the 100-KR-4 Groundwater Operable Unit Interim Action</i> , Rev. 0 TPA-CN-0858, 2019, <i>Tri-Party Agreement Change Notice Form: DOE/RL-2013-33, Remedial Design/Remedial Action Work Plan for the 100-KR-4 Groundwater Operable Unit Interim Action</i> , Rev. 0							
RAOs (abbreviated description)	1. Protect aquatic receptors in the river bottom substrate from contaminants in groundwater entering the Columbia River 2. Protect human health by preventing exposure to contaminants in the groundwater 3. Provide information that will lead to the final remedy								
COC	Hexavalent chromium								
Remedy Component (primary)		Status (approximate percentage complete for implementing the interim remedy component as of December 2020) ^a					Duration of O&M (~years) ^b	Finish ^c (Est'd year)	
		0	1-25	26-50	51-75	76-99			100%
Pump-and-treat with ion exchange resins								TBD	TBD
Reinjection/Flow path control								TBD	TBD
Institutional controls								TBD	TBD
Compliance monitoring for river protection								TBD	TBD

^a Percentages reflect implementation status of the remedy component; post-startup remedial process optimization is considered part of O&M. 100% = fully implemented and now in O&M mode.

^b O&M and duration and completion timeframes are TBD as the interim ROD indicates that the remedy will continue until a final ROD is issued. A final ROD will not be issued until after this 5-year review period (i.e., post-2020).

^c Estimated year when remedy component will be completed.

DOE/RL-2013-33, 2013, *Remedial Design/Remedial Action Work Plan for the 100-KR-4 Groundwater Operable Unit Interim Action*, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <https://pdw.hanford.gov/document/0073409H>.

EPA/ROD/R10-96/134, 1996, *EPA Superfund Record of Decision: Hanford 100-Area (USDOE)*, EPA ID: WA3890090076, OU 02, Benton County, WA, 03/26/1996, U.S. Environmental Protection Agency, Washington, D.C. Available online at <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0078950H>.

TPA-CN-0858, 2019, *DOE/RL-2013-33, Remedial Design/Remedial Action Work Plan for the 100-KR-4 Groundwater Operable Unit Interim Action, Rev 0*, U.S. Environmental Protection Agency and U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <https://pdw.hanford.gov/document/AR-02672>.

COC = contaminant of concern
 O&M = operation and maintenance
 OU = operable unit
 RAO = remedial action objectives
 RDR/RAWP = remedial design report/remedial action work plan
 ROD = record of decision
 TBD = to be determined

Table 2-21. Contaminant Mass Removed from 100-KR-4 Groundwater Operable Unit Extraction Systems. (2 Pages)

System (Startup)	Constituent	Mass Removed (kg)					
		2016	2017	2018	2019	2020	Since Startup
KW (Jan 2007)	Hexavalent chromium	2.9	14.4	7.6	19.6	7.2	289.8
KR4 (Sept 1997)	Hexavalent chromium	2.5	1.4	1.2	1.7	1.7	384
KX (Nov 2008)	Hexavalent chromium	25.6	21.0	26.2	27.3	17.9	340.8

Table 2-21. Contaminant Mass Removed from 100-KR-4 Groundwater Operable Unit Extraction Systems. (2 Pages)

Source: Annual pump-and-treat reports:

DOE/RL-2016-68, *Calendar Year 2016 Annual Summary Report for the 100-HR-3 and 100-KR-4 Pump-and-Treat Operations, and 100-NR-2 Groundwater Remediation*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <https://pdw.hanford.gov/document/0087503>.

DOE/RL-2017-67, *Calendar Year 2017 Report for the 100-HR-3 and 100-KR-4 Pump and Treat Operations and 100-NR-2 Groundwater Remediation*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <https://pdw.hanford.gov/document/0083709>.

DOE/RL-2018-67, 2019, *Calendar Year 2018 Annual Summary Report for the 100-HR-3 and 100-KR-4 Pump and Treat Operations, and 100-NR-2 Groundwater Remediation*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <https://pdw.hanford.gov/document/AR-03039>.

DOE/RL-2019-67, 2020, *Calendar Year 2019 Annual Summary Report for the 100-HR-3 and 100-KR-4 Pump and Treat Operations, and 100-NR-2 Groundwater Remediation*, Rev 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <https://pdw.hanford.gov/document/AR-04067>.

DOE/RL-2020-61, 2021, *Calendar Year 2020 Annual Summary Report for the 100-HR-3 and 100-KR-4 Pump and Treat Operations, and 100-NR-2 Groundwater Remediation*, Rev 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <https://pdw.hanford.gov/document/AR-17526>.

Groundwater extraction, reinjection, and monitoring are conducted through a series of wells, as shown for 2020 in Figure 2-17. Specific details on the performance of each pump-and-treat system are updated and published each year in the *Annual Summary Report for the 100-HR-3 and 100-KR-4 P&T Operations and 100-NR-2 Groundwater Remediation*, which is available at <http://www.hanford.gov/page.cfm/SoilGroundwaterAnnualReports>.

Table 2-22 provides an overview of 100-KR-4 contaminant plume areas and associated changes to the areas during this 5-year review period. Plume maps in Figure 2-18 show the changes in plume shapes and areas during this 5-year review period. The Figure 2-19 trend plots depict the estimated annual changes in contaminant plume areas over the past several 5-year periods.

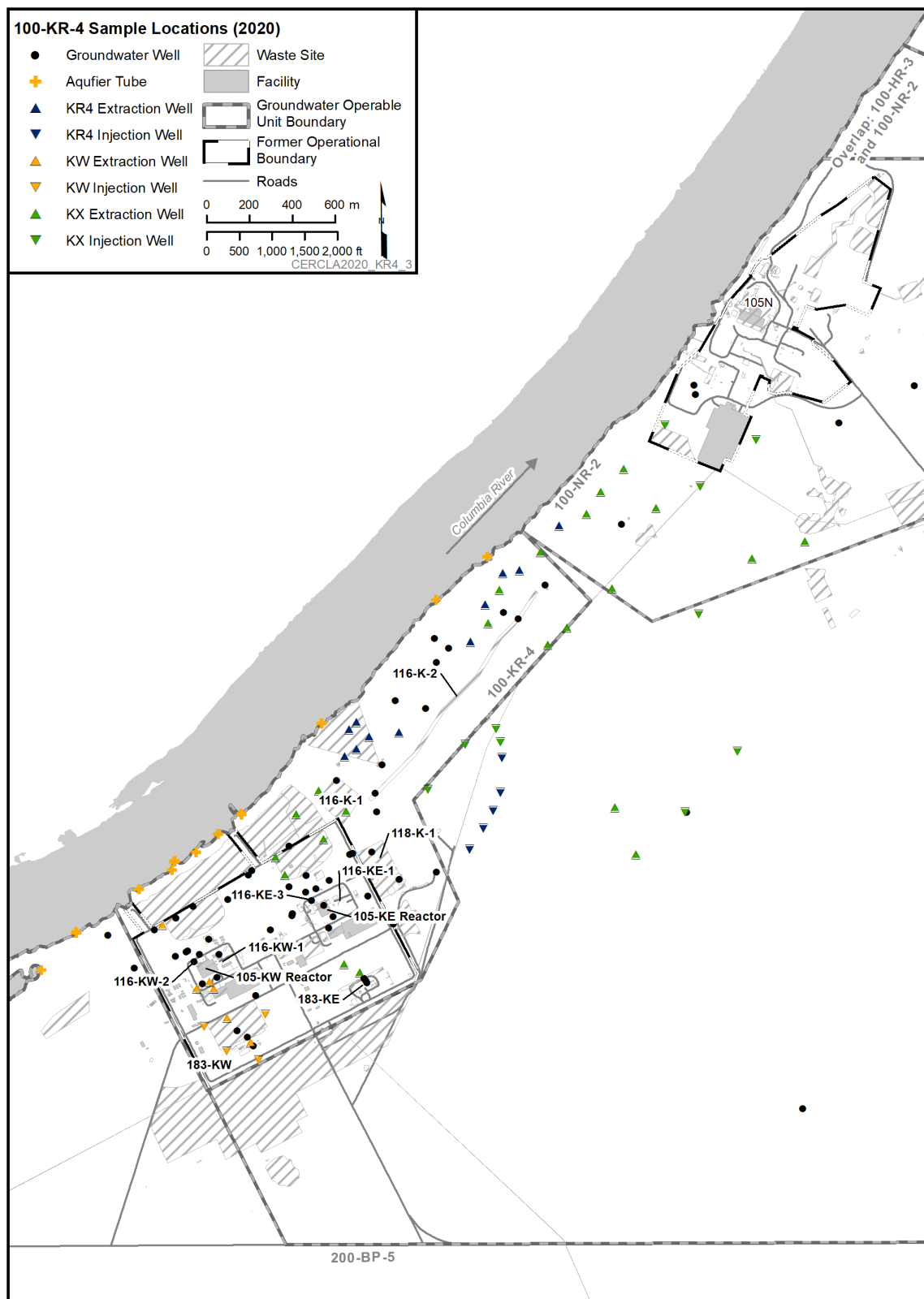


Figure 2-17. Locations of 100-KR-4 Wells and Aquifer Tubes Sampled in 2020.

Table 2-22. Overview of 100-KR-4 Groundwater Contaminant Plumes.^a

Groundwater Contaminant	Water Quality Standard ^b	Maximum Concentration (2020)	Plume Area ^c (km ²)			Shoreline Intersection (m) ^d		
			2015	2020	Change	2015	2020	Change
Hexavalent Chromium	10 µg/L ^e	349 µg/L	2.0 ^f	0.79	-1.21	271	128	-143
Hexavalent Chromium	48 µg/L	see entry above	0.07	0.02	-0.05	0	0	0
Tritium	20,000 pCi/L	280,000 pCi/L	0.11	0.06	-0.05	0	0	0
Nitrate	45 mg/L ^g	99.2 mg/L	<0.01	0.10	0.10	0	0	0
Strontium-90	8 pCi/L	1,290 pCi/L	0.03	0.03	0.00	0	0	0
Carbon-14	2,000 pCi/L	27,200 pCi/L	0.04	0.07	0.03	0	0	0
TCE	5 µg/L	8.2 µg/L	0.01	0.14	0.10	0	0	0

^a Source: Hanford Annual Groundwater Monitoring Reports for 2015 and 2020, DOE/RL-2016-09, *Hanford Site Groundwater Monitoring for 2015*, and DOE/RL-2020-60, *Hanford Site Groundwater Monitoring for 2020*, respectively.

^b Drinking water standard for all but hexavalent chromium.

^c Estimated area at a concentration greater than the listed water quality standard.

^d Length of Columbia River shoreline intersected by plume above the listed water quality standard.

^e The applicable standard is 10 µg/L where groundwater discharges to surface water (WAC 173-201A-240, Water Quality Standards for Surface Waters of the State of Washington), and 48 µg/L in the upland area (WAC 173-340, “Model Toxics Control Act – Cleanup”). The interim remedial action objective remains to protect the Columbia River against releases that would cause exceedance of the 10 µg/L surface water quality criterion.

^f Includes the hexavalent chromium plume on the border between 100-KR and 100-NR interest areas.

^g 45 mg/L as nitrate is equivalent to the drinking water standard of 10 mg/L as nitrogen.

DOE/RL-2016-09, 2016, *Hanford Site Groundwater Monitoring for 2015*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0075314H>.

DOE/RL-2020-60, 2021, *Hanford Site Groundwater Monitoring Report for 2020*, Rev 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <https://pdw.hanford.gov/document/AR-16952>.

WAC 173-201A, “Water Quality Standards for Surface Waters of the State of Washington,” *Washington Administrative Code*, as amended. Available online at <http://apps.leg.wa.gov/WAC/default.aspx?dispo=true&cite=173-201A>.

WAC-173-340, “Model Toxics Control Act – Cleanup,” *Washington Administrative Code*, as amended. Available online at <http://apps.leg.wa.gov/WAC/default.aspx?cite=173-340>.

N/A = not applicable
TCE = trichloroethene

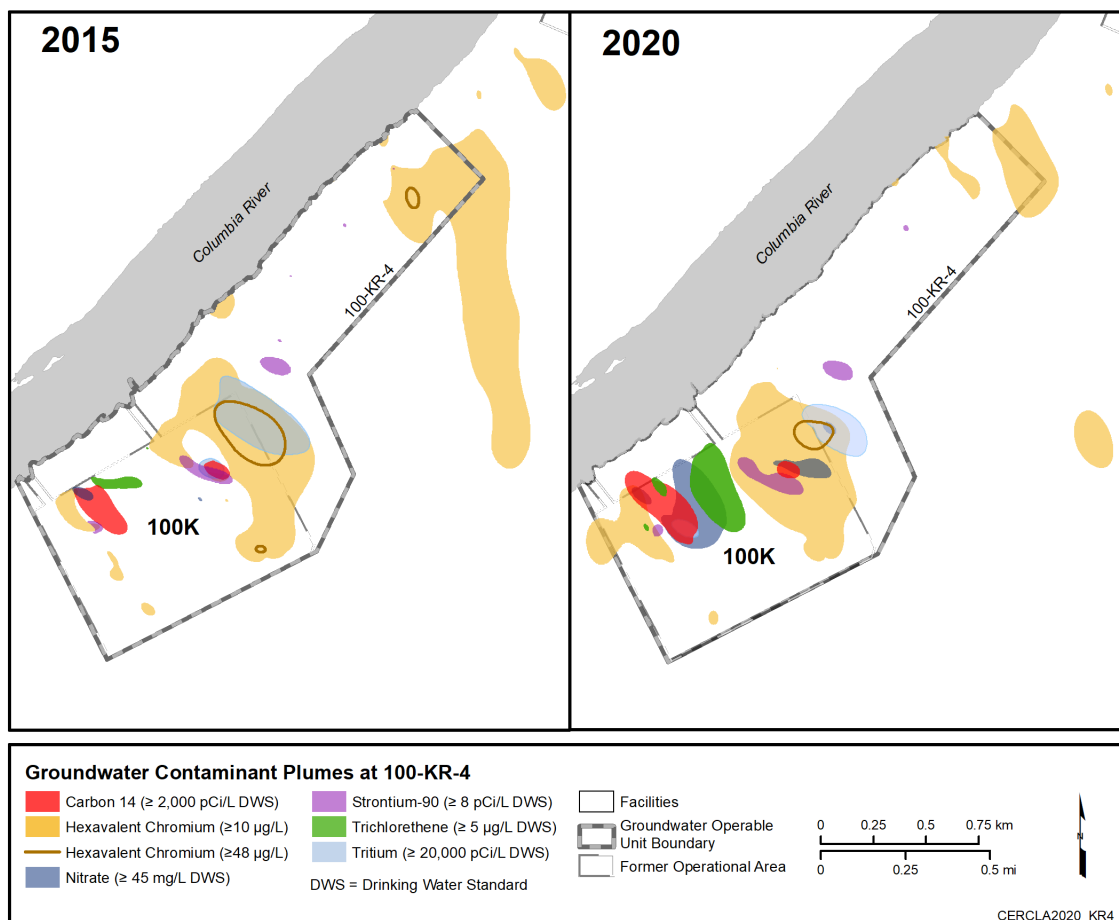


Figure 2-18. 100-KR-4 Groundwater OU Plumes in 2015 (left) and 2020 (right).

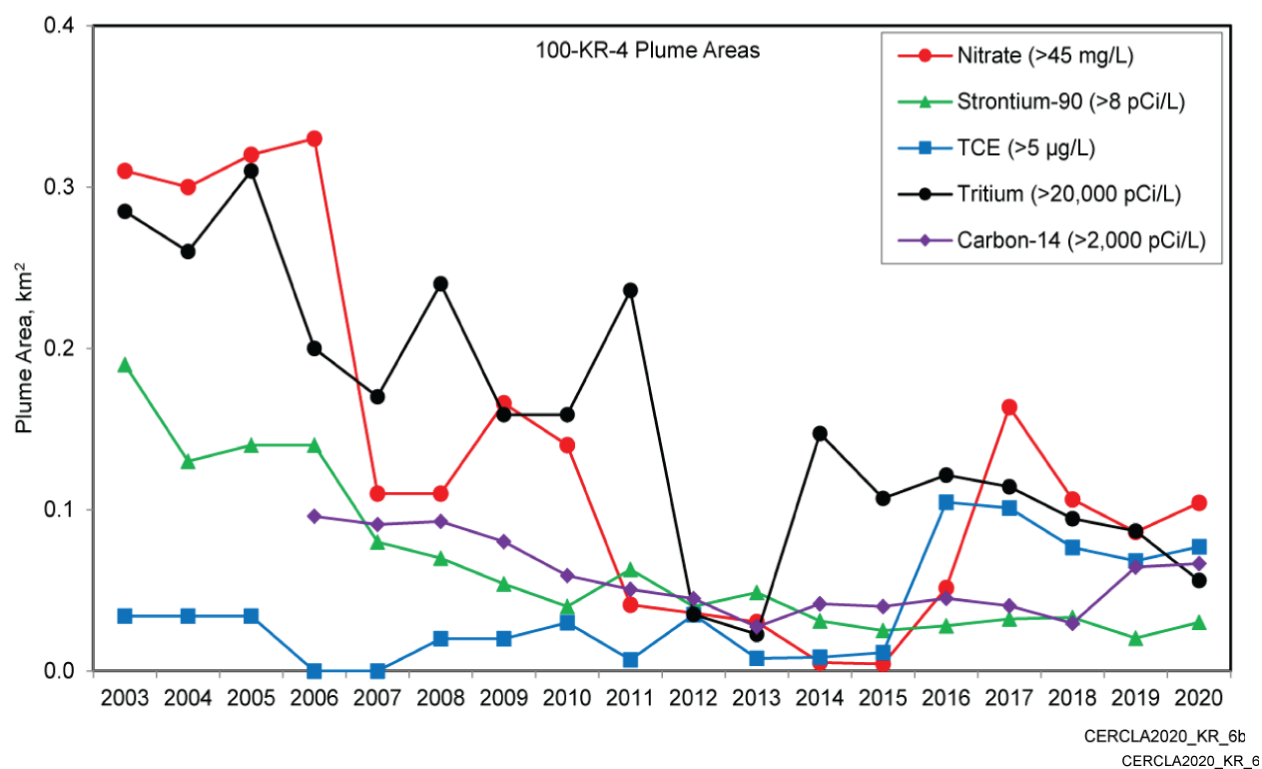
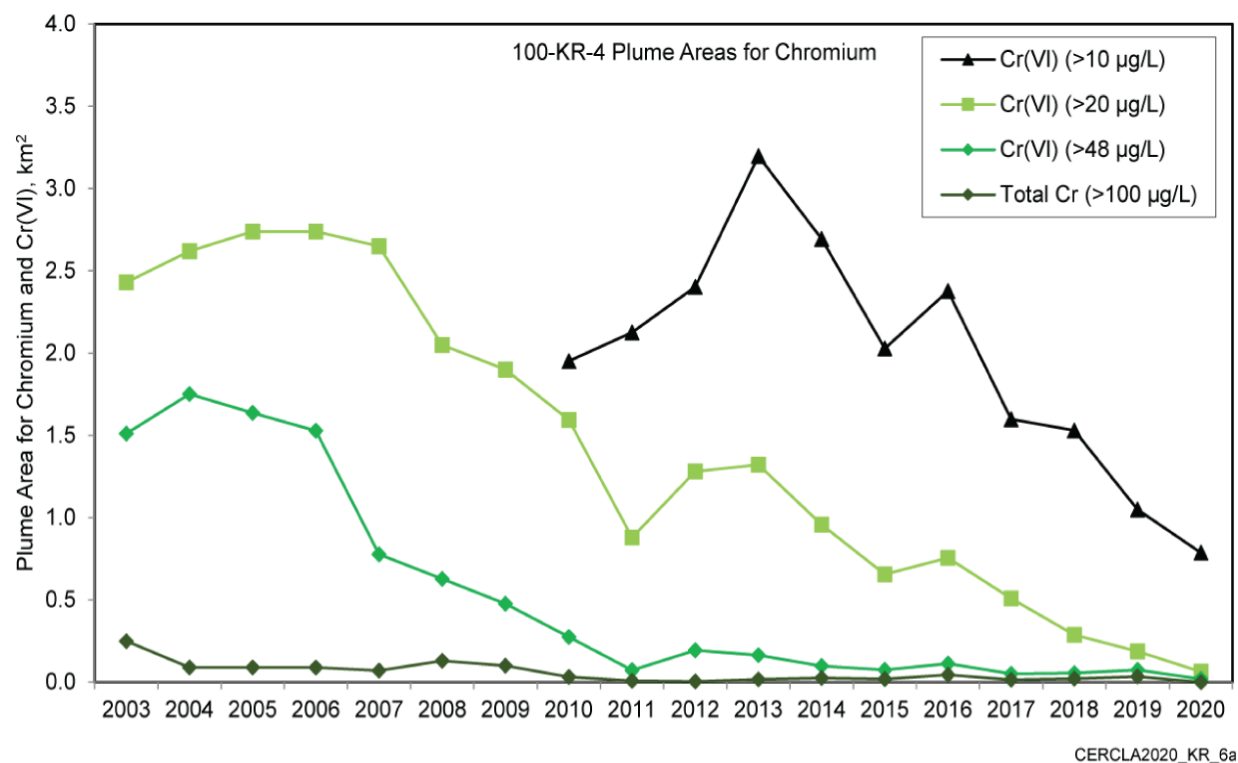


Figure 2-19. 100-KR-4 Trend Plots of Contaminant Plume Areas (2003-2020).

Hexavalent chromium is the contaminant of concern in the 100-KR-4 groundwater, per the interim action ROD ([EPA/ROD/R10-96/134](#)). Smaller plumes of tritium, nitrate, strontium-90, carbon-14, and TCE also are present. Hexavalent chromium plume areas above 10 µg/L have collectively decreased by approximately 60% since 2015 (i.e., from 2 to 0.79 km² [0.77 to 0.30 mi²]). In addition, the length of shoreline that the plume areas above 10 µg/L is interpreted to intersect has decreased between 2015 and 2020 (i.e., from 271 to 128 m (889 to 420 ft)). While the collective plume area for hexavalent chromium at concentrations above 48 µg/L has remained relatively constant during this past 5-year period from 0.07 km² to 0.02 km² (0.042 mi² to 0.008 mi²), the maximum sample concentration has slightly increased since 2015 (i.e., 348 µg/L in 2015 and 349 µg/L in 2020). Between 2016 and 2020, the observed increases are linked to various ongoing remediation activities for the 100-KR-2 source OU and the 100-KR-4 OU. A groundwater rebound test was performed between 2016 and 2017 ([SGW-62061](#)) that showed a continuing source of hexavalent chromium in the footprint of the 183.1KW Headhouse area; this led to a soil flushing treatability test ([DOE/RL-2019-77](#)) that proved to be successful and is being considered for future applications in other locations. The plume area for strontium-90 has remained relatively stable since the last 5-yr review (Figure 2-19). Plume areas for nitrate and TCE increased in 2016 and 2017 and is likely due to rebound of groundwater concentrations during shutdown of the pump-and-treat system, as well as the increase in waste site remediation activities. Additionally, a change in plume mapping methods occurred in 2017, which mapped maximum concentrations in lieu of average yearly concentrations. Since 2017, these contaminants have been declining gradually and are not reaching the Columbia River at levels above the water quality standards. However, an increase in carbon-14 occurred in 2019 and is likely due to plume migration away from an inland continuing source of groundwater contamination at the 116-KW-1 crib. Cleanup actions for these other contaminants will be defined in an upcoming ROD.

In support of ongoing RPO, four high-capacity groundwater extraction wells were installed and connected between 2016 and 2020 and a total of 18 well realignments (e.g., conversion of an existing monitoring well to an extraction well or injection well, or other conversions) occurred to increase plume containment and mass removal. The total number of realignments does not include interim steps to support ongoing waste site remediation efforts for the 100-KR-2 OU or disconnects for the KW Rebound Study ([DOE/RL-2016-42](#)). Twelve additional groundwater monitoring wells were installed at strategic locations to support plume definition, remedy monitoring, and implementation of the KW Rebound Study ([DOE/RL-2016-42](#)) and Soil Flushing Treatability Test ([DOE/RL-2017-30](#)).

As a result of the Soil Flushing Treatability Test ([DOE/RL-2019-77](#)), which combined soil flushing with continued pump-and-treat to expedite the removal of hexavalent chromium from the environment, DOE-RL and EPA are working to incorporate the use of soil flushing to address other continuing sources of hexavalent chromium in the 100-K Area that have been identified ([SGW-64284](#), *100-K Area Continuing Hexavalent Chromium Sources*). The application of the soil flushing technology in identified areas, such as the 183.1KE Headhouse, can effectively expedite mobilization of hexavalent chromium within the vadose zone to groundwater where it can be extracted and treated by the existing pump-and-treat system. An ESD is planned to be published early in the next [CERCLA](#) 5-year review period.

In 2020, as part of the groundwater modeling effort that supported the 100-K Feasibility Study ([DOE/RL-2018-22](#), Draft B), it was identified that groundwater monitoring along the KW shoreline may be insufficient based on model predictions. To address this, two new aquifer tubes are planned to be installed along the shoreline to better define groundwater contamination in this area. This work is also planned to occur early in the next [CERCLA](#) 5-year review period (2021-2025).

For more detailed information on the 100-KR-4 groundwater OU well locations, distribution of contaminant concentrations within each plume, historic trends associated with each 100-KR-4 plume area,

as well as for performance metrics associated with 100-KR-4 OU groundwater treatment, visit the following links:

- *Hanford Site Groundwater Monitoring Report* (published each summer for the previous calendar year): <http://www.hanford.gov/page.cfm/SoilGroundwaterAnnualReports>
- *Annual Summary Report for the 100-HR-3 and 100-KR-4 P&T Operations and 100-NR-2 Groundwater Remediation* (published for each prior calendar year): <http://www.hanford.gov/page.cfm/SoilGroundwaterAnnualReports>.

ICs for the 100-KR-4 groundwater OU, as required by the interim action ROD ([EPA/ROD/R10-96/134](#)), as amended, are described in [DOE/RL-2013-33](#), *Remedial Design/Remedial Action Work Plan for the 100-KR-4 Groundwater Operable Unit Interim Action*, Rev. 0, as amended by [TPA-CN-0858](#), and are actively managed. Specific details associated with each IC have also been incorporated into *Sitewide Institutional Controls Plan for the Hanford CERCLA Response Actions and RCRA Corrective Actions* ([DOE/RL-2001-41](#)), this report is routinely updated within 180 days after publication of each decision document that addresses ICs. The ICs implemented for the 100-KR-4 OU are required to prevent human exposure to contaminated groundwater and include access controls (warning notices and entry restrictions), land-use management (land use), groundwater-use management (excavation permits), and miscellaneous provisions. These ICs (supporting achievement of RAO 2) are assessed annually and DOE presents a summary including any noted issues or actions to the Site regulators each fall at the unit managers meeting. The presentation is documented in the meeting minutes, which are archived in the Hanford Site Administrative Record (see examples in Attachments 4 and 6 at the following link: <https://pdw.hanford.gov/document/AR-04230>). The annual IC assessments are also now captured in an annual report (e.g., [HNF-65616](#), *FY2020 Sitewide Institutional Control Assessment*). During the 5-year review period of 2016 through 2020, appropriate ICs for the 100-KR-4 groundwater OU were found to be in place and maintained; the objectives for the ICs are being met.

Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of remedy selection still valid?

As described earlier and captured in the ESDs ([EPA 2009](#)), hexavalent chromium cleanup levels for protection of aquatic life were modified from 11 to 10 µg/L in 1997. Otherwise, exposure assumptions, toxicity data, cleanup levels, and interim RAOs used at the time of original remedy selection are still valid. These criteria will be reviewed and updated, as needed, to support final remedy selection.

Has any other information come to light that could call into question the protectiveness of the remedy?

No new information is known that could call into question the protectiveness of the remedy for the 100-KR-4 OU. Data collected during this period indicate that the interim groundwater remedial action implemented for control of hexavalent chromium has been effective at reducing the discharge of contaminated groundwater to the Columbia River, controlling plume migration toward exposure points, and reducing the concentration of hexavalent chromium observed in groundwater at 100-KR-4 OU.

Issues/Recommendations During this Review Period

To achieve protectiveness in the long term, the final RI/FS documents needs to be completed to support a future final remedy ROD. DOE has submitted Draft B versions of the RI ([DOE/RL-2010-97](#), Draft B) and FS ([DOE/RL-2018-22](#), Draft B) to EPA for review.

Issue KR1/2/4-1: A full human health and ecological risk assessment for 100-KR-1 and 100-KR-2 source OUs and the 100-KR-4 groundwater OU has not been finalized.

Recommendation KR1/2/4-1: Finalize a full human health and ecological risk assessment for the 100-KR-1 and 100-KR-2 source OUs and the 100-KR-4 groundwater OU as part of the 100-K Area RI/FS (Milestone Date: September 30, 2022).

Does this issue/action currently affect the protectiveness of the remedy? – NO.

Will this issue/action affect the protectiveness of the remedy in the future? – YES.

Protectiveness Statement

100-KR-4 Groundwater OU – Short-Term Protective. The interim remedy at the 100-KR-4 groundwater OU currently focuses on hexavalent chromium contamination and currently protects human health and the environment because the KR-4, KW, and KX groundwater treatment systems' operations and the flow-path control components of the interim remedy are ongoing, and they are demonstrating effective progress in reducing contaminant plume sizes and concentrations. ICs have been implemented and continue to ensure that unacceptable risks to human health are being controlled. However, in order for the 100-KR-4 remedy to be protective in the long term, an evaluation of risk for all contaminants in the final RI and FS is needed.

2.3.5 100-N Operable Units

The 100-N Area is located in the north-central region of the Hanford Site, adjacent to the Columbia River. The 100-N Area contains the 100-NR-1 source OU and the 100-NR-2 groundwater OU. Figure 2-20 shows the current boundaries for the 100-N Area OUs.

2.3.5.1 100-NR-1 Source Operable Unit

Background

The 105N Reactor operated from 1963 until 1987. It was a dual-purpose reactor that produced plutonium for DOE and steam for the Hanford Generating Plant, located adjacent to the 105N Reactor. The Hanford Generating plant produced electrical power. The Bonneville Power Administration switching station also is located in the 100-N Area. In 1991, DOE issued the final decision to permanently retire the 105N Reactor from service.

Past operations associated with the 105N Reactor contributed to soil and groundwater contamination in the 100-N Area. The 100-NR-1 source OU includes liquid and solid waste disposal sites and unplanned releases in the vicinity of or related to the 105N Reactor. These waste sites include cribs, trenches, pits, French drains, solid waste burial grounds, septic tanks, and drain fields. Cleanup decisions for this region were initiated in the 1990s.

Chronology

Table 2-23 lists remedial action decision documents relevant to the 100-NR-1 source OU as of December 31, 2020.

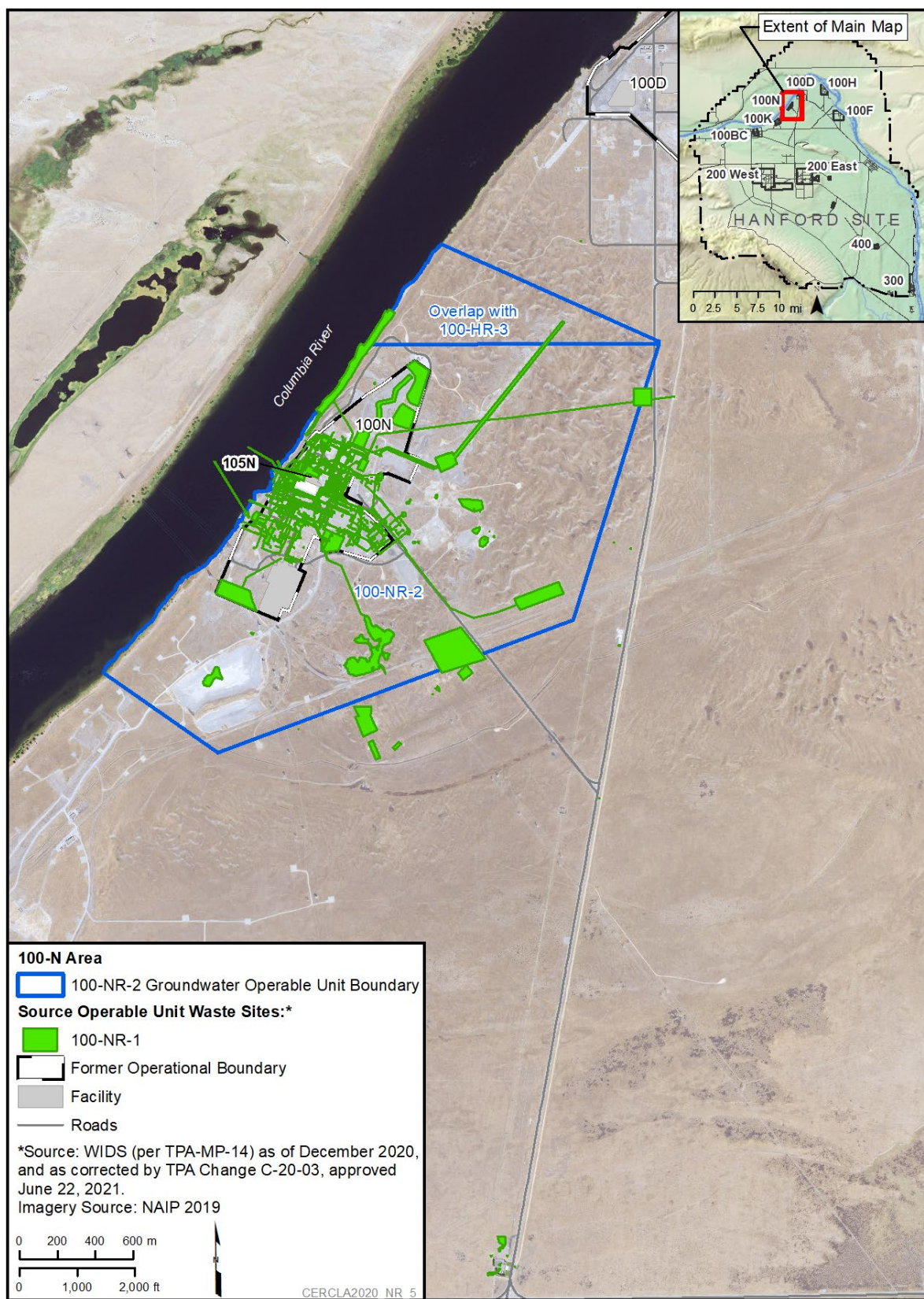


Figure 2-20. Location of 100-N Area Operable Units.

Table 2-23. Decision Documents for the 100-NR-1 Source Operable Unit.

Date	Location	Title
9/1999	EPA/ROD/R10-99/112	<i>Interim Remedial Action Record of Decision for the 100-NR-1 and 100-NR-2 Operable Units, Hanford Site, Benton County, Washington.</i> This interim action ROD requires the OUs to continue removing strontium-90 through pump-and-treat with ion exchange and discharge-treated groundwater upgradient into the aquifer, maintain groundwater monitoring networks to monitor pump-and-treat operations and impacts to groundwater, evaluate technologies for strontium-90 removal and aquatic and riparian receptor impacts from contaminated groundwater, remove petroleum hydrocarbons (free-floating product) from any monitoring well and dispose of it at an approved facility, remove petroleum-contaminated solid waste, and dispose of non-hazardous wash/rinse waters to Ecology-approved facilities.
1/2000	EPA/ROD/R10-00/120	<i>Interim Remedial Action Record of Decision for the 100-NR-1 Operable Unit of the Hanford 100-N Area.</i> This interim action ROD requires RTD of the 116-N-1 and 116-N-3 cribs with disposal at ERDF, backfilling, and revegetation; any pipelines will be sampled and removed or left in place based on sample results.
5/2003	EPA/ESD/R10-03/605	<i>Explanation of Significant Difference for the 100-NR-1 Operable Unit Treatment, Storage, and Disposal Interim Action Record of Decision and 100-NR-1/100-NR-2 Operable Unit Interim Action Record of Decision.</i> This ESD removes the July 31 annual ICs requirement and consolidates reporting with the sitewide IC annual report, eliminates the requirement to evaluate applying 76 cm (30 in.) of irrigation water to determine whether remaining contaminants will impact groundwater for 116-N-1, and identifies the need for additional ICs to preclude access to contaminated groundwater; any additional ICs will be incorporated into the sitewide IC document.
3/2011	EPA 2011a	<i>Explanation of Significant Differences for the 100-NR-1 and 100-NR-2 Operable Units Interim Remedial Action Record of Decision, Hanford Site, Benton County, Washington.</i> This ESD adds 45 waste sites in the 100-NR-1 OU for remediation by RTD (characterized per the 100-N Area sampling and analysis plan) and increases the total cost by 38% to \$67,510,386.
8/2013	Ecology et al. 2013	<i>Explanation of Significant Difference for the 100-NR-1 and 100-NR-2 Operable Units Interim Remedial Action Record of Decision, Hanford Site, Benton County, Washington.</i> This ESD adds two waste sites in the 100-NR-1 OU for remediation by RTD and increases the total cost by \$401,500.

Ecology = Washington State Department of Ecology
ERDF = Environmental Restoration Disposal Facility
ESD = explanation of significant differences
IC = institutional control

OU = operable unit
ROD = record of decision
RTD = removal, treatment (as required), and disposal

See Appendix B for a consolidated list of decision documents for Hanford Site OUs.

Remedial Action

Goals and Objectives. The following RAOs set forth in the interim action RODs listed in the chronology are narrative statements that define the extent to which the waste sites require cleanup to protect human health and the environment.

- RAO 1. Protect human and ecological receptors from exposure to radioactive contaminants in surface and subsurface soils, structures, and debris.
- RAO 2. Protect potential human and ecological receptors from exposure to nonradioactive contaminants present in the upper 4.6 m (15 ft) of soil and debris.

- RAO 3. Protect the unconfined groundwater system from adverse impacts by reducing concentrations of radioactive and nonradioactive chemical contaminants present in the soil column that could migrate to the groundwater.
- RAO 4. Protection of the Columbia River from adverse impacts so that designated beneficial uses are maintained.
- RAO 5. Prevent destruction of significant cultural resources and sensitive wildlife habitat.

Remedy Components. Remedy components for the 100-NR-1 source OU waste sites generally include the following steps:

- Remove contaminated soil, structures, and debris from 100 Area source waste sites using the observational approach, which uses field data and analytical screening during remediation to guide the extent of excavation. Remediation proceeds until it can be demonstrated through a combination of field screening and verification sampling that cleanup goals have been achieved.
- Treat the waste as required to meet applicable waste disposal criteria; for petroleum contaminated waste sites this includes in situ and ex situ bioremediation
- Dispose of contaminated materials, preferably at ERDF or another location approved by the regulators
- Backfill excavated areas and revegetate
- Implement ICs where wastes are left in place and preclude unrestricted land use.

Detailed descriptions of the remedy components are provided in the “Selected Remedy” section of each interim action ROD, as amended.

Remedy Implementation Progress Prior to this Review Period ([DOE/RL-2016-01](#)). Work on the interim remedy began after issuance of the ROD in 1999, with the initial cleanup verification package approved in 2004. Before 2016, interim remedial actions had been completed at 127 of approximately 139 waste sites in the 100-NR-1 OU.

Issues/Corrective Actions from the Previous (2011-2015) 5-Year Review. No previous issues or actions were noted for the 100-NR-1 OU in the 2011-2015 [CERCLA](#) 5-year review.

Protectiveness Statement from the Previous (2011-2015) 5-Year Review Report ([DOE/RL-2016-01](#)). The protectiveness statement from the previous (2011-2015) 5-year review report for the 100-NR-1 OU was as follows:

***100-NR-1 Source OU – Will Be Protective.** The remedy at the 100-NR-1 source OU is expected to be protective of human health and the environment upon completion of the final remedy. Implementation of the interim remedy (primarily involving RTD, backfilling, recontouring, revegetation, and ICs) at the 100 NR-1 source OU has demonstrated that exposure pathways that could result in unacceptable risks are being controlled.*

Progress Since 2011-2015 Review

Accomplishments. Since the 2011-2015 5-year review, primary accomplishments for the 100-NR-1 source OU include the following:

- Due to the extensive revisions to address regulator review comments to [DOE/RL-2012-15](#), *Remedial Investigation Feasibility Study for 100-NR-1 and 100-NR-2 Operable Units*, Draft A, it was jointly decided between DOE and Ecology to issue a Draft B of the document. [DOE/RL-2012-15](#), *Remedial Investigation Feasibility Study for 100-NR-1 and 100-NR-2 Operable Units*, Draft B was prepared and transmitted to Ecology for review on November 18, 2019. Ecology review comments were transmitted to DOE on July 9, 2020. DOE has been working with Ecology to disposition review comments to issue Revision 0 of the RI/FS; comment resolution will continue into 2022. The RI/FS will be used to support future cleanup decisions and to prepare a proposed plan and ROD.
- Risk assessment evaluations completed for the Draft B RI/FS ([DOE/RL-2012-15](#)) identified no unacceptable groundwater and surface water, human health, and ecological risks for more than 100 waste sites remediated under the interim remedial actions.

While most remediation was done prior to this review period, RTD remediation activities were completed in 2016 for the 100-N-83, Unplanned Release WIDS waste site. Table 2-24 summarizes the waste site cleanup status for the 100-NR-1 source OU waste sites, including metrics on work accomplished during the current 5-year period (2016-2020). Figure 2-21 shows the general locations and closure status as of December 2020 for waste sites in the 100-NR-1 source OU.

Table 2-24. 100-NR-1 Operable Unit Cleanup Status.

Source OU	Number of Waste Sites ^a	Sites Dispositioned ^b			
		Pre-2016	2016 – 2020	Total	Percent
100-NR-1	141	125	1	126	89
Total	141	125	1	126	89%

^a Approximate number of accepted waste sites within the OU, according to WIDS, as of December 2020 (and subsequently corrected per TPA Change C-20-03). Actual numbers can and do change if sites are added to or moved from a given OU in accordance with DOE and regulatory agency approvals.

^b Approximate number of sites dispositioned; includes the number of sites that have been reclassified in WIDS, as of December 2020 (and subsequently corrected per TPA Change C-20-03), as either closed out, interim closed, final closed, interim no-action or final no-action in accordance with the guideline TPA-MP-14.

TPA-MP-14, 2011, *Maintenance of the Waste Information Data System (WIDS)*, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1109271360>.

TPA Change C-20-03, 2021, *River Corridor Waste Site Updates in the Tri-Party Agreement, Appendix C*, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <https://pdw.hanford.gov/document/AR-14219>

DOE = U.S. Department of Energy

OU = operable unit

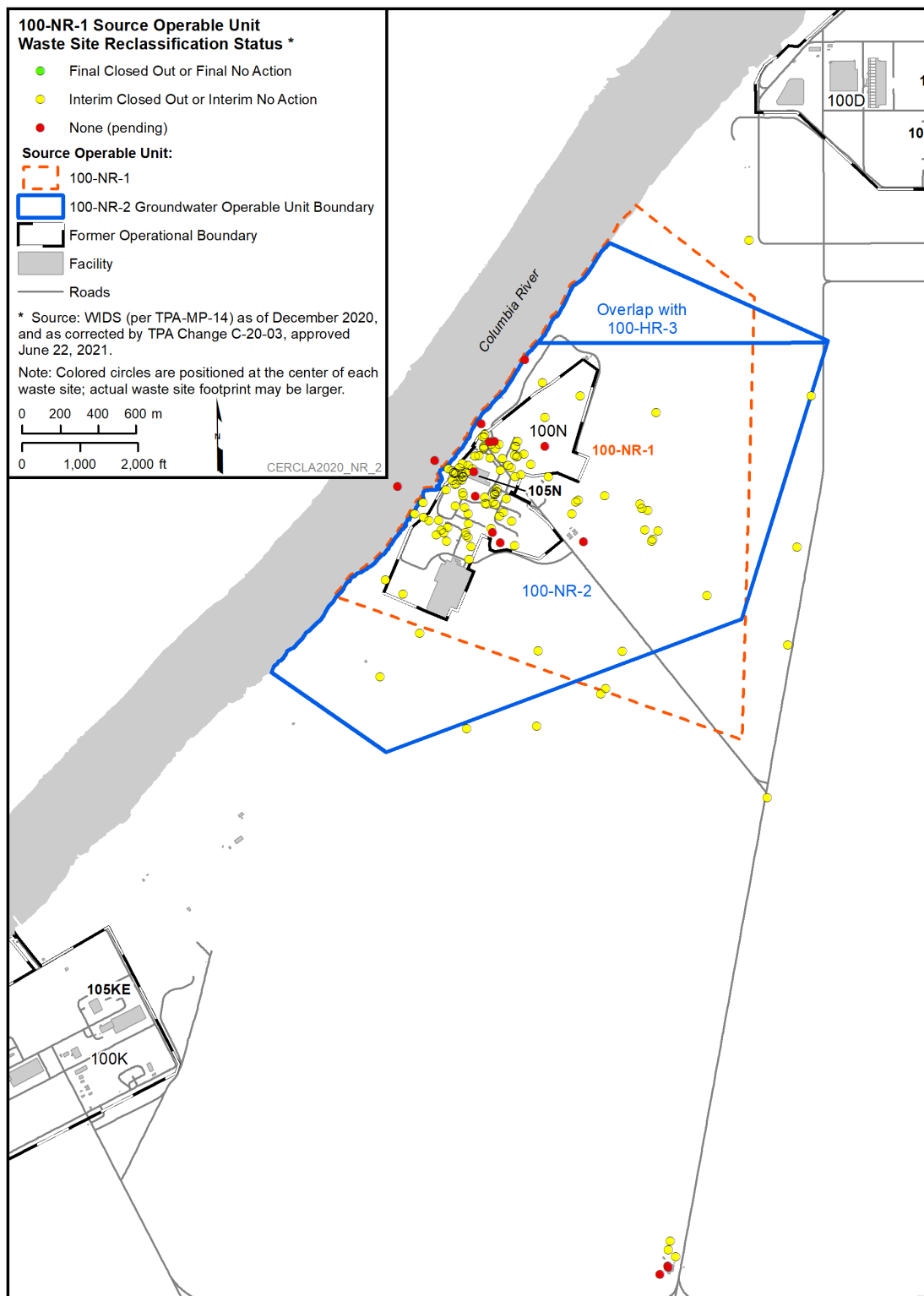


Figure 2-21. Geographic Distribution and WDS Reclassification Status of 100-NR-1 Source Operable Unit Waste Sites as of December 2020.

Remedy Implementation. The *Remedial Design Report/Remedial Action Work Plan for the 100-N Area* ([DOE/RL-2005-93](#), Rev. 1) describes the design and implementation of remedial action processes for the 100-NR-1 OU, excluding the 100-N TSD units.

The majority of the remedial activities in the 100-N Area have been completed. Approximately 15 remaining accepted waste sites in the 100-N Area have not been reclassified, and these sites can be summarized as follows:

- Subsurface soil contamination associated with the 105-N/109-N facility
- Subsurface soil associated with subsurface petroleum releases that are actively being treated
- Sites associated with active facilities (e.g., 100 Area fire station)
- Sites associated with underground radioactive material area postings
- Sites where cleanup decisions have been deferred to the final ROD.

ICs have been implemented and maintained during this 5-year review period to control access to residual contamination in soil and groundwater above standards for unlimited use and unrestricted exposure.

Technical Assessments

Is the remedy functioning as intended by the decision documents?

Yes, the interim remedy (primarily involving RTD, backfilling, revegetation, and ICs) is functioning as intended by the interim action RODs (as amended). As of December 2020, 126 of the 141 100-NR-1 source OU accepted waste sites had been remediated. Full-scale in situ bioventing remediation operations began in 2012 and continued through this review period.

In accordance with [TPA-MP-14](#), *Maintenance of the Waste Information Data System (WIDS)*, the 100-NR-1 remediated waste sites have been documented in the WIDS as either interim closed or interim no-action. Cleanup verification packages (including sampling data and other technical information) to support the reclassification to interim closed and/or no-action are included in the Hanford Site Administrative Record for the 100-NR-1 source OU. The RAGs (contaminant-specific soil cleanup criteria developed to ensure that remedial actions to be implemented will meet the RAOs) are described in Chapter 2 of the *Remedial Design Report/Remedial Action Work Plan for the 100-N Area* ([DOE/RL-2005-93](#), Rev. 1).

The RAOs for 100-NR-1 remediated waste sites, and the methods used for achieving the RAOs through the interim remedial actions are summarized in the following list:

- RAO 1. Protect human and ecological receptors from exposure to radioactive contaminants in surface and subsurface soils, structures, and debris.
 - Will be achieved by reducing concentrations of contaminants in the upper 4.6 m (15 ft) of soil. The levels of reduction are such that the total dose does not exceed 15 millirem (mrem)/year above Hanford Site background for 1,000 years following remediation. The 1,000-year requirement ensures that the proposed standard accounts for decay of radionuclides to daughter products that are more highly radioactive.
- RAO 2. Protect potential human and ecological receptors from exposure to nonradioactive contaminants present in the upper 4.6 m (15 ft) of soil and debris.
 - Will be achieved by reducing concentrations of contaminants in the upper 4.6 m (15 ft) of soil to the Washington State MTCA Method B levels or alternatives as allowed by MTCA.

- RAO 3. Protect the unconfined groundwater system from adverse impacts by reducing concentrations of radioactive and nonradioactive chemical contaminants present in the soil column that could migrate to the groundwater.
 - Will be achieved by reducing contaminant levels such that concentrations reaching the groundwater do not exceed the Washington State MTCA Method B levels or maximum concentration level (MCL).
- RAO 4. Protection of the Columbia River from adverse impacts so that designated beneficial uses are maintained.
 - Will be achieved by reducing concentrations of, or limiting exposure pathways to, contaminants present in the soil column that could migrate to the groundwater and eventually to the river. Contaminant levels were reduced so that concentrations reaching the river do not exceed MTCA Method B values, MCLs promulgated under the federal [Safe Drinking Water Act](#), Washington State's DWS, ambient water quality criteria, or Washington State's Surface Water Quality Standards (including hexavalent chromium standard of 10 µg/L) ([WAC 173-201A](#)), whichever is most stringent.
- RAO 5. Prevent destruction of significant cultural resources and sensitive wildlife habitat.
 - Will be achieved by performance of cultural and ecological reviews before the start of remedial action activities, and by restricting access to areas not directly required to complete remedial action activities.

ICs for the 100-NR-1 source OU, as required by the interim action RODs (as amended), are described in [DOE/RL-2005-93](#), *Remedial Design Report/Remedial Action Work Plan for the 100-N Area*, Rev. 1, as well as in DOE/RL-2000-16, *Remedial Design Report/Remedial Action Work Plan for the 100-NR-1 Treatment, Storage, and Disposal Units*, and are actively managed. Specific details associated with each IC have also been incorporated into *Sitewide Institutional Controls Plan for the Hanford CERCLA Response Actions and RCRA Corrective Actions* ([DOE/RL-2001-41](#)); this report is routinely updated within 180 days after publication of each decision document that addresses ICs. The ICs implemented for the 100-NR-1 OU include waste-site-specific ICs (e.g., drilling and excavation restrictions for waste sites where residual contamination remains at depth, and an irrigation restriction) and general-areas ICs including access control (i.e., warning notices, entry restrictions), land-use management (i.e., land use, drilling, and excavation restrictions), and miscellaneous provisions. These ICs are assessed annually, and DOE presents a summary including any noted issues or actions to the Site regulators each fall at the unit managers meeting. The presentation is documented in the meeting minutes, which are archived in the Hanford Site Administrative Record (see examples in Attachments 4 and 6 at the following link: <https://pdw.hanford.gov/document/AR-04230>). The annual IC assessments are also now captured in an annual report (e.g., [HNF-65616](#), *FY2020 Sitewide Institutional Control Assessment*). The 100-NR-1 source operable unit waste sites that were inspected during the 2020 assessment included:

- 100-N-31, 100-N-32, 100-N-38, 100-N-50, 100-N-51, 100-N-51B, 100-N-61:3, 100-N-64:3, 100-N-68, 100-N-84:2, 116-N-2, 118-N-1, 124-N-2, UPR-100-N-10, UPR-100-N-12, UPR-100-N-25, UPR-100-N-3, UPR-100-N-37, UPR-100-N-5 and UPR-100-N-7.

During the 5-year review period of 2016 through 2020, appropriate ICs for the 100-NR-1 source OU were found to be in place and maintained, and the objectives for the ICs are being met.

Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of remedy selection still valid?

The exposure assumptions and the interim RAOs used at the time of remedy selection are still valid; they support interim actions to protect adverse conditions until a final remedy can be implemented. The toxicity data and cleanup levels have been reviewed and updated in the Draft B RI/FS ([DOE/RL-2012-15](#)) to support a final remedy selection. The risk assessment evaluations completed for the Draft B RI/FS identified no unacceptable groundwater and surface water, human health, and ecological risks for more than 100 waste sites remediated under the interim remedial actions. This demonstrates the source site interim actions were effective and do not preclude additional actions that may need to be taken for a final remedy.

Has any other information come to light that could call into question the protectiveness of the remedy?

Of the 127 waste sites remediated under the interim remedial actions, 7 have radionuclide concentrations in shallow soil (less than 4.6 m [15 ft] bgs) that met the interim action cleanup levels but exceed a preliminary remediation goal concentration value established in the Draft B RI/FS ([DOE/RL-2012-15](#)) for human health direct contact and 8 waste sites have chemical or radionuclide concentrations in soil greater than 4.6 m (15 ft) bgs that exceed a preliminary remediation goal concentration value for groundwater protectiveness.

Issues/Recommendations During this Review Period

The RAOs and preliminary remediation goals for the interim action RODs in the River Corridor only set cleanup levels based on human health and are not appropriate for a final action ROD. The interim action cleanup requirements for the 100-NR-1 source OU were based on consideration of state MTCA ([WAC 173-340](#), “Unrestricted Land Use Soil Cleanup Standards”) cleanup requirements for chemical contaminants and a dose-based standard of 15 mrem per year for radiological constituents based on DOE guidance for residential exposure (not a risk-based number for radionuclides). Additionally, ecological risks were not considered for the interim action cleanup levels. For purposes of establishing cleanup requirements for a final action ROD for the 100-NR-1 source OU, the Draft B RI/FS ([DOE/RL-2012-15](#)), currently undergoing a comment resolution process with Ecology, reflects the revised MTCA values for chemical contaminants and includes risk-based assessments for human health and ecological exposure in RI/FS Chapters 6 and 7, respectively.

Issue NR1/2-1. A full human health and ecological risk assessment for the 100-NR-1 source OU and 100-NR-2 groundwater OU has not been finalized.

Recommendation-NR1/2-1. Finalize full human health and ecological risk assessments for the 100-NR-1 source OU and 100-NR-2 groundwater OU (Milestone Date: March 30, 2023).

Does this issue/action currently affect the protectiveness of the remedy? – NO.

Will this issue/action affect the protectiveness of the remedy in the future? – YES.

Protectiveness Statements

100-NR-1 Source OU – Will Be Protective. The remedy at the 100-NR-1 source OU is expected to be protective of human health and the environment upon completion of the final remedy. Implementation of the interim remedy (primarily involving RTD, backfilling, recontouring, and revegetation) at the 100-NR-1 OU is ongoing. In the interim, remedial activities completed to date, including ICs, have adequately addressed all exposure pathways that could result in unacceptable risks in these areas.

2.3.5.2 100-NR-2 Groundwater Operable Unit

Background

The 100-NR-2 groundwater OU (previously shown in Figure 2-20) is 1 of 10 groundwater OUs on the Hanford Site and 1 of 6 located in the River Corridor. Groundwater contamination in 100-NR-2 is primarily associated with waste effluents produced by the 105N Reactor and associated waste effluents disposed of in the 100-NR-1 OU waste sites.

The 105N Reactor operated from 1963 to 1987 and was unique among the Hanford Site's plutonium production reactors in that it was a dual-purpose reactor that produced plutonium for defense purposes and steam for generating electrical power. Groundwater contamination in the 100-NR-2 OU primarily consists of strontium-90, nitrate, hexavalent chromium, and tritium produced by the reactor and associated processes. This OU also addresses a total petroleum hydrocarbon (TPH) plume present in the groundwater as result of a release from a fuel storage tank in the 1960s.

COCs for the 100-NR-2 groundwater OU include strontium-90 and TPH-diesel. Monitoring is also performed for nitrate, hexavalent chromium, sulfate, tritium, and manganese.

Groundwater in the 100-NR-2 OU generally flows northwest toward the Columbia River. Groundwater flow is influenced by groundwater extraction and injection for the KX Pump and Treat remediation system located in the southwest portion of the 100-NR-2 OU. A groundwater mound approximately 1 m (3.3 ft) high surrounding the KX injection wells creates local radial flow.

The recent past activities in the 100-NR-2 OU area have been industrial in nature and primarily focused on remediation. Access to the waste site areas and contaminated groundwater is restricted. The Columbia River (adjacent to 100-NR-2 OU) is used for recreational activities such as fishing and boating, and supports a large variety of aquatic and riparian animals and plants.

A summary of the 100-NR-2 groundwater monitoring and remediation, as of 2020, is included in [DOE/RL-2020-60](#), *2020 Hanford Site Groundwater Monitoring Report*, as well as in [DOE/RL-2020-61](#), *Calendar Year 2020 Annual Summary Report for the 100-HR-3 and 100-KR-4 P&T Operations and 100-NR-2 Groundwater Remediation*. Additionally, these annual reports and similar reports for calendar years prior to 2020 can be accessed online as noted below:

- *Hanford Site Groundwater Monitoring Report* published annually to address the previous calendar year and available online at <http://www.hanford.gov/page.cfm/SoilGroundwaterAnnualReports>.
- *Annual Summary Report for the 100-HR-3 and 100-KR-4 P&T Operations and 100-NR-2 Groundwater Remediation* for each prior year can be accessed through the same link at <http://www.hanford.gov/page.cfm/SoilGroundwaterAnnualReports>.

Chronology

Table 2-25 lists the remedial action decision documents associated with the 100-NR-2 groundwater OU as of December 31, 2020.

Table 2-25. Decision Documents for the 100-NR-2 Groundwater Operable Unit.

Date	Location	Title
9/1994	Ecology and EPA 1994	Action Memorandum: N Springs Expedited Response Action Cleanup Plan. This ERA identifies a pump-and-treat system combined with a vertical barrier for implementation at N Springs. These systems are a component of overall N Springs cleanup, but also were intended to provide additional information to the ongoing CERCLA and RCRA processes. This ERA is not a final decision.
9/1999	EPA/ROD/R10-99/112	Interim Remedial Action Record of Decision for the 100-NR-1 and 100-NR-2 Operable Units, Hanford Site, Benton County, Washington. Continue removing strontium-90 through pump-and-treat with ion exchange and discharge treated groundwater upgradient into the aquifer, maintain groundwater monitoring networks to monitor pump-and-treat operations and impacts to groundwater, evaluate technologies for strontium-90 removal and aquatic and riparian receptor impacts from contaminated groundwater, remove petroleum hydrocarbons (free-floating product) from any monitoring well and dispose of at an approved facility, remove petroleum-contaminated solid waste, and dispose of non-hazardous wash/rinse waters to Ecology-approved facilities.
5/2003	EPA/ESD/R10-03/605	Explanation of Significant Difference for the 100-NR-1 Operable Unit Treatment, Storage, and Disposal Interim Action Record of Decision and 100-NR-1/100-NR-2 Operable Unit Interim Action Record of Decision. This ESD removes the IC annual reporting requirements and consolidates reporting with the sitewide IC annual report, eliminates requirement to evaluate applying 76 cm (30 in.) of irrigation water to determine whether remaining contaminants will impact groundwater, and identifies a need for additional ICs to preclude access to contaminated groundwater; these will be incorporated into the sitewide IC document.
9/2010	EPA 2010	U.S. Department of Energy, 100-NR-1 and NR-2 Operable Units, Hanford Site – 100 Area, Benton County, Washington, Amended Record of Decision, Decision Summary and Responsiveness Summary. This amended ROD summary deploys an apatite sequestration technology for remediating strontium-90 in the 100-NR-2 OU by extending the existing apatite permeable reactive barrier to approximately 762 m (2,500 ft), allows for deployment of the apatite sequestration technology elsewhere in the 100-NR-2 OU in accordance with an Ecology-approved work plan, and includes decommissioning the treatment components of the existing 100-NR-2 Pump and Treat System.
7/2019	Ecology et al. 2019	Explanation of Significant Differences for the 100-NR-1 and 100-NR-2 Operable Unit Interim Action Record of Decision, Hanford Site, Benton County, Washington. This ESD allows for miscellaneous solid waste to be collected when generated from the 100-NR-2 groundwater OU, transported, and stored at a central location in the Central Plateau.

CERCLA = Comprehensive Environmental Response,
Compensation and Liability Act of 1980
Ecology = Washington State Department of Ecology
ERA = expedited response action
ESD = explanation of significant difference
IC = institutional control

O&M = operation and maintenance
OU = operable unit
RAO = remedial action objective
RCRA = Resource Conservation and Recovery Act of 1976
ROD = record of decision

See Appendix B for a consolidated list of decision documents for Hanford Site OUs.

Remedial Actions

Goals and Objectives. In accordance with the NCP, “EPA expects to return useable ground waters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site” ([40 CFR 300.430](#)[a][1][iii][F]). EPA generally defers to state definitions of

groundwater classification provided under EPA-endorsed Comprehensive State Groundwater Protection Programs ([EPA/540/G-88/003](#)).

Groundwater from the 100-NR-2 OU is contaminated and is not currently withdrawn from the aquifer for beneficial use; however, the highest potential beneficial use of the groundwater is as a drinking water source. Consistent with the beneficial-use classifications of Washington State and the EPA, the goal for remediating 100-NR-2 OU groundwater is to reduce contaminants to levels that will allow its use as a future drinking water source.

Based on the expectations for 100-NR-2 groundwater restoration, the interim RAOs, as stated in the interim remedial action ROD ([EPA 1999](#) as amended), are as follows:

- RAO 1. Protect the Columbia River from adverse impacts from the 100-NR-2 groundwater so that designated beneficial uses of the Columbia River are maintained. Protect associated potential human and ecological receptors using the river from exposure to radioactive and nonradioactive contaminants present in the unconfined aquifer. Protection will be achieved by limiting exposure pathways, reducing or removing contaminant sources, controlling groundwater movement, or reducing concentrations of contaminants in the unconfined aquifer.
- RAO 2. Protect the unconfined aquifer by implementing remedial actions that reduce concentrations of radioactive and nonradioactive contaminants present in the unconfined aquifer.
- RAO 3. Obtain information to evaluate technologies for strontium-90 removal and evaluate ecological receptor impacts from contaminated groundwater (by October 2004).

NOTE: In accordance with [DOE/RL-2001-27](#), Rev. 1, this RAO was achieved with the issuance of [FH-0403540](#), “Transmittal of the Draft Letter Report, Evaluation of Strontium-90 Treatment Technologies for the 100-NR-2 Groundwater Operable Unit,” and [DOE/RL-2006-26](#), *Aquatic and Riparian Receptor Impact Information for the 100-NR-2 Groundwater Operable Unit*. In 2006, Ecology, EPA, and DOE approved placing the pump-and-treat system in cold-standby status and constructing a permeable reactive barrier (PRB). A 90-m (295-ft) long apatite PRB was completed as a treatability test in accordance with [DOE/RL-2005-96](#), *Strontium-90 Treatability Test Plan for 100-NR-2 Groundwater Operable Unit*. Based on the treatability test results ([PNNL-17429](#), *Interim Report: 100-NR-2 Apatite Treatability Test: Low-Concentration Calcium-Citrate-Phosphate Solution Injection for In Situ Strontium-90 Immobilization*; [PNNL-SA-70033](#), *100-NR-2 Apatite Treatability Test FY09 Status: High-Concentration Calcium-Citrate-Phosphate Solution Injection for In Situ Strontium-90 Immobilization*), the apatite technology showed promise as a remediation option. As a result, the interim action ROD was amended in 2010 to allow for expansion of the apatite barrier and permanent decommissioning of the 100-NR-2 Pump and Treat System.

- RAO 4. Prevent destruction of sensitive wildlife habitat. Minimize the disruption of cultural resources and wildlife habitat in general and prevent adverse impacts to cultural resources and threatened or endangered species.

Remedy Components. The current interim action is a blend of remedy components that were first identified in the initial interim action ROD ([EPA/ROD/R10-99/112](#)), then amended by *U.S. Department of Energy 100-NR-1 and NR-2 Operable Units, Hanford Site – 100 Area, Benton County, Washington* ([EPA 2010](#)) to include new activities while retaining some of the original remedy components. A consolidated description of the remedy components can be found in [DOE/RL-2001-27](#), *Remedial Design/Remedial Action Work Plan for the 100-NR-2 Operable Unit*, latest version as of publication date

of this 5-year review. This RD/RAWP was approved by both DOE and Ecology (the Tri-Party Agreement lead regulating agency for the 100-NR-2 OU) in July 2016. For purposes of this 5-year review, selected and, for some remedy components, abbreviated narrative from the RD/RAWP were used as the primary source for the following remedy components descriptions.

Extend Apatite Permeable Reactive Barrier. Extend the length of the existing apatite PRB from 311 m (1,020 ft) to approximately 760 m (2,500 ft). Perform additional apatite injections at a subset of injection well locations within 5 years of completing all first-round apatite injections, as determined through performance monitoring of the PRB in both the saturated and vadose zones.

Decommission the Pump-and-Treat System. Concurrent with or following extension of the apatite PRB, DOE will decommission the treatment components of the existing 100-NR-2 OU Groundwater Pump and Treat System. The decommissioning work will include removing any residual ion exchange media and disposing of it at ERDF, dismantling all noncontact treatment system hardware and salvaging reusable components, and cutting the high-density polyethylene conveyance piping into short lengths for transport to and disposal at ERDF. Wells will remain in place and be reconfigured as monitoring wells. The status of the decommissioning work will be provided at unit managers' meetings and summarized in a future Hanford Site groundwater monitoring and performance report or an interim action status report.

Perform Groundwater Monitoring. Long-term and routine monitoring for the 100-NR-2 OU under [CERCLA](#) are ongoing, conducted in accordance with approved sampling and analysis plans (SAP) and further described in [DOE/RL-2001-27](#), latest version as of publication date.

Allow MNA for Strontium-90 in Groundwater Upgradient of the PRB. MNA is the reliance on natural processes, within the context of a carefully controlled and monitored cleanup, to reduce the mass, toxicity, mobility, volume, and/or concentration of contaminants in affected media. MNA will play an important role in upland groundwater remediation of strontium-90 (radioactive decay and sorption to aquifer materials). Because strontium-90 is strongly retarded and has a relatively short half-life, the majority of the strontium-90 present in the aquifer and associated sediments upgradient of the apatite PRB will attenuate in place through radioactive decay. MNA will be used to monitor this plume and confirm that strontium-90 concentrations decline as expected; it also will be used to monitor and confirm the rate of natural degradation. Monitoring of the MNA will be conducted in accordance with the well network and schedule outlined in [EPA/ROD/R10-99/112](#). Long-term monitoring results will be presented in future Hanford Site groundwater monitoring and performance reports.

Remove Free-Phase Petroleum Hydrocarbon. [EPA/ROD/R10-99/112](#) requires the remediation of free-phase hydrocarbon product (i.e., diesel) observed in any 100-N Area monitoring well. Normally, petroleum product cleanup is regulated under [RCRA](#) corrective action, not [CERCLA](#) remedial action. However, as discussed in the Tri-Party Agreement ([Ecology et al. 1989](#)), the [CERCLA](#) remedial actions will meet the technical requirements of [RCRA](#) corrective actions. This remedy element currently consists of removing TPH-diesel from well 199-N-18. If TPH-diesel is observed in other wells, this remedy would apply in those cases. The passive remediation approach involves the use of a polymer (Smart Sponge[™]) that selectively absorbs petroleum product from the surface of water. Every 2 months, two sponges are lowered to the surface of the water table in well 199-N-18. The sponges are weighed both before insertion and after removal from the well; the difference in weight represents the amount of diesel fuel contamination removed from the well.

Institutional Controls. The remedy selected in [EPA/ROD/R10-99/112](#) requires the maintenance of ICs. The following ICs are required as part of the interim action ROD, as amended:

[™]Smart Sponge is a trademark of AbTech Industries, Scottsdale, Arizona.

- DOE will continue to use a badging program and control access to the sites associated with the interim action ROD for the duration of the interim action. Visitors entering any of the sites associated with the interim action ROD must be escorted at all times.
- DOE will use the onsite excavation permit process to control land use, well drilling, and soil excavation within the 100 Area OUs to prohibit any drilling or excavation except as approved by Ecology.
- DOE will maintain existing signs prohibiting public access.
- Trespass incidents will be reported to the Benton County Sheriff's Office for investigation and evaluation for possible prosecution.
- DOE will notify Ecology on discovery of any trespass incidents.
- DOE will take the necessary precautions to add access-restriction language to any land transfer, sale, or lease of property that the U.S. Government considers appropriate while ICs are compulsory, and Ecology will have to approve any access restrictions before transfer, sale, or lease.
- Until final remedy selection, DOE shall not delete or terminate any IC requirement established in the interim action ROD unless Ecology has provided written concurrence on the deletion or termination and appropriate documentation has been placed in the Administrative Record. DOE shall evaluate the implementation and effectiveness of ICs for the 100-NR-1 source OU on an annual basis. DOE shall submit a report to EPA and Ecology, as required by [DOE/RL-2001-41](#), summarizing the results of the evaluation for the preceding calendar year. At a minimum, the report shall contain an evaluation of whether the IC requirements continue to be met and describe any deficiencies discovered and corrective measures taken.

Maintain Riprap Cover. DOE will maintain the existing riprap cover placed over the historical groundwater seeps and springs along the shoreline. Maintenance will consist of periodic visual monitoring of the riprap cover along the shoreline and replacing any eroded cover material. Any maintenance performed will be described in future annual Hanford Site groundwater monitoring and performance reports.

Remedy Implementation Progress Prior to this Review Period. The 100-NR-2 remediation scope began with a pump-and-treat system to remove strontium-90 from groundwater. The pump-and-treat system operated from 1995 to 2006 when the system was placed into cold-standby status to facilitate a treatability test for construction of an apatite PRB along the 100-N Area shoreline. Based on the treatability test results, the apatite technology showed promise as a remediation option. The initial apatite PRB was constructed from 2006 through 2008 for the treatability test, which placed a 91-m (300-ft) long apatite PRB along the 100-N Area shoreline. The Tri-Party Agencies amended the interim action ROD in 2010 to allow for permanent decommissioning of the 100-NR-2 OU Pump and Treat System and expansion of the existing PRB from approximately 91 m (300 ft) long to 760 m (2,500 ft) long. Additional detail on this earlier period of remediation can be found in the previous 5-year review report ([DOE/RL-2016-01](#), Rev.0).

Issues/Corrective Actions from the Previous 5-Year Review. The previous [CERCLA](#) 5-Year Review report ([DOE/RL-2016-01](#)) for the period of 2011 through 2015 included the following issue and corrective action for the 100-NR-2 groundwater OU:

- **Issue NR2-1.** *Permeable reactive barrier test has not been expanded from 1,000 ft to 2,500 ft.*
- **Corrective Action NR2-1.** *Complete full implementation of the permeable reactive barrier (Action Due Date: September 30, 2018).*

As of December 2020, full implementation of the PRB had not been completed. The [National Historic Preservation Act of 1966](#) (NHPA) Section 106 reviews for re-injection and expansion of the PRB were conducted during FY 2017 and 2018. Several consultation meetings were held with the Tribes, but a memorandum of agreement could not be reached for full implementation of the permeable reactor barrier. During this period, the remedial alternatives evaluated for preparation of the Draft B remedial investigation and feasibility study identified implementing a 670-m (2,200-ft) long PRB to achieve the RAOs rather than a 760-m (2,500-ft) long PRB. For these reasons, it was decided to defer further consultation on remedy implementation until additional information on remedy decision becomes available with completion of the 100-N remedial investigation and feasibility study and a final ROD determination. This decision to defer expansion of the PRB is under review.

Protectiveness Statement from the Previous (2011-2015) 5-Year Review Report ([DOE/RL-2016-01](#)).

The protectiveness statement from the previous (2011-2015) 5-year review report for the 100-NR-2 groundwater OU was as follows:

***100-NR-2 Groundwater OU -- Not Protective.** The interim remedy at the 100-NR-2 OU source is not protective because expansion of the permeable reactive barrier remedy-component for addressing strontium-90-contaminated groundwater has not been completed. Approximately 1,000 ft of the 2,500-ft-long barrier have been installed at the time of this report. The action necessary to address protectiveness (per the interim ROD) is to complete the apatite-forming chemical injections at 1,500 ft of the 2,500-ft-long permeable reactive barrier. To address TPH-diesel contamination, in situ bioventing system operations and the free-product removal operations are under way to reduce contaminant mass in the lower vadose zone and groundwater, respectively. Additionally, ICs are in place and are preventing human exposure to the groundwater. Groundwater monitoring and MNA also are under way and will continue to help determine a comprehensive final remedy for 100-NR-2 groundwater.*

Progress Since the 2011-2015 Review

Accomplishments. The primary remedial action accomplishments for the 100-NR-2 groundwater OU during the past 5 years can be summarized as follows:

- Continued groundwater monitoring and management of ICs as interim remedy components under the interim action ROD.
- Continued performance of interim actions for cleanup of strontium-90 and TPH-diesel in 100-NR-2 groundwater. Additionally, the following document-related accomplishments during this 5-year review period are worth noting:
 - Submitted [DOE/RL-2012-15](#), *Remedial Investigation Feasibility Study for 100-NR-1 and 100-NR-2 Operable Units*, Draft B, to Ecology for review in 2019. Ecology transmitted comments to DOE on July 9, 2020; DOE has since been working with Ecology to disposition review comments to issue Revision 0 of the RI/FS.

- Issued [DOE/RL-2001-27](#), *Remedial Design Report/Remedial Action Work Plan for the 100-NR-2 Operable Unit*, Rev. 2, in 2016. This second revision updates the previous remedial design/remedial action work plan for the 100-NR-2 groundwater OU and includes an updated sampling analysis plan.

Additional narrative on 100-NR-2 OU accomplishments relative to each RAO (as of 2020) can be viewed in [DOE/RL-2020-61](#), *Calendar Year 2020 Annual Summary Report for the 100-HR-3 and 100-KR-4 Pump and Treat Operations and 100-NR-2 Groundwater Remediation*.

Remedy Implementation. Implementation of the interim remedy components was conducted under the RDR/RAWP for the 100-NR-2 OU ([DOE/RL-2001-27](#)). While detailed status about the implementation of the 100-NR-2 OU remedy components is routinely provided in the Hanford Site's annual groundwater monitoring report (e.g., DOE/RL-2020-60) and DOE/RL-2020-61, *Annual Summary Report for the 100-HR-3 and 100-KR-4 Pump-and-Treat Operations, and 100-NR-2 Groundwater Remediation*, the following is a summary-level overview.

Extend Apatite Permeable Reactive Barrier. When the expedited response action for N Springs was issued in 1994, the approved cleanup alternative for strontium-90 in groundwater involved applying pump-and-treat and a vertical barrier. The 100-NR-2 Groundwater Pump and Treat System was constructed in 1995 and operated from 1995 until 2006. The system removed approximately 1.8 Ci of strontium-90 from the aquifer, which was less than the amount removed by radioactive decay during the same period. Because strontium-90 binds strongly to the sediment, the pump-and-treat system was not effective in removing strontium-90 from the aquifer. One of the requirements of the interim action ROD was to evaluate alternative technologies for groundwater cleanup. Therefore, in 2006, Ecology, EPA, and DOE approved placing the pump-and-treat system in cold standby status and constructing a PRB. A 90-m (300-ft) long apatite PRB was completed as a treatability test in accordance with [DOE/RL-2005-96](#), *Strontium-90 Treatability Test Plan for 100-NR-2 Groundwater Operable Unit*.

Based on the treatability test results ([PNNL-17429](#), *Interim Report: 100-NR-2 Apatite Treatability Test: Low-Concentration Calcium-Citrate-Phosphate Solution Injection for In Situ Strontium-90 Immobilization*; [PNNL-SA-70033](#), *100-NR-2 Apatite Treatability Test FY02 Status: High-Concentration Calcium-Citrate-Phosphate Solution Injection for In Situ Strontium-90 Immobilization, Interim Report*), the apatite technology showed promise as a remediation option. As a result, the interim action ROD was amended in 2010 to allow for expansion of the apatite barrier and permanent decommissioning of the 100-NR-2 Pump and Treat System.

The original, 90-m (300-ft) long apatite PRB was created by injecting apatite-forming solutions into 16 wells from 2006 through 2008 ([PNNL-19572](#), *100-NR-2 Apatite Treatability Test: High-Concentration Calcium-Citrate-Phosphate Solution Injection for In Situ Strontium-90 Immobilization, Final Report*). The expanded apatite PRB well network was installed between late 2009 and early 2010, extending the original barrier well network both upriver and downriver for a total length of 760 m (2,500 ft). No apatite solutions were injected into these wells during the expansion of the barrier well network.

In September 2011, apatite solutions were injected into 24 wells upriver and 24 wells downriver of the original barrier in accordance with [DOE/RL-2010-29](#), *Design Optimization Study for Apatite Permeable Reactive Barrier Extension for the 100-NR-2 Operable Unit*, extending the length of the apatite PRB to approximately 311 m (1,020 ft). These injections extended the apatite PRB along the 100-N shoreline to intercept the strontium-90 groundwater plume before it reaches the river. Performance of all three barrier segments (upriver, central [original], and downriver) is monitored annually.

In 2009, a field demonstration was completed to evaluate potential strategies for jet injection of three different media:

- A phosphate-only solution
- Preformed apatite
- Phosphate combined with preformed apatite ([SGW-47062](#), *Treatability Test Report for Field-Scale Apatite Jet Injection Demonstration for the 100-NR-2 Operable Unit*).

The injections were conducted upgradient of the existing apatite PRB within a moderate-concentration region of the strontium-90 plume. The solutions were injected into the vadose zone and the upper portion of the unconfined aquifer. Sediment cores were collected from four boreholes located within the test plot footprints. Results from collected sediment cores indicated that jet injection is a viable method for emplacing phosphate and preformed apatite in the vadose zone. The details of the core analyses are provided in [PNNL-19524](#), *Hanford 100-N Area In Situ Apatite and Phosphate Emplacement by Groundwater and Jet Injection: Geochemical and Physical Core Analysis*.

Based on the results from the treatability tests documented in [SGW-47062](#), [DOE/RL-2010-68](#), *Jet Injection Design Optimization Study for 100-NR-2 Groundwater Operable Unit*, was developed. [DOE/RL-2010-68](#) includes a detailed design for the vertical extension of the PRB into the unsaturated vadose zone.

Apatite solutions have not been jet-injected in the vadose zone. Plans for further expansion of the apatite barrier via saturated zone and vadose zone injections and associated PRB performance monitoring are outlined in [DOE/RL-2001-27](#), latest version. The barrier was expanded in accordance with a design optimization study ([DOE/RL-2010-29](#)), which had seven objectives for evaluating barrier implementation and effectiveness. Data from the injections and subsequent performance monitoring are used to evaluate these objectives.

As of December 2020, full implementation of the PRB has not been completed. The NHPA Section 106 reviews for re-injection and expansion of the PRB were conducted during FY 2017 and 2018. Several consultation meetings were held with the Tribes, but a memorandum of agreement could not be reached for full implementation of the permeable reactor barrier. During this period, the remedial alternatives evaluated for preparation of the Draft B remedial investigation and feasibility study identified implementing a 670-m (2,200-ft) long PRB to achieve the RAOs rather than a 760-m (2,500-ft) long PRB. For these reasons, it was decided to defer further consultation on remedy implementation until additional information on remedy decision becomes available with completion of the 100-N remedial investigation and feasibility study and a final ROD determination.

Decommission the Pump-and-Treat System. In accordance with [DOE/RL-2001-27](#), decommissioning planning was initiated in 2014. The 100-NR-2 Pump and Treat System demolition, excavation, and removal was completed in 2017. The site was revegetated in 2019.

Perform Groundwater Monitoring. Groundwater monitoring included final status detection monitoring at the 1301-N, 1324-N/NA, and 1325-N facilities (waste sites 116-N-1, 120-N-1, 120-N-2, and 116-N-3) to meet requirements of [RCRA](#) and [WAC 173-303](#), “Dangerous Waste Regulations.” The 1301-N Crib and Trench and 1325-N Crib and Trench [RCRA](#) sites have undergone [RCRA](#) closure, and the requirements were removed from the permit in December 2018 ([19-ESQ-0024](#), *Class 1 Modifications to the Hanford Facility Resource Conservation and Recovery Act Permit, Quarter Ending December 31, 2018*). The 1324-N and 1324-NA [RCRA](#) sites have undergone [RCRA](#) closure and were removed from the Hanford

[RCRA](#) Permit in June 2018 ([18-ESQ-0079](#), *Class 1 Modifications to the Hanford Facility Resource Conservation and Recovery Act Permit, Quarter Ending June 30, 2018*). Groundwater monitoring of the waste sites continues as part of the [CERCLA](#) groundwater monitoring program for the 100-NR-2 OU. Performance monitoring of the PRB continued during high-river and low-river stages with details provided in the annual groundwater monitoring reports.

Allow MNA for Strontium-90 in Groundwater Upgradient of the PRB. Strontium-90 in the aquifer is naturally attenuating through radioactive decay. Groundwater monitoring wells are periodically sampled to assess the ongoing decline in contaminant concentrations within the groundwater OU.

Remove Free-Phase Petroleum Hydrocarbon. TPH-diesel groundwater contamination is the result of a 1966 diesel fuel spill at unplanned release site UPR-100-N-17. Removal of petroleum hydrocarbon light, nonaqueous-phase liquid from well 199-N-18 continued. In 2017, smart sponge assemblies were also installed in well 199-N-183, which was drilled near well 199-N-18 as a replacement well. Total product removal since this activity began in October 2003 through the end of 2020 is 20.9 kg (46.1 lb).

Institutional Controls. Implemented ICs include entry restrictions (security), escorts, and badging of site visitors; drilling and excavation restrictions; surveillance; posted signs; and deed notifications to restrict land and groundwater use ([DOE/RL-2001-27](#)).

Maintain Riprap Cover. The riprap cover was placed over the groundwater seeps and springs to prevent erosion of the river shoreline. Maintenance, which could include moving or adding riprap, will be conducted, if needed, to prevent erosion of the river shoreline ([DOE/RL-2001-27](#)). The existing riprap cover is being maintained and no issues have been noted during this review period (DOE/RL-2020-61). Table 2-26 presents an overview of the primary components of the 100-NR-2 remedy and their implementation status.

Table 2-26. Overview of 100-NR-2 Operable Unit Interim Action Remedy Implementation.
(2 Pages)

Document Type	Date	Title
Interim Action ROD	9/1999, amended 9/2010	(EPA 2010), <i>Interim Remedial Action Record of Decision for the 100-NR-1 and 100-NR-2 Operable Units, Hanford Site, Benton County, Washington</i>
RD/RAWP	07/2016	(DOE/RL-2001-27), <i>Remedial Design/Remedial Action Work Plan for the 100-NR-2 Operable Unit, latest version as of publication</i>
Applicable RAOs (brief description)	1. Protect the Columbia River from adverse impacts from the 100-NR-2 groundwater OU so designated beneficial uses of the Columbia River are maintained. Protect associated potential human and ecological receptors using the river from exposure to radioactive and nonradioactive contaminants present in the unconfined aquifer. Protection will be achieved by limiting exposure pathways, reducing or removing contaminant sources, controlling groundwater movement, or reducing concentrations of contaminants in the unconfined aquifer. 2. Protect the unconfined aquifer by implementing remedial actions that reduce concentrations of radioactive and nonradioactive contaminants present in the unconfined aquifer. 4. Restore groundwater impacted by Hanford Site releases to cleanup levels that include DWSs, within a reasonable timeframe given the particular circumstances of the site.	
COCs	Strontium-90, TPH	

Table 2-26. Overview of 100-NR-2 Operable Unit Interim Action Remedy Implementation.
(2 Pages)

Remedy Component	Status (approximate percentage complete for implementing the remedy component as of December 2020) ^a						Duration of O&M (~years) ^b	Finish (Est'd year) ^c
	0	1-25	26-50	51-75	76-99	100%		
Extend Apatite Barrier to 2,500 ft							N/A	2029
Decommission Pump & Treat System							N/A	2017
Groundwater Monitoring							115	2125
MNA for Sr-90 (upgradient)							300	2310
Remove Total Petroleum Hydrocarbons							TBD	TBD
Institutional Controls							300	2310
Maintain Riprap Cover							300	2310

^a Percentages reflect implementation status of the remedy component; post-startup upgrades and system performance optimization is considered part of O&M. 100% = fully implemented and now in O&M mode.

^b Approximate number of years to operate remedy component as estimated in ROD (shorter durations for certain COCs) or RD/RAWP.

^c Estimated year when remedy component will be completed.

DOE/RL-2001-27. 2016, *Remedial Design Report/Remedial Action Work Plan for the 100-NR-2 Operable Unit*, Rev. 2, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0075571H>.

EPA, 2010, *Interim Remedial Action Record of Decision for the 100-NR-1 and 100-NR-2 Operable Units, Hanford Site, Benton County, Washington*, U.S. Environmental Protection Agency, Region 10, Seattle, Washington, Available online at <https://pdw.hanford.gov/document/0084198>.

COC	= contaminant of concern	OU	= operable unit
DWS	= drinking water standards	RAO	= remedial action objectives
MNA	= monitored natural attenuation	RD/RAWP	= remedial design/remedial action work plan
N/A	= not applicable	ROD	= record of decision
O&M	= operation and maintenance	TBD	= to be determined

Technical Assessment

Is the remedy functioning as intended by the decision documents?

No, the interim remedy is not completely functioning as intended because it is still in the process of being implemented. The pump-and-treat remedy selected in the 1999 ROD did not function within the specified RAOs; as a result, the 1999 ROD was amended. The 2010 amended-ROD revised the selected interim remedial action for the strontium-90 groundwater contamination in the 100-NR-2 OU. The amended-ROD selected the PRB technology to sequester strontium-90 (supporting achievement of RAO 1). The monitoring results for the current 305-m (1,000-ft) long PRB remedy indicate that the barrier shows promise in meeting the RAOs. Field construction of the current remedy components to extend the apatite barrier will continue beyond this 5-year review period. Remedy components involving groundwater monitoring, MNA for strontium-90, removal of TPHs, ICs, and maintenance of the N Springs riprap cover have been implemented.

Table 2-27 provides an overview of 100-NR-2 contaminant plume areas and associated changes to the areas during this 5-year review period. The network of wells sampled in 2020 is shown in Figure 2-22. Plume maps in Figure 2-23 show the changes in plume shapes and areas during this 5-year review period. The plots in Figure 2-24 depict the estimated annual changes in contaminant plume areas over the past several 5-year periods. The strontium-90 plume area has been relatively constant since 2003. The nitrate plume area has increased during the past 5 years. The plume area increase is associated with change in the

plume interpretation where the isolated inland hotspots in the 2015 interpretation are connected with the larger plume. The TPH diesel plume area has remained relatively constant during the past 5 years. Hexavalent chromium and filtered total chromium continued to be detected below the 48 µg/L MTCA standard in wells monitoring the unconfined aquifer. This chromium is not believed to be associated with 100-NR waste sites. This chromium contamination migrated inland while the 116-K-2 trench was in use and a groundwater mound was present. A portion of this 100-KR chromium plume has migrated northward into the 100-NR Area. Only one well in the 100-N Area, well 199-N-80 in a semi-confined aquifer, had dissolved chromium above the federal DWS (100 µg/L) in 2020; this water-bearing zone has not been identified in surrounding wells and boreholes and is not believed to be laterally continuous. Manganese and sulfate associated with reducing conditions created by the TPH plume continue to be detected above their respective secondary DWSs at wells located within the TPH plume area. The maximum concentrations for manganese and sulfate in 2020 were 7.59 and 722 mg/L, respectively. While the tritium plume area was not calculated because tritium is infrequently detected at concentrations greater than 20,000 pCi/L, tritium concentrations have declined in the aquifer tube cluster where elevated concentrations were observed since 2013. The declining concentrations suggests that an isolated slug of tritium is moving through the area as a result of the addition of dust-suppression water during deep excavation remediation of waste sites between the reactor and the river ([DOE/RL-2019-66](#)).

More detailed information on the 100-NR-2 groundwater OU well locations, distribution of contaminant concentrations within each plume, and historic trends associated with each 100-NR-2 OU COCs, as well as for performance metrics associated with 100-NR-2 OU groundwater treatment, is available in the *Hanford Site Groundwater Monitoring Report* (published each summer for the previous calendar year). The reports are available at <http://www.hanford.gov/page.cfm/SoilGroundwaterAnnualReports>.

Approximately 311 m (1,020 ft) of the apatite PRB have been treated. As of 2020, the strontium-90 concentrations were still considerably lower in the wells monitored along the central segment of the barrier than before the injections started in 2008. The treatability test plan objective for the PRB was a 90% reduction in strontium-90 concentrations in the performance monitoring wells; this objective has not yet been fully met. The 2020 data indicate that the strontium-90 concentrations in two of the four wells monitored along the central section of the barrier have been reduced by approximately 90%. Since injection of apatite forming chemicals in the central section of the barrier, the percent reduction in strontium-90 in all four wells ranged from 66% to 97%. In 2020, the percent reduction in strontium-90 concentration in monitoring wells along the upriver barrier extension ranged from 57% to 96%. The downriver barrier segment monitoring wells indicated 77% strontium-90 reduction from pre-injection concentrations in one of the four monitoring wells; the other three monitoring wells showed increasing trends in 2020 and rebounded to pre-injection concentrations in two of the monitoring wells. Ongoing monitoring will allow the determination of the continued effectiveness of the apatite barrier and support decisions regarding additional future apatite treatments and need for reinjection.

Table 2-27. Overview of 100-NR-2 Groundwater Contaminant Plumes.^a

Groundwater Contaminant	Water Quality Standard	Maximum Concentration (2020)	Plume Area ^b (km ²)			Shoreline Intersection ^c (m)		
			2015	2020	Change	2015	2020	Change
Strontium-90	8 pCi/L ^d	15,700 pCi/L	0.64	0.63	-0.01	670	699	29
Nitrate	45 mg/L ^e	279 mg/L	0.55	0.66	0.11	80	213	133
Diesel (as TPHs)	0.5 mg/L ^f	19.9 mg/L	0.02	0.02	0.00	60	53	-7
Hexavalent Chromium	48 µg/L / 10 µg/L ^g	124 µg/L ^h	0.0/0.49 ⁱ	0.0/0.55	U/0.15	0	0	N/A
Sulfate	250 mg/L ^d	722 mg/L	N/C ^j	N/C ^j	N/C ^j	N/C ^j	N/C ^j	N/C ^j
Manganese	50 µg/L	7,590 µg/L	N/C ^j	N/C ^j	N/C ^j	N/C ^j	N/C ^j	N/C ^j
Tritium	20,000 pCi/L ^d	171,000 pCi/L	N/C ^j	<0.01	N/A	N/C	54	N/A

^a Source: Hanford annual groundwater monitoring reports for 2015 and 2020, available at

<http://www.hanford.gov/page.cfm/SoilGroundwaterAnnualReports>.

^b Estimated area at a concentration greater than the listed cleanup level.

^c Length of Columbia River shoreline at 100-NR that is intersected by contaminant plumes.

^d Drinking water standard; secondary drinking water standard for sulfate.

^e 45 mg/L (expressed as the nitrate ion) is an equivalent concentration to the federal drinking water standard for nitrate of 10 mg/L (expressed as nitrate-nitrogen). To convert nitrate as the nitrate ion, the nitrate-nitrogen drinking water standard value is multiplied by 4.43.

^f MTCA Method A for TPH-diesel range organics.

^g 48 µg/L MTCA standard (WAC 173-340), 10 µg/L surface water standard per WAC 173-201A, "Water Quality Standards for Surface Waters in the State of Washington."

^h Maximum values in the semi-confined and unconfined aquifer are listed.

ⁱ Includes one hexavalent chromium plume completely within the 100-NR Area. Excludes plume partially within the 100-KR Area as it is believed to have origins in the 100-KR Area.

^j Not calculated since standard is a secondary drinking water standard and detected contamination is associated with reducing conditions created by the TPHs plume.

WAC 173-201A, "Water Quality Standards for Surface Waters of the State of Washington," *Washington Administrative Code*, as amended. Available online at <http://apps.leg.wa.gov/WAC/default.aspx?dispo=true&cite=173-201A>.

WAC-173-340, "Model Toxics Control Act – Cleanup," *Washington Administrative Code*, as amended. Available online at <http://apps.leg.wa.gov/WAC/default.aspx?cite=173-340>.

DWS	= drinking water standards	N/C	= not calculated
MTCA	= Model Toxics Control Act	TPH	= total petroleum hydrocarbon
N/A	= not applicable	U	= undefined.

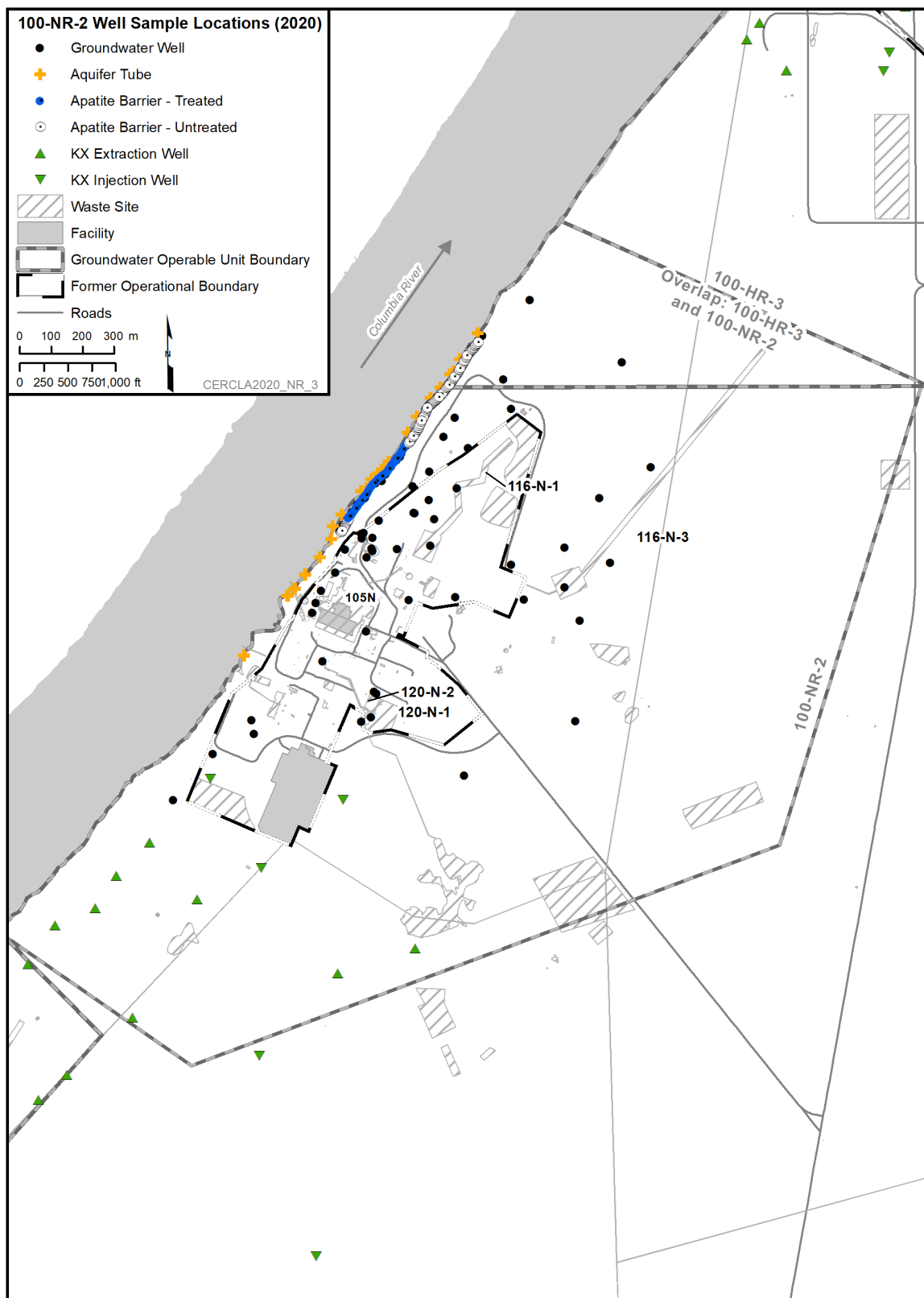


Figure 2-22. Locations of 100-NR-2 Wells and Aquifer Tubes Sampled in 2020.

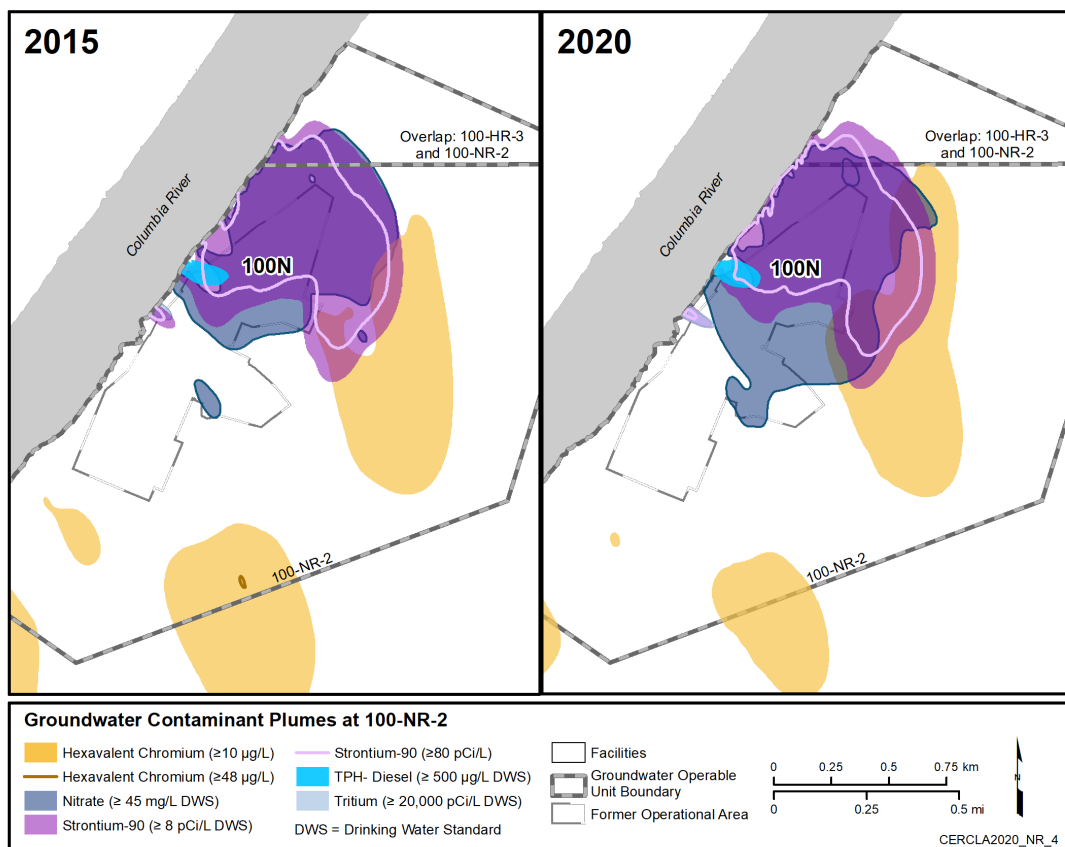


Figure 2-23. 100-NR-2 Groundwater OU Plumes in 2015 (left) and 2020 (right).

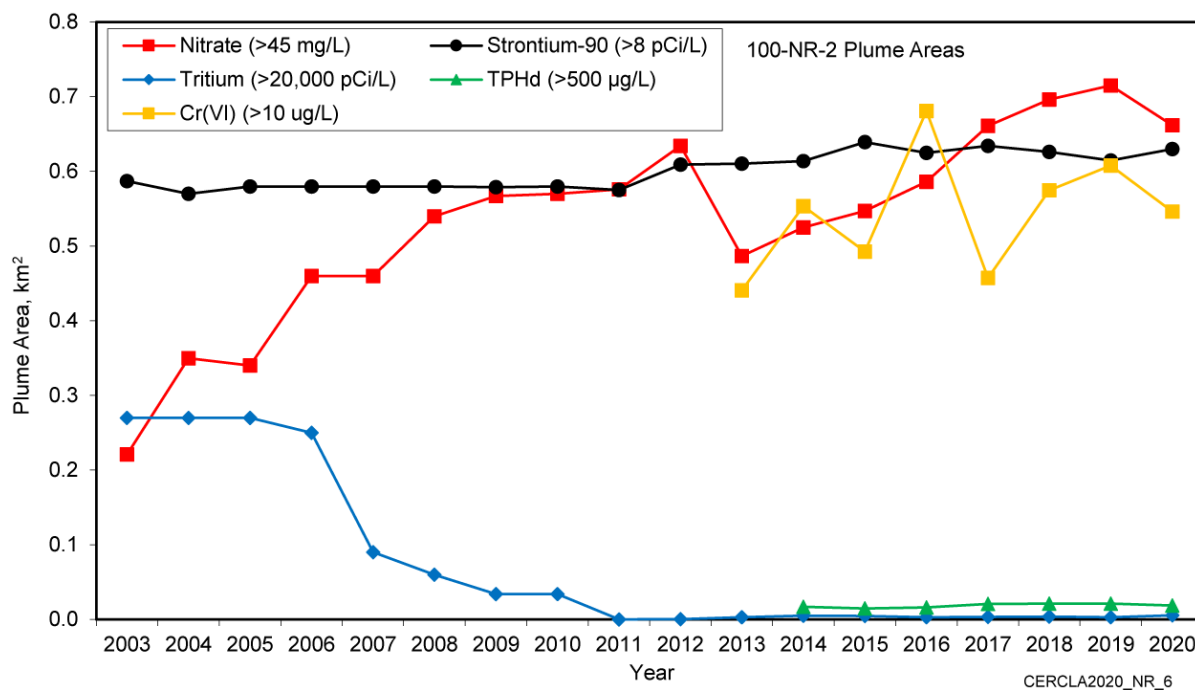


Figure 2-24. 100-NR-2 Trend Plots of Contaminant Plume Areas (2003-2020).

Delays in expanding the treated zone of the PRB from 305 to 762 m (1,000 to 2,500 ft) are associated with traditional cultural property issues. [DOE/RL-2001-27](#), Rev. 1, of the RD/RAWP, was approved and issued in September 2014 to implement the recommendations from the *Design Optimization Study for Apatite Permeable Reactive Barrier Extension for the 100-NR-2 Operable Unit* ([DOE/RL-2010-68](#)). However, effective January 2014, a revised traditional cultural property boundary encompassed the PRB project area; cultural review of the project activities, addressing the requirements of the NHPA Section 106 process (specifically [36 CFR 800.3](#) through [800.5](#)), deemed the project to have an “adverse effect” on the traditional cultural property, as defined in [36 CFR 800.5\(b\)](#). Therefore, the work involved in expanding the barrier is dependent on completion of the NHPA, Section 106, reviews and is subject to schedule delays pending establishment of a memorandum of agreement to conduct the project activities deemed to have an adverse effect on the traditional cultural property. Collectively, this is viewed as potentially challenging the achievement of RAO 4, which includes preventing adverse impacts to cultural resources. RD/RAWP ([DOE/RL-2001-27](#), Rev. 2) was published in July 2016 and updates the anticipated period of performance for expansion of the barrier in FY 2017 and 2018 (following completion of NHPA). As of December 2020, full implementation of the PRB has not been completed. The NHPA Section 106 reviews for re-injection and expansion of the PRB were conducted during FY 2017 and 2018. Several consultation meetings were held with the Tribes but a memorandum of agreement could not be reached for full implementation of the permeable reactor barrier. DOE intends to continue with consultation on remedy implementation.

Per DOE/RL-20120-61, the following status applies to 100-NR-2 as of December 2020, relative to each RAO.

- RAO 1. Protect the Columbia River from adverse impacts from the 100-NR-2 OU groundwater so designated beneficial uses of the Columbia River are maintained.
 - The PRB captures strontium-90 contamination moving in groundwater along the treated section of the shoreline with the highest historical groundwater contamination. Strontium-90 concentrations in some monitoring wells near the apatite PRB temporarily increased in response to the apatite injections, as was expected. Concentrations in the majority of the monitoring wells during 2020 were lower than pre-injection levels, declining from pre-injection levels by 64% to 97%. However, in 2015, strontium-90 concentrations increased in some monitoring wells and remained elevated, with concentrations in three monitoring wells at pre-injection levels in 2020. DOE plans to reinject apatite into poor-performing sections of the PRB and to expand the PRB in the future once the final action ROD is approved.
 - Free product removal and bioremediation continue to reduce TPH contaminant mass in groundwater and the lower vadose zone.
- RAO 2. Protect the unconfined aquifer by implementing remedial actions that reduce concentrations of radioactive and nonradioactive contaminants in the unconfined aquifer.
 - The apatite PRB was installed along the section of the 100-N Area shoreline with the highest historical groundwater contamination. The injection design emplaces sufficient apatite in the PRB to sequester strontium-90 flux to the river for the duration needed for the upland strontium-90 groundwater contamination to naturally decay.

- Smart sponges used in wells 199-N-18 and 199-N-183 removed a total of 1,090 g (2.4 lb) of TPH-diesel free product in 2020. Since the start of free product removal, 20.9 kg (46.0 lb) of TPH-diesel has been removed through the end of 2020.
- A full-scale bioventing system for remediating TPH-diesel in the deep vadose zone near waste site UPR-100-N-17 was implemented in December 2012, and the system continued operating in 2020.
- RAO 3. Obtain information to evaluate technologies for strontium-90 removal and evaluate ecological receptor impacts from contaminated groundwater.
 - A 311-m (1,020-ft) long apatite PRB is installed near the Columbia River shoreline. The remainder of the planned PRB extension to approximately 760 m (2,500 ft) will be performed in the future.
 - Three additional types of strontium-90 remediation technologies were tested for potential use in the 100-NR-2 OU in addition to the apatite PRB. Passive infiltration did not prove to be a viable method for emplacing apatite-forming chemicals along the 100-N Area shoreline. Jet injection tests showed that the technology could effectively place apatite or apatite-forming chemicals into the upper vadose zone with good coverage. Phytoextraction has the potential to remove strontium-90 from the shoreline area, as demonstrated by greenhouse and laboratory (growth chamber) studies of strontium-90 uptake and field studies in a contaminant-free location in the 100-K Area. Additional work regarding these technologies did not occur in this review period (2016-2020).
 - Technologies evaluated for remediating strontium-90 are identified in the Draft B RI/FS ([DOE/RL-2012-15](#)) report for the 100-NR-1 and 100-NR-2 OUs. The Draft B RI/FS was submitted for review in November 2019 to Ecology (the lead regulatory agency for the 100-NR-1 and 100-NR-2 OUs). Ecology review comments were transmitted to DOE on July 9, 2020; DOE has since been working with Ecology to disposition review comments to issue revision 0 of the RI/FS. The RI/FS will be used to support future cleanup decisions and to prepare a proposed plan and ROD.
- RAO 4. Prevent destruction of sensitive wildlife habitat. Minimize disruption of cultural resources and wildlife habitat, in general, and prevent adverse impacts to cultural resources and threatened or endangered species.
 - The interim remedial action ROD ([EPA/ROD/R10-99/112](#) and [EPA 2010](#)) established the following ICs that were implemented and maintained throughout this review period. These provisions include access control and visitor escorting requirements; maintaining signs prohibiting public access (new signs were placed along the river and at major road entrances at each reactor area); an excavation permit process to control all intrusive work (e.g., well drilling and soil excavation); and regulatory agency notification of any trespassing incidents.

ICs for the 100-NR-2 groundwater OU, as required by the interim action ROD (as amended), are described in the latest version of *Remedial Design Report/Remedial Action Work Plan for the 100-NR-2 Operable Unit*, ([DOE/RL-2001-27](#)), and are actively managed. Specific details associated with each applicable IC have been incorporated into *Sitewide Institutional Controls Plan for the Hanford CERCLA Response Actions and RCRA Corrective Actions* ([DOE/RL-2001-41](#)); this report is routinely updated within 180 days after publication of each decision document that addresses ICs. As indicated earlier, the ICs for the 100-NR-2 OU include the following categories/type: access control (i.e., warning notices and

entry restrictions), land-use management (i.e., land use, excavation, and drilling restrictions), and miscellaneous provisions. These ICs are assessed annually and DOE presents a summary including any noted issues or actions to the Site regulators each fall at the unit managers meeting. The presentation is documented in the meeting minutes, which are archived in the Hanford Site Administrative Record (see examples in Attachments 4 and 6 at the following link: <https://pdw.hanford.gov/document/AR-04230>). During the 5-year review period of 2016 through 2020, no deficiencies were noted for the 100-NR-2 groundwater OU. The annual IC assessments are also now captured in an annual report (e.g., [HNF-65616, FY2020 Sitewide Institutional Control Assessment](#)). During the 5-year review period of 2016 through 2020, appropriate ICs for the 100-NR-2 groundwater OU were found to be in place and maintained, and the objectives for the ICs are being met.

Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of remedy selection still valid?

The exposure assumptions, toxicity data, cleanup levels, and interim RAOs used at the time of remedy selection are still valid for this OU for purposes of implementing the interim action ROD. However, since the issuance of the interim action ROD (as amended in 2010), cleanup levels, toxicity data, and risk assessment guidance have been revised. Groundwater remediation to the interim action cleanup levels for strontium-90 and petroleum hydrocarbons is expected to achieve the preliminary remediation goals established in the Draft B RI/FS ([DOE/RL-2012-15](#)). The groundwater remedial actions are ongoing and the revised information will be considered during development of the final ROD.

Has any other information come to light that could call into question the protectiveness of the remedy?

No information has come to light that would call into question the protectiveness of the remedy. Performance monitoring has indicated that the PRB technology can be effective; however, some sections of the barrier expansion have experienced contaminant rebound since the initial injections suggesting the potential need for reinjection and/or refinement of the barrier injection methodology.

Issues/Recommendations During this Review Period

For purposes of establishing cleanup requirements for a final action ROD for the 100-NR-1 source OU and 100-NR-2 groundwater OU, the Draft B RI/FS ([DOE/RL-2012-15](#)), currently undergoing a comment resolution process with Ecology, needs to be finalized.

Therefore, the following issue is noted for future action:

Issue NR1/2-1 A full human-health and ecological risk assessment for the 100-NR-1 source OU and 100-NR-2 groundwater OU has not been finalized.

Recommendation NR1/2-1: Finalize a full human health and ecological risk assessments for the 100-NR-1 source OU and 100-NR-2 groundwater OU (Milestone Date: March 30, 2023).

Does this issue/action currently affect the protectiveness of the remedy? – NO.

Will this issue/action affect the protectiveness of the remedy in the future? – YES.

Protectiveness Statement

100-NR-2 Groundwater OU – Will Be Protective. The remedy at the 100-NR-2 groundwater OU is expected to be protective of human health and the environment upon completion of the final remedy. Construction of the interim remedy component involving a permeable reactive barrier for addressing strontium-90 contamination has been partly completed, pending reinjection and further expansion. To address TPH-diesel contamination, in situ bioventing system operations and the free-product removal operations are under way to reduce contaminant mass in the lower vadose zone and groundwater, respectively. Additionally, ICs are in place and are preventing human exposure to the groundwater.

Groundwater monitoring and MNA also are under way and will continue to help determine a comprehensive final remedy for 100-NR-2 groundwater.

2.4 300 Area National Priorities List Site

The 300 Area is located in the southeastern portion of the Hanford Site along the Columbia River and adjacent to the northern city limits of Richland, Washington, as previously shown in Figure 1-1. The 300 Area, as currently described for remediation purposes, encompasses approximately 105 km² (40 mi²) and comprises the 300 Area Industrial Complex including major liquid waste disposal sites and solid waste burial grounds, waste sites associated with the Fast Flux Test Facility in the 400 Area, the 618-10 and 618-11 Burial Grounds, and waste sites near and east of the 300 Area Industrial Complex.

The 1.35 km² (0.52 mi²) 300 Area Industrial Complex, which was used for uranium fuel fabrication and research and development activities for the Hanford Site, began operations in 1943. During the 300 Area Industrial Complex's operating period (most operations ended before or during the 1990s), fuel fabrication and laboratory facilities' disposal practices and spills and other unplanned releases resulted in contamination of the facilities, surface, underlying soil column, and groundwater.

Waste from 300 Area operations was purposefully disposed of in unlined landfills and burial grounds and discharged to unlined surface ponds and trenches. Solid waste was disposed of in burial grounds and shallow landfills from 1943 through the 1950s. In later years, highly radioactive waste, including waste with TRU contaminants, was disposed of in the 600 Area burial grounds.

Industrial activities associated with operations in the 400 Area also resulted in soil contamination and are addressed by the 300 Area NPL Site cleanup.

While facility deactivation, decommissioning, and demolition has been ongoing in the 300 Area Industrial Complex for more than a decade, a few buildings primarily dedicated to research and development may be in use through at least 2045. The DOE, Pacific Northwest Site Office documents this need to maintain a presence in the 300 Area in [16-PNSO-0057](#), "*Need for the Pacific Northwest National Laboratory (PNNL) Occupied/Operated 300 Area Environmental Management (EM) Facilities Anticipated to Extend Through 2045.*"

Land adjacent to the 300 Area Industrial Complex and associated outlying waste sites is shrub steppe habitat with the following exceptions:

- Adjacent to the 618-11 Burial Ground is an operating commercial nuclear power plant.
- Adjacent and east of the 300 Area Industrial Complex is the Columbia River.
- The southern part of the 300 Area wraps around the DOE Hanford Patrol Academy and the Volpentest Hazardous Materials Management and Emergency Response Federal Training Center (HAMMER).
- The northwest quadrant of the 300 Area includes the deactivated Fast Flux Test Facility in a small region known as the 400 Area.

The 300 Area NPL site is being addressed by two source OUs (300-FF-1 and 300-FF-2) and one groundwater OU (300-FF-5). The 300-FF-1 OU contains principally liquid waste disposal sites in the

northeast quadrant of the 300 Area Industrial Complex. The 300-FF-2 OU contains principally solid waste disposal sites in the 300 Area. The 300-FF-5 OU addresses groundwater contamination from past disposal to 300-FF-1 and 300-FF-2 waste sites. Approximate locations of the 300-FF-1 and 300-FF-2 source OUs and the 300-FF-5 groundwater OU are shown in Figure 2-25.

300 Area NPL Site Land and Water Uses

Given that land use helps form the basis for exposure assessment assumptions and risk characterization conclusions under [CERCLA](#), the 300 Area NPL Site's current and reasonably anticipated future land use, current groundwater uses, and potential future beneficial uses of groundwater are described in the subsections below. The primary basis for the following land and water uses narrative is the 300 Area NPL Site's most recent CERCLA ROD: *Hanford Site 300 Area Record of Decision for 300-FF-2 and 300-FF-5, and Record of Decision Amendment for 300-FF-1* ([EPA and DOE 2013](#)).

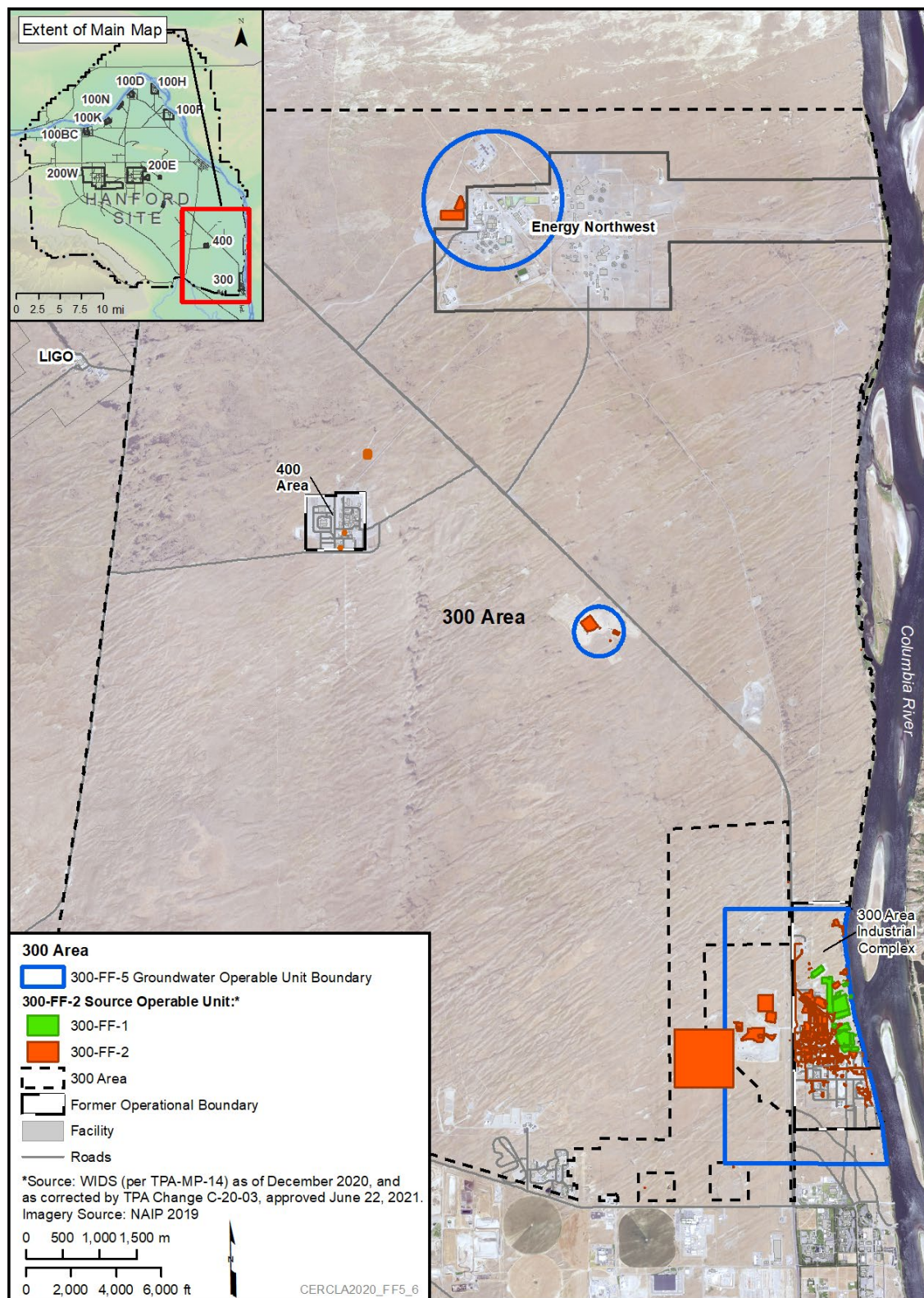
Current On-Site and Adjacent/Surrounding Land Uses

The 300-FF-1, 300-FF-2 and 300-FF-5 OU Areas are managed by the DOE and public access and use is restricted. The 300 Area OUs contains the following: (1) The 300 Area Industrial Complex (major liquid waste disposal sites, burial grounds and other waste sites); (2) The 400 Area waste sites contaminated by releases from the Fast Flux Test Reactor and support facilities; and (3) The 600 Area that includes the 618-11 and 618-10/316-4 Burial Grounds and undeveloped open land. Research and development activities within the 300 Area Industrial Complex are ongoing and projected to continue within designated facilities through at least 2035.

Land adjacent to 300-FF-1 and 300-FF-2 waste site areas is shrub steppe habitat with several exceptions: Adjacent and east of 618-11 Burial Ground is an operating commercial nuclear power plant. Adjacent to and east of the 300 Area Industrial Complex is the Columbia River. The southern part of the 300 Area wraps around DOE's Hanford Patrol Academy and HAMMER training facilities. The land use further away, beyond the Hanford boundaries contains irrigated agriculture and to the south and east are the cities of Richland, West Richland and Pasco.

Reasonably Anticipated Future Land Uses

The 300 Area Industrial Complex has been an industrial site since the 1940s. This area contains laboratories operated by the Pacific Northwest National Laboratory that are expected to operate at least until 2035. The 618-11 Burial Ground is immediately adjacent to an operating commercial nuclear reactor. Per the HCP-EIS (DOE/EIS-0222-F, see Section 4.0 for access to document) the reasonably anticipated future land use for the 300 Area Industrial Complex and 618-11 Burial Ground is industrial. Also per the HCP-EIS (DOE/EIS-0222-F, see Section 4.0 for access to document) DOE's reasonably anticipated future land use for the remaining portions of the 300 Area will be industrial; EPA believes other uses including residential are the reasonably anticipated future land use for the remaining areas. The expected timeframe for that land use is from the present into the foreseeable future. A portion of 300-FF-2 is mostly uncontaminated land with a small number of waste sites. The small number of waste sites are primarily away from the above active industrial areas and are surrounded by shrub steppe habitat. The 300 Area Industrial Complex and 618-11 Burial Ground have industrial based cleanup levels that will achieve a level of cleanup that allows industrial use. For the remaining portion of 300-FF-2, residential based cleanup levels are used, which also achieves a level of cleanup that allows for industrial use.



The 300-FF-5 OU is defined as groundwater contaminated by Hanford 300 Area releases (EPA and DOE 2013).

Figure 2-25. 300 Area Operable Units.

Current Groundwater use and Designation

Some of the groundwater in the 300 Area is currently contaminated above standards, and withdrawal of this contaminated groundwater for uses other than remediation, research and monitoring is prohibited by ICs currently in place. Under current site use conditions and controls, the only complete human exposure pathway to groundwater in the 300 Area is the potential for limited exposure to groundwater from intermittent seeps along the Columbia River or during remediation, research and monitoring activities. The 300-FF-5 groundwater is not being used for drinking water.

Potential Beneficial Groundwater Use

The NCP (40 CFR 300) 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” (“Remedial Investigation/Feasibility Study and Selection of Remedy” [40 CFR 300.430(a)(1)(iii)(F)]). Washington State regulations contain a similar expectation. Given the nature of the groundwater in 300-FF-5, potential beneficial groundwater uses include drinking water, irrigation and industrial uses. Drinking water use includes other domestic uses such as bathing and cooking. The Tri-Party Agencies’ goal for Hanford groundwater is consistent with the NCP.

2.4.1 300 Area Operable Units

2.4.1.1 300-FF-1 and 300-FF-2 Source Operable Units

Background

The 300-FF-1 OU is bound on the east by the Columbia River and on the north, south, and west by the 300-FF-2 OU. The 300-FF-1 OU includes the major 300 Area liquid and process waste disposal sites, the 618-4 Burial Ground, and three small landfills. The liquid and process waste disposal sites were unlined trenches and ponds that received discharges of millions of gallons of contaminated wastewater. These liquid and process waste disposal sites are suspected to be the primary source of uranium contamination in the groundwater beneath the 300 Area.

The 300-FF-2 OU contains primarily solid waste disposal sites located beneath facilities and/or covered areas inside the 300 Area Industrial Complex fences. This OU also contains several waste sites that were identified outside the industrial complex fences, including general-content burial grounds located near the 300 Area (one was beneath a building in the complex area), and two burial grounds containing TRU-contaminated material located north of the 300 Area fenced complex.

Chronology

Table 2-28 lists the remedial action decision documents associated with the 300-FF-1 and 300-FF-2 source OUs as of December 31, 2020.

**Table 2-28. Decision Documents for the 300 Area Source Operable Units
(300-FF-1 and 300-FF-2). (2 Pages)**

Date	Location	Document Title
7/1996	EPA/ROD/R10-96/143	Record of Decision for the 300-FF-1 and 300-FF-5 Operable Units. This document contains a final action ROD for the 300-FF-1 OU to remove contaminated soil and debris, dispose of it at ERDF, backfill and recontour the site, and implement ICs. It also contains an interim action ROD for the 300-FF-5 OU that implements monitoring and ICs.
1/2000	EPA et al. 2000	Explanation of Significant Differences for 300-FF-1 Operable Unit Site-Specific Variance from Land Disposal Restrictions Treatment Standard for Lead. This ESD is a site-specific land disposal restriction treatability variance for lead contamination found in the 628-4 waste site, also known as Landfill 1D.
4/2001	EPA 2001c	Record of Decision for the 300-FF-2 Operable Unit Interim Actions. This document is an interim action ROD to remove contaminated soil, structures, and debris from the 300-FF-2 OU; treat as needed; dispose of at ERDF, WIPP, or another repository; backfill and revegetate the site; establish ICs; continue monitoring groundwater under the 300-FF-5 OU; and define a plug-in approach for accelerating future decisions.
5/2004	DOE 2004	Explanation of Significant Differences for the 300-FF-2 Operable Unit Record of Decision. This ESD modifies the uranium soil cleanup level from 350 to 267 pCi/g, based on an engineering study, to ensure protectiveness of the groundwater and river; modifies the land-use assumption for eight outlying waste sites from industrial to unrestricted; and changes cleanup levels for these sites to be consistent with 100 Area cleanup.
8/2009	EPA et al. 2009	Explanation of Significant Differences for the 300-FF-2 Operable Unit Interim Action Record of Decision. This ESD incorporates 14 plug-in sites into the ROD and subsequent ESDs, incorporates 2 newly discovered sites into the ROD and subsequent ESDs, and allows future newly discovered sites to be incorporated into the ROD and ESDs, as long as cost impacts remain within specified limits.
10/2010	E1009034	TPA Fact Sheet: “300-FF-2 “Plug-In” Waste Sites for Fiscal 2010.” This is the 2010 list of waste sites plugged into the RTD remedy in the 2001 interim action ROD for the 300-FF-2 OU.
8/2011	EPA 2011c	TPA Explanation of Significant Differences, Hanford 300 Area, 300-FF-2 Operable Unit, 618-10 Burial Ground. This ESD modifies the remedy to allow necessary treatment of liquid waste in bottles, up to 1 gal/bottle, to occur in trays within the excavation area in accordance with an approved work plan.
8/2011	DOE et al. 2011	TPA Fact Sheet: 300-FF-2 “Plug-In” Waste Sites for Fiscal 2011. This is the 2011 list of waste sites plugged into the RTD remedy in the 2001 interim action ROD for the 300-FF-2 OU.
9/2012	DOE et al. 2012	TPA Fact Sheet: 300-FF-2 “Plug-In” Waste Sites for Fiscal 2012. This is the 2012 list of waste sites plugged into the RTD remedy in the 2001 interim action ROD for the 300-FF-2 OU.

**Table 2-28. Decision Documents for the 300 Area Source Operable Units
(300-FF-1 and 300-FF-2). (2 Pages)**

Date	Location	Document Title
11/2013	EPA and DOE 2013	<i>Record of Decision for 300-FF-2 and 300-FF-5, and Record of Decision Amendment for 300-FF-1 Hanford Site, Benton County, Washington.</i> This ROD selects a final remedy for the waste sites in the 300-FF-2 OU, a final remedy for the groundwater in the 300-FF-5 OU, and it amends the remedy for three 300-FF-1 OU waste sites. This final action remedy replaces the interim action remedies for the 300-FF-5 and 300-FF-2 OUs selected in 1996 and 2000, respectively. The 1996 remedy for 300-FF-1 is amended for additional remedial action of uranium from three sites. Contaminated buildings are being removed in accordance with CERCLA action memoranda and are not part of the OUs addressed by this ROD. The major components of the selected remedy for the 300-FF-2 OU are as follows: • Remove, treat, and dispose of at waste sites • Emplace temporary surface barriers and fill pipeline voids • Perform enhanced attenuation of uranium using sequestration in the vadose zone, periodically rewetted zone, and top of the aquifer • Institute ICs, including the requirement that DOE prevent the development and use of 300 Area Industrial Complex and 618-11 Burial Ground property that does not meet residential cleanup levels for other than industrial uses (e.g., residential housing, elementary and secondary schools, childcare facilities, and playgrounds). The major components of the selected remedy for the 300-FF-5 OU are as follows: • Monitored natural attenuation • Groundwater monitoring • Enhanced attenuation of uranium at the top of aquifer • ICs. The major component of the amended remedy for the 300-FF-1 OU is enhanced attenuation of uranium using sequestration in the vadose zone, periodically rewetted zone, and top of the aquifer.
9/2015	DOE and EPA 2015	<i>Explanation of Significant Differences for the Hanford Site 300 Area Record of Decision for 300-FF-2 and 300-FF-5, and Record of Decision Amendment for 300-FF-1.</i> This ESD adds two waste sites to the 300 Area ROD, Table 1. Waste site 600-386 requires no additional action to meet the selected remedy requirement of the 300-FF-2 OU and waste site 600-393 was added for RTD to residential cleanup levels.
4/2016	16-AMRP-0097	<i>Explanation of Significant Differences #2, for the Hanford Site 300 Area Record of Decision for 300-FF-2 and 300-FF-5, and Record of Decision Amendment for 300-FF-1 Operable Unit #4.</i> This ESD adds one waste site (600-403) to the final action ROD, Table 1 as well as providing a modified technology/approach for another waste site (300-288:2, or 300-288 subsite #2) as RTD to residential cleanup levels without backfilling.

CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980

ERDF = Environmental Restoration Disposal Facility

ESD = explanation of significant difference

IC = institutional control

OU = operable unit

ROD = record of decision

RTD = removal, treatment, and disposal

TPA = Tri-Party Agreement

WIPP = Waste Isolation Pilot Plant

See Appendix B for a consolidated listing of decision documents for Hanford Site OUs.

Remedial Action

Goals and Objectives. The RAOs for the 300-FF-1 OU and 300-FF-2 OU waste sites, as stated in the 2013 ROD ([EPA and DOE 2013](#)), are as follows: RAOs 2 through 6 apply to the 300-FF-2 OU and

RAOs 2 and 7 apply to the 300-FF-1 OU ROD amendment because remediation of the 300-FF-1 OU waste sites had been completed under the 1996 ROD ([EPA/ROD/R10-96/143](#)). RAO 1, not listed, and RAO 7 apply to the 300-FF-5 groundwater OU. These RAOs are compatible with the RAOs in the previous RODS for these OUs ([DOE/RL-2014-13](#)).

- RAO 2. Prevent COCs migrating and/or leaching through soil that will result in groundwater concentrations above cleanup levels (CULs) for protection of groundwater, and of surface water concentrations above CULs for the protection of surface water at locations where groundwater discharges to surface water.
- RAO 3. Prevent human exposure to the upper 4.6 m (15 ft) of soil, structures and debris contaminated with COCs at concentrations above residential scenario-based CULs in areas outside both the 300 Area Industrial Complex and waste site 618-11 Burial Ground (adjacent to Energy Northwest).
- RAO 4. Prevent human exposure to the upper 4.6 m (15 ft) of soil, structures and debris contaminated with COCs at concentrations above CULs for industrial use in the 300 Area Industrial Complex and waste site 618-11 Burial Ground (adjacent to Energy Northwest).
- RAO 5. 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 6. Prevent ecological receptors from direct exposure to the upper 4.6 m (15 ft) of soil, structures and debris contaminated with COCs at concentrations above CULs.
- RAO 7. Restore groundwater impacted by Hanford Site releases to CULs which include DWSs, within a timeframe that is reasonable given the particular circumstances of the site.

Remedy Components. The final action ROD for the 300-FF-2 source OU and the ROD amendment for the 300-FF-1 source OU, as published in 2013 ([EPA and DOE 2013](#)), provided the following summary-level descriptions (see italicized text in the following box) of the major components of the selected remedy (i.e., RTD, temporary surface barriers and pipeline-void filling, ICs, and enhanced attenuation of uranium).

Excerpt from ROD (EPA and DOE 2013):

RTD at Waste Sites for 300-FF-2 -- RTD of waste sites to achieve RAOs and CULs through (a) RTD the soil with COCs exceeding CULs identified in table 4 above as deep as 4.6 m (15 ft) bgs to protect human health and ecological receptors from direct exposure to contaminants, (b) remove the engineered structures which includes pipelines with contamination exceeding CULs (e.g., burial ground trenches, drums, caissons and vertical pipe units), (c) RTD the soil and engineered structures below 4.6 m (15 ft) bgs with COCs other than uranium that exceeds CULs in table 4 for groundwater and river protection and (d) backfill and revegetate the excavated waste sites. Except as specified in section 12.2.6 and 12.2.7 below, uranium that is identified during remedial activities to exceed CULs below 4.6m will be addressed either by RTD and/or sequestration with phosphate as approved by EPA.

Contaminated soil, structures and debris with concentrations above the CULs will be removed from the waste sites, treated as necessary to meet disposal facility requirements and sent to ERDF, which is considered onsite, or another facility approved by EPA. CULs apply to soil, structures which includes pipelines and debris. CULs do not apply to chemicals that are an integral part of manufactured structures (for example zinc in galvanized metal). The chemicals that are an integral part of manufactured structures are not considered contamination. The need for remedial action is based on contamination. In addition, treatment will be conducted as necessary in advance of

removal to control worker exposure and minimize airborne releases (e.g., for highly radioactive materials, including principal threat waste).

Soil from waste site 300-296 below the 324 Building B Cell is part of 300-FF-2 and is addressed in the selected remedy. The highly contaminated soil that requires remote excavation methods will be retrieved and placed into other non-leaking 324 Building hot cells. These cells provide additional shielding to workers from radioactive contaminants. Removal of the 324 Building, and the hot cells that would contain this 300-296 waste, will be performed under the CERCLA Action Memorandum #2 for the 300 Area Facilities. In addition, closure of the TSD units in the 324 Building Radiochemical Engineering Cells will be performed under the RCRA Closure Plan.

Principal threat waste from the 300-296 waste site, vertical pipe units at 618-10 and 618-11 and caissons at 618-11 will be treated to the maximum extent practicable to reduce the toxicity, mobility, contamination or radiation exposure. Treatment may be in-situ or during excavation as needed to control worker exposure. Treatment will be with grout or an alternative method approved by EPA during remedial design.

Temporary Surface Barriers and Pipeline Void Filling for 300-FF-2 -- For waste sites that exceed CULs in table 4 [referring to table 4 in the ROD] that are adjacent to the 300 Area facilities and utilities that will remain in operation through at least 2027 (long-term facilities), temporary surface barriers will be installed and maintained in areas specified in the RD/RAWP to reduce infiltration and contaminant flux to groundwater. The design of the barriers will be described in the RD/RAWP. Surface barriers will be constructed of asphalt or alternative materials approved by EPA in the RD/RAWP to decrease permeability. In addition, pipelines with uranium and/or mercury contamination that exceed CULs in table 4 for groundwater and river protection that are inaccessible for the RTD remedy because of their close proximity to long-term facilities will be void filled to the maximum extent practicable as defined in the RD/RAWP to immobilize radionuclides (and elemental mercury in waste site 300 RRLWS) in the pipelines for groundwater protection. When the long-term facilities are no longer in use and are removed, the waste sites and pipelines will be remediated as described above in the RTD discussion. The long-term retained facilities are shown on figure 3.

Institutional Controls Common Elements for 300-FF-2 and 300-FF-5 -- ICs are required before, during and after the active phase of remedial action implementation where ICs are needed to protect human health and the environment. ICs are used to control access to residual contamination in soil and groundwater above standards for unlimited use and unrestricted exposure. DOE shall be responsible for implementing, maintaining, reporting on and enforcing ICs. Although the DOE may later transfer these procedural responsibilities to another party by contract, property transfer agreement or through other means, the DOE shall retain ultimate responsibility for remedy integrity and ICs. In the event that land is transferred out of federal ownership, deed restrictions (proprietary controls such as easements and covenants) are required that are legally enforceable against subsequent property owners.

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

The following institutional control performance objectives are required to be met as part of this remedial action. Land-use controls will be maintained until CULs are achieved and the concentrations of hazardous substances are at such levels to allow for unlimited use and unrestricted exposure and EPA authorizes the removal of restrictions. ICs to be implemented by DOE to support achievement of the RAOs include the following:

- In the event that land is transferred out of federal ownership, deed restrictions (proprietary controls such as easements and covenants) are required that are legally enforceable against subsequent property owners.

- *In the event of any unauthorized access (e.g. trespassing), DOE shall report such incidents to the Benton County Sheriff's Office for investigation and evaluation of possible prosecution.*
- *Activities that would disrupt or lessen the performance of any component of the remedies are prohibited.*
- *The DOE shall report on the effectiveness of ICs for 300-FF-2 and 300-FF-5 in an annual report, or on an alternative reporting frequency specified by the lead regulatory agency. Such reporting may be for 300-FF-2 and 300-FF-5 alone or may be part of the Hanford Sitewide ICs report.*

Measures that are necessary to ensure continuation of ICs shall be taken before any lease or transfer of any land subject to ICs. DOE will provide notice to Ecology and EPA at least 6 months before any transfer or sale of land subject to ICs so that the lead regulatory agency can be involved in discussions to ensure that appropriate provisions are included in the transfer terms or conveyance documents to maintain effective ICs. If it is not possible for DOE to notify Ecology and EPA at least 6 months before any transfer or sale, DOE will notify Ecology and EPA as soon as possible, but no later than 60 days before the transfer or sale of any property subject to ICs. In addition to the land transfer notice and discussion provisions, DOE further agrees to provide Ecology and EPA with similar notice, within the same time frames, as to federal-to-federal transfer of property. DOE shall provide a copy of the executed deed or transfer assembly to Ecology and EPA. DOE shall notify EPA and Ecology immediately upon discovery of any activity inconsistent with the specific ICs.

Institutional Controls Unique Elements for 300-FF-2 -- The following institutional control performance objectives are required to be met as part of this remedial action for 300-FF-2. Land-use controls will be maintained until CULs are achieved and the concentrations of hazardous substances are at such levels to allow for unlimited use and unrestricted exposure and EPA authorizes the removal of restrictions. ICs to be implemented by DOE to support achievement of the RAOs include the following:

- *Exposure to contamination deeper than 4.6 m (15 ft) bgs is not anticipated. Where contamination at depth exceeds the residential or industrial use CULs, ICs are required to ensure future activities do not bring this contamination to the surface or otherwise result in exposure to contaminant concentrations that exceed the CULs.*
- *The DOE will prevent the development and use of property that does not meet residential CULs at the 300 Area Industrial Complex and 618-11 (figure 10 [from the ROD]) for other than industrial uses, including use of property for residential housing, elementary and secondary schools, childcare facilities and playgrounds.*
- *Signage and access control to waste sites with contamination above CULs will be provided.*
- *DOE shall employ and maintain an excavation permit program for protection of human health against unacceptable exposure, and protection of environmental and cultural resources.*
- *Prevent enhanced recharge in the 300 Area Industrial Complex and 618-11 over or near waste sites with soil concentration at any depth that exceed residential (irrigation-based) groundwater and surface water protection CULs until the CULs are achieved. Enhanced recharge controls are no irrigation or landscape watering, control drainage from low permeability areas including paved parking lots or buildings, and prevent bare gravel or bare sand covers.*

Enhanced Attenuation of Uranium Common Elements for 300-FF-1 and 300-FF-2 -- Enhanced attenuation of uranium is to be achieved via sequestration treatment with phosphate. Phosphate will be applied near the ground surface; within the lower vadose zone, [periodically rewetted zone] PRZ and top of the aquifer via injection wells; and within the top of the aquifer toward the east and south of the vadose treatment area.

Uranium sequestration by phosphate application will be implemented to enhance the natural attenuation of the uranium source mass in the vadose zone, PRZ and top of the aquifer in the area of highest uranium contamination (figure 9). The groundwater plume in this area results from three 300-FF-1 sites (316-1, 316-2 and 316-5) and four 300-FF-2 waste sites (316-3, 618-1, 618-2 and 618-3.) The treatment area is approximately 1 hectare (3

acres) and includes injection of phosphate at the top of the aquifer to address uranium that may be mobilized during the treatment process. The specific target area will be identified in the RD/RAWP. Uranium concentration and leachability characterization will be conducted on vadose zone and PRZ core samples collected before and after phosphate treatment to quantify the vadose zone and PRZ treatment effectiveness, and to refine the groundwater model. Groundwater monitoring will be conducted to assess changes in uranium concentrations and the lateral spread of phosphate.

Wells will be used for injection of phosphate to a zone that is located just above and/or within the aquifer to mitigate potential impacts to the aquifer from uranium that may be carried downward by the water used to inject the phosphate. This treatment zone will be in place during water and reagent application in the vadose zone and maintained for a short period afterwards to react with any uranium that leaches into groundwater as a result of the phosphate solution applied to the vadose zone and PRZ. Phosphate injections will be performed when groundwater conditions are favorable (e.g., when groundwater flows in from the river during rising and high river stages).

The specific reagent blends of phosphate will be designed to optimize desired treatment characteristics, depending on the delivery method and target media. For instance, a slower release formulation that contains polyphosphate is desirable for infiltration and PRZ injection applications, where the slower delivery rate and less certain reagent distribution pattern would benefit from a slower reaction time to allow the reagent to migrate further into the unsaturated soil. In contrast, a faster-reacting formulation containing 100 percent orthophosphate is beneficial when targeting groundwater at the top of the aquifer during transient high-water stages. The feasibility study was based a reagent blend of 20 percent polyphosphate and 80 percent orthophosphate for infiltration and PRZ injections, and a 100 percent orthophosphate reagent was assumed for aquifer injections. The reagent blend will be determined during remedial design.

Near surface treatment will use the following general approach, with details to be developed in remedial design and established in the RD/RAWP:

- Surface infiltration with phosphate reagent-amended water
- Reagent mixing facility, pipelines, injection wells, pumps, valves
- Reagent delivery system for surface application
- Monitoring and verification sampling, including soil borings and monitoring wells to monitor effectiveness and potential impacts to groundwater
- Estimated system flow rate ranging from 190 to 1,135 L/min (50 to 300 gal/min) per acre

Phosphate reagent will be injected into the lower vadose zone and PRZ through wells selectively screened or packed to apply reagent into a focused treatment interval. Treatment will use the following general approach, with details to be developed in remedial design and established in the RD/RAWP:

- Well injection with phosphate reagent-amended water
- Reagent mixing facility, pipelines, injection wells, pumps, valves
- Phosphate reagent injection wells will be spaced approximately 15 m (50 ft) apart. Wells will be screened across the lower vadose zone and PRZ within the footprint of and adjacent to (along the river side) of the 1 hectare (3 acre) target area. Preliminary design includes 47 injection wells.
- Monitoring and verification sampling including soil borings and monitoring wells to monitor effectiveness and potential impacts to groundwater
- Injection rates ranging from approximately 380 to 760 L/min (100 to 200 gal/min) for each well.

The timing of the application in the PRZ would be scheduled to maximize contact with the smear zone during the seasonal high groundwater elevation. Properly deployed, lateral reagent injection will be capable of contacting lower vadose zone and PRZ sediment at distances approximately 15 m (50 ft) from each injection well.

Transition from Interim Remedy to Final Action Remedy for 300-FF-2 and 300-FF-5 -- In-progress interim action shall use the CULs in this ROD immediately upon issuance of this ROD. All other aspects of the interim actions shall continue to be performed in accord with the existing RD/RAWP. DOE shall develop, and submit for EPA approval, a new RD/RAWP prepared in accordance with the Tri Party Agreement. When the new RD/RAWP is approved, that document will direct future remedial actions and will replace all interim action ROD work plan requirements.

Description of Amended Remedy for 300-FF-1 -- The ROD for 300-FF-1 is amended to require enhanced attenuation with sequestration for uranium using phosphate at 300-FF-1 waste sites as described above in section 12.2.6 [in the ROD] Phosphate will be applied to the vadose zone and PRZ using a combination of surface infiltration and injection into the deep vadose zone and PRZ near the southern portion of waste site 316-5 as described above. Uranium sequestration will be conducted at the top of the aquifer below the vadose treatment zone to limit the mobility of any uranium mobilized from the vadose zone during surface infiltration and injection into the vadose zone and PRZ.

The remedies selected may change somewhat as a result of the remedial design and construction process. Any changes to the remedies described in the ROD are typically documented using a technical memorandum in the Administrative Record, an ESD, a ROD amendment, or version-control of the RDR/RAWP, as appropriate.

COCs for the 300-FF-1 and 300-FF-2 OUs include radionuclides, nonvolatile organic compounds, volatile organic compounds, metals, inorganic ions, and asbestos. The detailed lists are provided in the respective ROD and ROD amendment.

Remedy Implementation Progress Prior to This (2016-2020) Review Period ([DOE/RL-2016-01](#), Rev. 0). Work on the 300-FF-1 OU remedy began after issuance of the ROD in 1996, with the initial cleanup verification package approved in 1997. By 2004, remedial actions had been completed at all 39 300-FF-1 OU waste sites, as documented in [DOE/RL-2004-74](#), *300-FF-1 Operable Unit Remedial Action Report*. Work on the 300-FF-2 OU interim remedy began after issuance of the interim action ROD in 2001. Before 2016, remedial actions had been completed at 87 of approximately 107 waste sites in the 300-FF-2 OU. In late 2015, the first phase (Stage A) of a two-phase remedy for enhanced attenuation of uranium in the vadose zone was implemented, as documented in [SGW-59614](#), *300-FF-5 Operable Unit Enhanced Attenuation Stage A Delivery Performance Report*.

Issues/Actions from the Previous (2011-2015) 5-Year Review Report ([DOE/RL-2016-01](#), Rev. 0). No issues or actions were noted for the 300-FF-1 source OU or the 300-FF-2 source OU in the 2011-2015 [CERCLA](#) 5-year review.

Protectiveness Statements from the Previous (2011-2015) 5-Year Review Report ([DOE/RL-2016-01](#), Rev. 0). The protectiveness statements from the previous (2011-2015) 5-year review report for the 300-FF-1 and 300-FF-2 source OUs were as follows:

300-FF-1 Source OU – Will Be Protective. *The final remedy at the 300-FF-1 source OU waste sites is expected to be protective of human health and the environment upon completion of the final remedy actions. The final remedy actions (primarily involving*

RTD, backfilling, recontouring, revegetation, and ICs) ensure that exposure pathways that could result in unacceptable risks are being controlled.

300-FF-2 Source OU – Will Be Protective. *The final remedy at the 300-FF-2 source OU waste sites is expected to be protective of human health and the environment upon completion of the final remedy actions. The final remedy actions (primarily involving RTD, backfilling, recontouring, revegetation, and ICs) ensure that exposure pathways that could result in unacceptable risks are being controlled.*

Progress Since 2011-2015 Review

Accomplishments. Primary remedial action accomplishments for the 300-FF-1 and 300-FF-2 source OUs during the past 5 years (2016-2020) are summarized as follows:

- Completed interim stabilization activities at three waste sites in the 300-FF-2 OU in 2018. The interim stabilization activities were required by the RDR/RAWP ([DOE/RL-2014-13-ADD1](#)), and included the installation of an asphalt barrier at the 300-5 site and installation of an impermeable liner over the 331 LSLT1 and 331 LSLT2 sites. Completion of these stabilization activities is documented through a Tri-Party Agreement change notice ([TPA-CN-0839](#)).
- Three 300-FF-1 OU and four 300-FF-2 OU sites were identified as the primary contributors of groundwater uranium contamination in the ROD ([EPA and DOE 2013](#)). Stages A and B of the enhanced attenuation of uranium remedy were implemented in late 2015 and late 2018, respectively, and documented in [SGW-63113](#), *300-FF-5 Operable Unit Enhanced Attenuation Uranium Sequestration Completion Report*.
- ICs for the 300-FF-1 and 300-FF-2 source OUs, where applicable, were effectively managed, regularly assessed, and maintained.

While the 39 300-FF-1 source OU waste sites were cleaned up in the period from 1997 to 2004, the remedial actions in the 300-FF-2 source OU began in 2002. The primary cleanup actions for the 300-FF-2 OU involve removing contaminated soil and debris; treating the material, as appropriate, to reduce waste toxicity, mobility, or volume; disposing of the material in an appropriate long-term waste management facility; backfilling; and revegetating the area, and, where appropriate, implementing ICs. By 2012, all 300-FF-2 waste sites located in the northern portion of the 300 Area Industrial Complex (i.e., North of Apple Street) had been completed. Remedial actions in the southern portion of the 300 Area continued through 2015. The majority of the waste from the 300 Area cleanup has been disposed of at ERDF. Remediation of the 618-10 Burial Ground trenches began in 2011 and field work was completed in 2017. The WIDS reclassification form was signed in 2018.

Six 300-FF-2 source OU waste sites have been remediated and documented in waste site cleanup verification packages or remaining sites verification packages in the period from 2016 to 2020. The waste sites that were remediated and reclassified during this 5-year review period are as follows:

- 300-288:2 Dumping Area
- 316-4 Crib
- 600-63 Experiment/Test Site
- 600-393 Dumping Area
- 600-403 Unplanned Release
- 618-10 Burial Ground.

Figure 2-26 shows the general locations and closure status as of December 2020 for waste sites in the 300-FF-1 and 300-FF-2 source OUs. Table 2-29 summarizes the waste site cleanup status for the 300-FF-1 OU and 300-FF-2 OU waste sites, including metrics on work accomplished during the current 5-year period (2016-2020).

Remedy Implementation. The 2011 through 2015 5-year review period involved transitions in ROD status for the 300-FF-1 and 300-FF-2 source OUs. The 2013 ROD for the 300 Area ([EPA and DOE 2013](#)) includes an amendment to the original 300-FF-1 OU final action ROD from 1996 ([EPA/ROD/R10-96/143](#), as amended), and a final action ROD for the 300-FF-2 OU. The 300-FF-2 OU has transitioned from the 2001 interim action ROD ([EPA 2001c](#), as amended) to the 2013 final action ROD. Some remedy components (e.g., RTD and ICs) have continued in the field during this transition period. Enhanced attenuation of uranium was being prepared for field implementation in late 2015 (Stage A, as documented in [SGW-59455](#), *300-FF-5 Operable Unit Stage A Uranium Sequestration System Installation Report*, Rev. 0) and in late 2018 (Stage B, as documented in [SGW-60778](#), *300-FF-5 Operable Unit Stage B Uranium Sequestration System Installation Report*, Rev. 0).

Remedy implementation is being accomplished per the following RDR/RAWP: [DOE/RL-2014-13](#); [DOE/RL-2014-13-ADD1](#), and [DOE/RL-2014-13-ADD2](#). Stages A and B of the enhanced attenuation of uranium remedy were implemented in late 2015 and late 2018, respectively. The initial performance evaluation of Stage A, which improved Stage B implementation, was issued in 2016 ([SGW-59614](#), *300-FF-5 Operable Unit Enhanced Attenuation Stage A Delivery Performance Report*, Rev. 0). Stage B was implemented in late 2018 and the initial performance evaluation was issued in September 2020 ([SGW-63113](#)). The initial evaluation indicates uranium sequestration treatment has effected the leachability of uranium to groundwater. Long-term groundwater monitoring is currently underway to better assess protectiveness as the fate and transport model is calibrated. Continued comprehensive updates on remedy implementation and assessment of protectiveness will be included in future 5-year review reports.

RTD of 300-FF-2 OU waste sites will continue in the future. Remedial action completion for a majority of the 300-FF-2 OU waste sites is summarized in [DOE/RL-2016-45](#), *300-FF-2 Operable Unit Remedial Action Report* (Rev. 0). While most of the 300 Area Industrial Complex facilities have been demolished, some facilities and utilities in the 300 Area supporting the continuing mission of the Pacific Northwest National Laboratory (PNNL) are expected to be retained through at least 2045. Some waste sites adjacent to these active facilities and utilities have received interim stabilization (i.e., temporary surface barriers and pipeline void-fill grouting) until final remedial actions can take place after 2045. Preparations for remote excavation of highly contaminated soil (WIDS waste site 300-296) beneath the 324 Building have been initiated and will continue into the next five-year review period of 2021-2025. The 300-FF-2 cleanup levels for soils structures and debris, as presented in Table 4 of the ROD ([EPA and DOE 2013](#)), are included in Appendix C of this report.

ICs, as required by the ROD amendment and ROD for the 300-FF-1 and 300-FF-2 OUs, respectively, have been incorporated into [DOE/RL-2001-41](#) and implemented.

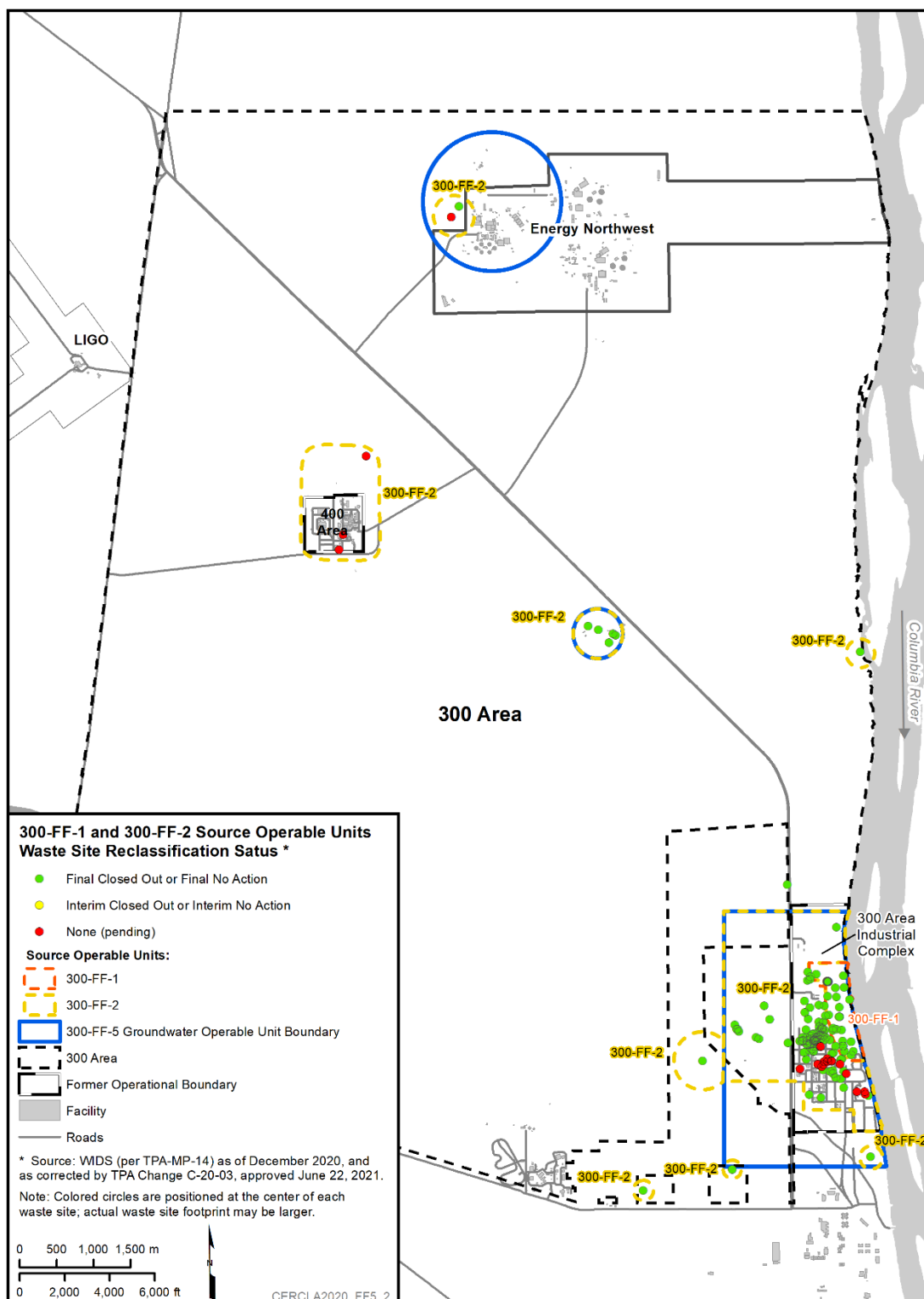


Figure 2-26. Geographic Distribution and WIDS Reclassification Status of the 300-FF-1 and 300-FF-2 Source Operable Unit Waste Sites as of December 2020.

Table 2-29. 300-FF-1 and 300-FF-2 Cleanup Status.

Source OU Cleanup Status - 300 Area					
Source OU	Number of Waste Sites ^a	Sites Dispositioned ^b			
		Pre-2016	2016 - 2020	Total	Percent
300-FF-1 ^c	39	39	0	39	100
300-FF-2	127	102	6	108	85
Total	166	141	6	147	88%

^a Number of waste sites in each OU, according to WIDS, as of December 2020 (and subsequent corrections per TPA Change C-20-03).

^b Number of sites dispositioned as of December 2020; includes the number of sites that have been reclassified in WIDS, as of December 2020 (and subsequently corrected per TPA Change C-20-03), as either interim closed, final closed, interim no-action, or final no-action in accordance with the guideline TPA-MP-14.

^c Three 300-FF-1 OU and four 300-FF-2 OU sites that were identified as primary contributors of uranium contamination to groundwater (per the 2013 ROD amendment for the 300-FF-1 OU and ROD for the 300-FF-2 OU) are being addressed in DOE/RL-2014-13-ADD2, the Remedial Design Report/Remedial Action Work Plan Addendum for the 300 Area Groundwater.

DOE/RL-2014-13-ADD2, 2015, *Remedial Design Report/Remedial Action Work Plan Addendum for the 300 Area Groundwater*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <https://pdw.hanford.gov/document/0081151H>.

TPA-MP-14, 2011, *Maintenance of the Waste Information Data System (WIDS)*, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1109271360>.

TPA Change C-20-03, 2021, *River Corridor Waste Site Updates in the Tri-Party Agreement, Appendix C*, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <https://pdw.hanford.gov/document/AR-14219>.

DOE = U.S. Department of Energy

ROD = record of decision

OU = operable unit

WIDS = Waste Information Data System

Technical Assessments

The 5-year review determines whether the remedy at a site is, or upon completion will be, protective of human health and the environment. The following is the technical assessment response to the technical assessment questions provided in the EPA guidance for the 300 Area source OU remedy. These questions also establish a framework for organizing and evaluating data and ensuring that all relevant issues are considered when determining the protectiveness of the remedy.

Is the remedy functioning as intended by the decision document?

Yes, the remedies for the 300-FF-1 and 300-FF-2 OU waste sites are functioning as intended by the decision document to the extent the actions have been completed. Remediation of all 39 waste sites in the 300-FF-1 OU were completed before this review period. As of December 2020, 108 of 127 waste sites in the 300-FF-2 OU had been remediated.

An evaluation of the final ROD RAOs for 300-FF-2 OU sites closed under an interim action ROD was completed. In accordance with [TPA-MP-14](#), *Maintenance of the Waste Information Data System (WIDS)*, the remediated waste sites have been documented in the WIDS as either final closed or final no-action. Cleanup verification packages (including sampling data and other technical information) to support the WIDS reclassification to final closed or final no-action are included in the Hanford Site Administrative Record for the 300-FF-1 and 300-FF-2 OUs.

The 300-FF-1 OU sites were remediated under the 1996 ROD ([EPA/ROD/R10-96/143](#)), as documented in *300-FF-1 Operable Unit Remedial Action Report* ([DOE/RL-2004-74](#)). The RAOs for the 300-FF-1 OU ROD amendment (RAOs 2 and 7 below) address uranium contamination in the vadose zone and

periodically rewetted zone that provides the greatest contribution to the uranium groundwater plume and also reflect the potential use of 300-FF-5 OU groundwater as a drinking water source. The RAOs for 300-FF-2 OU remediated waste sites (RAOs 2 through 6 below), and the methods used for achieving the RAOs through the remedial actions, are summarized in the following list ([DOE/RL-2016-45](#), Rev. 0):

- RAO 2. Prevent COCs migrating and/or leaching through soil that will result in groundwater concentrations above CULs for protection of groundwater and of surface water concentrations above CULs for the protection of surface water at locations where groundwater discharges to surface water.
 - Protection such that contaminant levels in soil after remediation did not result in an adverse impact to groundwater that exceeded any nonzero maximum contaminant level goals under the [Safe Drinking Water Act of 1974](#) or Method B cleanup levels under MTCA.
 - Protection such that contaminant levels in the soil after remediation did not result in an impact to groundwater and the Columbia River that exceeded the ambient water quality criteria under the [Clean Water Act of 1977](#) for protection of fish or Method B cleanup levels under MTCA. Because no ambient water quality criteria have been established for radionuclides; maximum contaminant levels from national primary DWSs were used.
 - Protection of receptors (aquatic species, with emphasis on salmon) in surface waters by reducing or eliminating further contaminant loadings to groundwater such that receptors at the groundwater discharge in the Columbia River were not subjected to any additional adverse risks.
- RAO 3. Prevent human exposure to the upper 4.6 m (15 ft) of soil, structures, and debris contaminated with COCs at concentrations above residential scenario-based CULs in areas outside both the 300 Area Industrial Complex and 618-11 Burial Ground (adjacent to Energy Northwest).
 - Cleanup levels for nonradionuclides in the 300 Area industrial land use scenario are based on [WAC 173-340-745\(5\)](#), which assumed that the exposure pathway for residual contamination will be from ingestion of contaminated soil. Soil cleanup levels were calculated using the equations provided by [WAC 173-340-745\(5\)](#), Method C, for carcinogens and noncarcinogens. For carcinogens, a lifetime cancer risk goal of 1×10^{-5} was achieved. For noncarcinogens, a hazard quotient of 1 will be achieved.
- RAO 4. Prevent human exposure to the upper 4.6 m (15 ft) of soil, structures and debris contaminated with COCs at concentrations above CULs for industrial use in the 300 Area Industrial Complex and 618-11 Burial Ground (adjacent to Energy Northwest).
 - The same method was used as is noted for RAO 3.
- RAO 5. Manage direct exposure to contaminated soils deeper than 4.6 m (15 ft) to prevent an unacceptable risk to human health and the environment.
 - Attain individual COC cleanup levels. Direct contact cleanup levels for nonradionuclides are based on risk calculations provided in the MTCA procedures. Direct contact cleanup levels for radionuclides are calculated based on an excess lifetime cancer risk of 1×10^{-4} or a radiological dose of 15 mrem/yr. For each radionuclide, the lower of risk- or dose-based calculations was used as the cleanup level.

- RAO 6. Prevent ecological receptors from direct exposure to the upper 4.6 m (15 ft) of soil, structures, and debris contaminated with COCs at concentrations above CULs.
 - Will be achieved through excavation to MTCA levels for organic and inorganic chemical constituents in soil to support unrestricted (residential) and/or industrial use. Achieved human health total radiological dose standards of less than 15 mrem/yr above background for radionuclides.
- RAO 7. Restore groundwater impacted by Hanford Site releases to CULs which include DWSs, within a timeframe that is reasonable given the particular circumstances of the site.

ICs applicable within the entire 300 Area IC boundary area include the application of deed restrictions in the event that land is transferred out of federal ownership, reporting of unauthorized access to the Benton County Sheriff's Office, prohibiting any activities that would disrupt or lessen the performance of any component of the remedy, and notifying EPA and Ecology on discovery of any activity inconsistent with the specific ICs. As further described in [DOE/RL-2001-41](#), DOE also has other administrative ICs (e.g., a site excavation permitting program) to limit the access and use of groundwater in a manner that is protective of human health where groundwater contamination is above the cleanup levels, protect environmental and cultural resources, and prevent enhanced recharge (e.g., no irrigation or landscape watering, controlling drainage, and prevention of bare gravel or bare sand covers). DOE also is required to prevent the development and use of property that does not meet the residential cleanup levels at the 300 Area Industrial Complex and the 618-11 Burial Ground. These and other ICs applicable to the 300-FF-1 and 300-FF-2 source OUs are assessed annually and DOE presents any noted issues or actions to the Site regulators each fall at the unit managers' meeting. The presentation is documented in the meeting minutes, which are archived in the Hanford Site Administrative Record (see example in Attachments 4 and 6 at the following link: <https://pdw.hanford.gov/document/AR-04230>). The annual IC assessments are also now captured in an annual report (e.g., [HNF-65616](#), *FY2020 Sitewide Institutional Control Assessment*, Rev. 0). The 300-FF-1 and 300-FF-2 source OU waste sites that were inspected during the 2020 assessment included:

- 300 ASH PITS, 300 RFBP, 300 RLWS:1, 300 RLWS:2, 300 RLWS:3, 300 RRLWS:1, 300 RRLWS:2, 300-110, 300-121, 300-15:1, 300-15:2, 300-15:3, 300-15:4, 300-15:6, 300-16:1, 300-16:2, 300-16:3, 300-175, 300-214:1, 300-214:2, 300-218, 300-219, 300-224, 300-24, 300-249, 300-251, 300-253, 300-256, 300-257, 300-262, 300-263, 300-265, 300-269, 300-270, 300-274, 300-28, 300-284, 300-286, 300-33, 300-34, 300-41, 300-43, 300-44, 300-46, 300-48, 300-50, 300-53, 300-80, 300-9, 303-M SA, 303-M UOF, 313 ESSP, 316-1, 316-2, 316-3, 331 LSLDF, 333 ESHWSA, 333 WSTF, 618-1, 618-1:1, 618-1:2, 618-10, 618-12, 618-2, 618-3, 628-4, UPR-300-10, UPR-300-12, UPR-300-15, UPR-300-17, UPR-300-19, UPR-300-20, UPR-300-21, UPR-300-22, UPR-300-23, UPR-300-24, UPR-300-25, UPR-300-26, UPR-300-27, UPR-300-28, UPR-300-29, UPR-300-30, UPR-300-32, UPR-300-33, UPR-300-34, UPR-300-35, UPR-300-36, UPR-300-37, UPR-300-38, UPR-300-4, UPR-300-46, UPR-300-47, UPR-300-48, UPR-300-7, UPR-300-8, UPR-300-9 and UPR-300-FF-1.

During the 5-year review period of 2016 through 2020, three deficiencies were specifically noted for the 300-FF-1 and 300-FF-2 OUs:

- In 2017, one warning sign near the former north parking lot entrance had fallen (most likely due to high winds) and was subsequently repaired the same year

- In 2019, the same sign was damaged and was replaced along with a new sign skid stabilized by cinder blocks
- In 2020, the warning sign near the entrance of 618-10 had been damaged. This sign was repaired in 2021.

All appropriate ICs for the 300-FF-1 and 300-FF-2 source OUs were found to be in place and maintained, and the objectives for the ICs are being met. Asphalt surrounding the 325 Building was resurfaced in 2020 to support longer-term integrity of the enhanced recharge IC that applies to waste sites in that area. As mentioned earlier, some waste sites near operating facilities in the 300 Area are not scheduled for remediation until facility operations end.

Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of remedy selection still valid?

The RAOs for the 300-FF-1 OU in the 1996 ROD broadly addressed protecting human and ecological receptors and controlling sources of potential contamination to groundwater and the Columbia River. These remain valid and conceptually consistent with RAOs in other more recent RODs for the Hanford Site. Associated cleanup levels were developed based on industrial use, which continues to be the anticipated land use. Some of the methodologies and toxicity data applicable at the time of the 1996 ROD have been replaced by updated guidance or data. More recent remedial investigation evaluations for the 300 Area ([DOE/RL-2010-99](#)) included evaluating 300-FF-1 waste sites using updated guidance and parameters. Potential concerns for groundwater protectiveness related to potential uranium leaching were identified for three waste sites which were subsequently addressed with a ROD amendment ([EPA and DOE 2013](#)). No other issues were identified.

The RAOs and exposure assumptions used for the 2013 ROD remain valid and consistent with anticipated future land uses. DOE regularly monitors toxicity data and applicable cleanup levels for chemicals as part of ongoing risk assessment and PRG development needs for other OUs. There have been no significant promulgated changes to relevant cleanup levels or to the sources of toxicity data underlying cleanup level development since the time of the ROD. EPA has recently updated their selection of industrial land use exposure scenarios. Risk-based radiological PRGs for the Outdoor Worker scenario have been calculated for source operable units within the Inner Area of the Hanford Site. Radiological PRG values for the Outdoor Worker are not functionally different than those for the Industrial Scenario used to calculate CULs. As a result, the cleanup levels identified for the 300-FF-2 OU are still valid.

Has any other information come to light that could call into question the protectiveness of the remedy?

No new information is known that could call into question the protectiveness of the remedy.

Issues/Recommendations During this Review Period

Issues. No issues specific to the 300-FF-1 and 300-FF-2 OUs were identified during this 5-year review (2016-2020).

Corrective Actions. No corrective actions are recommended.

Protectiveness Statements

300-FF-1 Source OU – Protective. The remedy at the 300-FF-1 source OU is protective of human health and the environment.

The RAOs for protecting human and ecological receptors from exposure to contamination, and for controlling the sources of groundwater contamination to minimize the impacts to groundwater resources,

and protecting the Columbia River from further impacts, have been met by RTD of waste sites and enhanced attenuation of uranium, and the implementation and continued management of ICs.

300-FF-2 Source OU – Will Be Protective. The final remedy at the 300-FF-2 source OU is expected to be protective of human health and the environment upon completion of the final remedy. Implementation of the final remedy (primarily involving RTD, backfilling, recontouring, and revegetation) at the 300-FF-2 OU is ongoing. In the interim, remedial activities completed to date, including ICs, have adequately addressed all exposure pathways that could result in unacceptable risks in these areas.

2.4.1.2 300-FF-5 Groundwater Operable Unit

Background

The 300-FF-5 groundwater OU (shown in Figure 2-25) is 1 of 10 groundwater OUs on the Hanford Site, and 1 of 6 located in the River Corridor. The 300-FF-5 OU is defined as the groundwater contaminated by releases from the 300-FF-1 OU and 300-FF-2 OU waste sites.

A subset of the waste sites in the 300-FF-1 and 300-FF-2 source OUs has contributed to the contamination plumes being addressed by the 300-FF-5 groundwater OU. These waste sites and associated groundwater plumes are located in three regions: the 300 Area Industrial Complex, the 618-11 Burial Ground located west of Energy Northwest, and a region that includes the 618-10 Burial Ground and 316-4 Crib located southeast of the 400 Area (Figure 2-25).

The 300-FF-5 OU groundwater contamination originated primarily from past disposal of liquid effluent associated with fabrication of nuclear fuel assemblies and research involving irradiated fuel processing. Because the principal liquid waste disposal facilities in the 300 Area have been out of service for decades and most have been remediated by removing contaminated soil, the contamination remaining in the underlying vadose zone and aquifer is residual.

COCs for the 300-FF-5 OU are *cis*-1,2-dichloroethene (DCE), gross alpha, nitrate, TCE, tritium, and uranium (as metal).

The groundwater in the unconfined aquifer beneath the southeastern portion of the Hanford Site flows primarily to the east or southeast toward the Columbia River. This flow direction is induced by regional groundwater flow that converges from the northwest, west, and southwest. Flow patterns throughout the region are complicated by the variable permeability of sediment in the upper portion of the unconfined aquifer. Near the river, groundwater flow also is influenced by river-stage fluctuations. Groundwater underlying the 300 Area Industrial Complex flows south-southeast during low river stage (typically September through mid-November) and south-southwest during high river stage (typically May through June).

Current onsite land use in and around the 300-FF-1, 300-FF-2, and 300-FF-5 OUs is industrial, and access to the waste site areas and contaminated groundwater is restricted. Ongoing research and development activities within the 300 Area Industrial Complex are projected to continue in designated facilities through at least 2045. The DOE, Pacific Northwest Site Office documents this need to maintain a presence in the 300 Area in [16-PNSO-0057](#), “Need for the Pacific Northwest National Laboratory (PNNL) Occupied/Operated 300 Area Environmental Management Facilities Anticipated to Extend Through 2045.”

A summary of the 300-FF-5 OU groundwater condition, as of 2020, is included in [DOE/RL-2020-60](#), *Hanford Site Groundwater Monitoring Report for 2020*. Additionally, this annual report and similar reports for calendar years prior to 2020 can be accessed online at <http://www.hanford.gov/page.cfm/SoilGroundwaterAnnualReports>).

Chronology

Table 2-30 lists the remedial action decision documents associated with the 300-FF-5 groundwater OU as of December 31, 2020.

Table 2-30. Decision Documents for the 300-FF-5 Groundwater Operable Unit. (2 Pages)

Date	Location	Title
7/1996	EPA/ROD/R10-96/143	<i>Declaration of the Record of Decision for the 300-FF-1 and 300-FF-5 Operable Units, Hanford Site, Benton County, Washington.</i> This was the final action ROD for the 300-FF-1 OU and interim action ROD for the 300-FF-5 OU. The 300-FF-1 OU actions required removal of contaminated soil and debris with disposal at ERDF, backfilling, recontouring, and implementing ICs. The 300-FF-5 OU actions included monitoring and maintaining ICs for groundwater.
6/2000	EPA/ESD/R10-00/524	<i>Explanation of Significant Difference for the 300-FF-5 Record of Decision.</i> This document expands the scope of the 300-FF-5 OU ROD to include groundwater in the 300 Area, including 300-FF-2 OU sites and any sites plugged into the 300-FF-1 OU ROD.
11/2013	EPA and DOE 2013	<i>Record of Decision for 300-FF-2 and 300-FF-5, and Record of Decision Amendment for 300-FF-1 Hanford Site, Benton County, Washington.</i> This ROD selects final remedies for the waste sites in the 300-FF-2 OU and the groundwater in the 300-FF-5 OU and amends the remedy for three 300-FF-1 OU waste sites. This final action remedy replaces the interim action remedies for the 300-FF-5 and 300-FF-2 OUs selected in 1996 and 2000, respectively. It amends the 1996 remedy for the 300-FF-1 OU to add remedial action for uranium from three sites. Contaminated buildings are being removed in accordance with CERCLA action memoranda and are not part of the OUs addressed by this ROD. The major components of the selected remedy for the 300-FF-2 OU are as follows: • RTD at waste sites • Emplace temporary surface barriers and fill pipeline voids • Perform enhanced attenuation of uranium using sequestration in the vadose zone, periodically rewetted zone, and top of the aquifer • Implement ICs, including the requirement that DOE prevent the development and use of property at the 300 Area Industrial Complex and 618-11 Burial Ground that does not meet residential cleanup levels for other than industrial uses (e.g., residential housing, elementary and secondary schools, childcare facilities, and playgrounds).
		The major components of the selected remedy for the 300-FF-5 OU are as follows: • Monitored natural attenuation • Groundwater monitoring • Enhanced attenuation of uranium at the top of aquifer • ICs. The major component of the amended remedy for 300-FF-1 OU is enhanced attenuation of uranium using sequestration in the vadose zone, periodically rewetted zone, and top of the aquifer.

Table 2-30. Decision Documents for the 300-FF-5 Groundwater Operable Unit. (2 Pages)

Date	Location	Title
6/2019	EPA 2019c	<i>Explanation of Significant Differences for the 300-FF-5 Operable Unit Record of Decision, Hanford Site, Benton County, Washington.</i> This ESD allows for miscellaneous solid waste generated in support of the 300-FF-5 OU final action to be collected and stored at a Central Plateau storage facility prior to disposal.
ARAR = applicable or relevant and appropriate requirement CERCLA = <i>Comprehensive Environmental Response, Compensation, and Liability Act of 1980</i> ERDF = Environmental Restoration Disposal Facility ESD = explanation of significant difference IC = institutional control O&M = operation and maintenance ROD = record of decision RTD = removal, treatment, and disposal		

See Appendix B for a consolidated list of decision documents for Hanford Site OUs.

Remedial Action

Goals and Objectives. In accordance with the NCP, “EPA expects to return useable ground waters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site” (40 CFR 300.430[a][1][iii][F]). EPA generally defers to state definitions of groundwater classification provided under EPA-endorsed Comprehensive State Groundwater Protection Programs ([EPA/540/G-88/003](#)).

Groundwater from the 300-FF-5 OU is contaminated and is not currently withdrawn from the aquifer for beneficial use; however, the potential beneficial use of the groundwater is as a drinking water source. Consistent with the beneficial-use classifications of Washington State and the EPA, the goal for remediating 300-FF-5 OU groundwater is to reduce contamination to levels that will allow its use as a future drinking water source.

Accordingly, the RAOs for the 300-FF-5 OU, as stated in the ROD ([EPA and DOE 2013](#)), are as follows:

- RAO 1. Prevent human exposure to groundwater containing COC concentrations above CULs.
- RAO 7. Restore groundwater impacted by Hanford Site releases to CULs, which include DWSs, within a timeframe that is reasonable given the particular circumstances of the site.

Remedy Components. The ROD for the 300-FF-5 OU, as signed in 2013, provided the following summary-level descriptions of the major components of the selected remedy (i.e., monitored natural attenuation, groundwater monitoring, enhanced attenuation of uranium at the top of the aquifer, and ICs); the italicized text in the following box is a direct quote from the 2013 ROD ([EPA and DOE 2013](#)). As noted in the ROD, the remedies selected may change somewhat through the remedy design and construction process. Any changes to the remedies described in the ROD will be documented using a technical memorandum in the administrative record, an ESD, or a ROD amendment, as appropriate.

Excerpt from ROD (EPA and DOE 2013):

Monitored Natural Attenuation (MNA) of Groundwater. Monitored natural attenuation is a remedial strategy that monitors natural attenuation processes until CULs are met, provided they are met within a reasonable timeframe. Natural attenuation relies on natural processes within the aquifer to achieve reductions in the toxicity, mobility, volume, concentration and/or bioavailability of contaminants. These natural processes include physical, chemical and biological transformations that occur without human intervention. Contaminants in

groundwater in 300-FF-5 that will be managed through MNA are nitrate and tritium down gradient from the 618-11 Burial Ground and TCE and DCE at the 300 Area Industrial Complex.

Natural attenuation of nitrate and tritium from the 618-11 Burial Ground will occur through a combination of dispersion during transport and natural radiological decay for tritium. Computer modeling predicts that the tritium concentrations will decrease to below the CUL by 2031. The waste within the 618-11 Burial Ground that released the nitrate and tritium will be removed by RTD.

MNA is used for the TCE and DCE in groundwater from the 300 Area Industrial Complex. Natural attenuation will occur primarily through physical attenuation (diffusion and dispersion) and biodegradation.

MNA includes monitoring to ensure the effectiveness of natural attenuation to meet CULs. Monitoring as a component of MNA as well as the remaining monitoring requirements for 300-FF-5 will be integrated into the sampling and analysis portion of the RD/RAWP. This integrated sampling is described in section 12.2.9 below (i.e., Section 12.2.9 in the ROD).

Groundwater Monitoring. Groundwater monitoring, including monitoring as required as a component of MNA, will be integrated into the sampling and analysis portion of the RD/RAWP. Sampling will be sufficient to document changes in contaminant plumes for all groundwater COCs. As part of monitoring the lateral extent of plumes, groundwater will be monitored in the near vicinity of the Columbia River throughout the 300 Area Industrial Complex and both north and south of that area to ensure lateral extent of the plumes are defined. Because several of the 300-FF-5 groundwater COCs are also contaminants in 200-PO-1 that move through the 300 Area, monitoring of 300-FF-5 COC plumes will include lateral extent sufficient to distinguish contamination that is part of 300-FF-5 versus 200-PO-1. Monitoring will continue until COCs have attained the CULs and are expected to continue to meet CULs and EPA approves termination of the monitoring. Considered in the evaluation will be processes that can affect concentrations such as river fluctuations, waste site activities and land use activities. Groundwater monitoring will be performed to evaluate the effectiveness of the selected 300-FF-5 remedy to achieve CULs. The monitoring will be for groundwater COCs (uranium, gross alpha, nitrate, TCE and DCE at the 300 Area Industrial Complex; uranium and gross alpha down gradient from the 618-7 Burial Ground; and tritium and nitrate down gradient from the 618-11 Burial Ground). [Note: monitoring is also conducted for uranium and gross alpha downgradient of the 618-10 Burial Ground and 316-4 crib in accordance with 300-FF-5 Operable Unit Remedy Implementation Sampling and Analysis Plan (DOE/RL-2014-42, Rev. 0).]

Enhanced Attenuation of Uranium at the Top of the Aquifer. Uranium sequestration phosphate solutions will be delivered to the top of the aquifer through injection wells to limit the lateral mobility of untreated uranium that may be mobilized from the vadose zone during surface infiltration and injection into the PRZ. Treatment will use the following general approach, with details to be developed in remedial design and established in the RD/RAWP:

- Well injection of phosphate reagent-amended water
- Reagent mixing facility, pipelines, injection wells, pumps, valves
- Phosphate reagent injection wells spaced approximately 60 to 120 m (200 to 400 ft) apart adjacent to (along the river side) the approximately 1 hectare (3 acre) target area. Preliminary design includes six injection wells
- Injection rates ranging from approximately 380 to 760 L/min (100 to 200 gal/min) for each well.

Institutional Controls (Common Elements for 300-FF-2 and 300-FF-5). "...Land-use controls will be maintained until CULs are achieved and the concentrations of hazardous substances are at such levels to allow for unlimited use and unrestricted exposure and EPA authorizes the removal of restrictions. ICs to be implemented by DOE to support achievement of the RAOs include the following:

- *In the event that land is transferred out of federal ownership, deed restrictions (proprietary controls such as easements and covenants) are required that are legally enforceable against subsequent property owners.*
- *In the event of any unauthorized access (e.g. trespassing), DOE shall report such incidents to the Benton County Sheriff's Office for investigation and evaluation of possible prosecution.*
- *Activities that would disrupt or lessen the performance of any component of the remedies are prohibited.*
- *The DOE shall report on the effectiveness of ICs for 300-FF-2 and 300-FF-5 in an annual report, or on an alternative reporting frequency specified by the lead regulatory agency. Such reporting may be for 300-FF-2 and 300-FF-5 alone or may be part of the Hanford Sitewide ICs report.*

Measures that are necessary to ensure continuation of ICs shall be taken before any lease or transfer of any land subject to ICs. DOE will provide notice to Ecology and EPA at least 6 months before any transfer or sale of land subject to ICs so that the lead regulatory agency can be involved in discussions to ensure that appropriate provisions are included in the transfer terms or conveyance documents to maintain effective ICs. If it is not possible for DOE to notify Ecology and EPA at least 6 months before any transfer or sale, DOE will notify Ecology and EPA as soon as possible, but no later than 60 days before the transfer or sale of any property subject to ICs. In addition to the land transfer notice and discussion provisions, DOE further agrees to provide Ecology and EPA with similar notice, within the same time frames, as to federal-to-federal transfer of property. DOE shall provide a copy of the executed deed or transfer assembly to Ecology and EPA. DOE shall notify EPA and Ecology immediately upon discovery of any activity inconsistent with the specific ICs."

Institutional Controls (Unique Elements for 300-FF-5): Land-use controls will be maintained until CULs are achieved and the concentrations of hazardous substances are at such levels to allow for unlimited use and unrestricted exposure and EPA authorizes the removal of restrictions. ICs to be implemented by DOE to support achievement of the RAOs are the following:

- *Administrative controls limiting 300-FF-5 groundwater access and use in a manner that is protective of human health where groundwater is above CULs (see figure 2 [of the 2013 ROD; the figure shows the 2012 locations of contaminant plumes for nitrate, tritium, and uranium within the 300-FF-5 OU]).*

Remedy Implementation Progress Prior to this (2016-2020) Review Period.

Both remedy components (i.e., continued monitoring of groundwater contaminated above health-based levels to ensure that concentrations continue to decrease, and ICs to ensure that groundwater use is restricted to prevent unacceptable exposures to groundwater), as specified in the 1996 interim action ROD ([EPA/ROD/R10-96/143](#), as amended), were implemented and continued up to and beyond the previous (2011-2015) review period. Remedy implementation highlights from the 2011-2015 period included the following:

- Submitted a draft proposed plan for remediation of the 300-FF-1, 300-FF-2, and 300-FF-5 OUs (December 2011)
- Issued the RI/FS and Proposed Plan: *Remedial Investigation/Feasibility Study for the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units* ([DOE/RL-2010-99](#)), *Remedial Investigation/Feasibility Study for the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units, Addendum* ([DOE/RL-2010-99-ADD1](#)), and *Proposed Plan for Remediation of the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units* ([DOE/RL-2011-47](#)) (July 2013)
- Issued a 300 Area ROD for the 300-FF-2 and 300-FF-5 OUs and a ROD amendment for the 300-FF-1 OU (November 2013)

- Continued to perform MNA and manage ICs as final action remedy components
- Issued the RDR/RAWP ([DOE/RL-2014-13](#)) and RDR/RAWP addendum for groundwater ([DOE/RL-2014-13-ADD2](#)) (June 2015)
- Completed implementation of enhanced attenuation remedy for uranium in the Stage A area (0.3 ha [0.75 ac]) in November 2015
- Issued *300-FF-5 Operable Unit Remedy Implementation Sampling and Analysis Plan* ([DOE/RL-2014-42](#)) (September 2015).

Further details on this earlier period of remedy implementation progress are included in the previous 5-year review report ([DOE/RL-2016-01](#), Rev. 0).

Issues/Corrective Actions from the Previous (2011-2015) 5-Year Review.

No issues/corrective actions specific to the 300-FF-5 OU were identified during the previous (2011-2015) 5-year review.

Protectiveness Statement from the Previous (2011-2015) 5-Year Review Report ([DOE/RL-2016-01](#)).

The 300-FF-5 OU protectiveness statement from the previous (2011-2015) 5-year review report was noted as follows:

***300-FF-5 Groundwater OU – Will Be Protective.** The remedy at the 300-FF-5 groundwater OU is expected to be protective upon completion. Groundwater monitoring is ongoing, and ICs are in place and are protecting human exposure to contaminated groundwater. Construction of the remedy component involving enhanced attenuation of uranium was completed in 2018 and documented in 2020; this is expected to reduce the timeframe for achieving uranium cleanup levels. In the interim, the remedial activities completed to date adequately address the exposure pathways that could result in unacceptable risks in these areas.*

Progress Since 2011-2015 Review

Accomplishments. The primary remedial action accomplishments for the 300-FF-5 groundwater OU during the past 5 years can be summarized as follows:

- Continued to perform MNA and manage ICs as final-action remedy components.
- Achieved the CUL for TCE at all 300-FF-5 OU wells in the TCE network (Table 17 in [ECF-300FF5-19-0031](#)); therefore, TCE is no longer monitored as a [CERCLA](#) COC as documented in [TPA-CN-0883](#) to the *300-FF-5 Operable Unit Remedy Implementation Sampling and Analysis Plan* (SAP) ([DOE/RL-2014-42](#)).
- Completed implementation of enhanced attenuation remedy for uranium in the Stage A area (0.3 ha [0.75 ac]) in November 2015 and in the Stage B area (0.91 ha [2.25 ac]) in September 2018.
- Published *300-FF-5 Operable Unit Enhanced Attenuation Stage A Delivery Performance Report* ([SGW-59614](#), Rev. 0) in December 2016.

- Issued *Remedial Action Report for the 300-FF-5 Operable Unit Interim Remedial Action* ([DOE/RL-2018-17](#)) to close out 300-FF-5 OU interim remedial action.
- Added an additional year of groundwater monitoring prior to implementation of Stage B as documented in [TPA-CN-0784](#) to [DOE/RL-2014-13-ADD2](#).
- Implemented Stage B of the enhanced attenuation remedy for uranium in September 2018 as documented in the initial performance evaluation [SGW-63113](#), *300-FF-5 Operable Unit Enhanced Attenuation Uranium Sequestration Completion Report*, issued in September 2020.
- Initiated monitoring at 28 additional wells to calibrate an expanded domain for the fate and transport model of the uranium plume in the 300 Area Industrial Complex, documented in [TPA-CN-0827](#) to [DOE/RL-2014-42](#).
- Added seven groundwater monitoring wells (13 wells total) to the pre- and post-Stage B monthly monitoring network, documented in [TPA-CN-0828](#) to [DOE/RL-2014-42-ADD1](#).
- Drilled, sampled, and decommissioned nine post-injection boreholes as part of implementation of the Stage B of the enhanced attenuation remedy for uranium, documented in [SGW-63544](#).
- Added 13 monitoring wells to be sampled quarterly for a year in the enhanced attenuation area to support calibration of the fate and transport model of the uranium plume in the 300 Area Industrial Complex, documented in [TPA-CN-0883](#) to [DOE/RL-2014-42](#).
- Initiated groundwater monitoring downgradient of the 324 Building and 300-296 waste site, documented in [TPA-CN-0883](#) to [DOE/RL-2014-42](#).
- Initiated higher frequency of groundwater monitoring at 11 wells in the vicinity of well 399-6-3 to support evaluation of possible sources for the temporarily elevated uranium concentration.

Remedy Implementation. The ROD ([EPA and DOE 2013](#)) was issued in 2013. In accordance with the 2013 ROD, the remedy for the 300-FF-5 OU consists of the following components:

- MNA for nitrate, tritium, TCE, and *cis*-1,2-DCE
- Groundwater monitoring for uranium, gross alpha, nitrate, tritium, TCE, and *cis*-1,2-DCE
- Enhanced attenuation of uranium using sequestration by phosphate application at the top of the aquifer
- ICs.

In accordance with the 2013 ROD, the in-progress interim actions were to use the cleanup levels in the 2013 ROD immediately upon its issuance. Performance of all other aspects of the interim action was to continue in accordance with the existing documents for the interim action until the new RDR/RAWP that implements the 2013 ROD was issued. The ROD also specifies that once the new RDR/RAWP is approved, it will direct future remedial actions and replace all interim-action ROD and earlier work plan requirements.

In 2015, DOE issued the following suite of RDR/RAWP documents:

- [DOE/RL-2014-13](#), *Integrated Remedial Design Report/Remedial Action Work Plan for the 300 Area (300-FF-1, 300-FF-2 & 300-FF-5 Operable Units)*, Rev. 0
- [DOE/RL-2014-13-ADD1](#), *Remedial Design Report/Remedial Action Work Plan for 300-FF-2 Soils*, Rev. 0
- [DOE/RL-2014-13-ADD2](#), *Remedial Design Report/Remedial Action Work Plan Addendum for the 300 Area Groundwater*, Rev. 0.

[DOE/RL-2014-13-ADD2](#), the RDR/RAWP for the 300-FF-5 OU, which implements the groundwater portion of the 2013 ROD, was issued in June 2015 and amended twice to accommodate schedule changes via [TPA-CN-700](#), “DOE/RL-2014-13-ADD2 Remedial Design Report/Remedial Action Work Plan Addendum for the 300 Area Groundwater,” in November 2015 and [TPA-CN-0784](#) in June 2017.

In June 2018, [DOE/RL-2018-17](#), *Remedial Action Report for the 300-FF-5 Operable Unit Interim Remedial Action*, was issued to close out the interim remedial action of MNA and IC for the 300-FF-5 OU documented in [EPA/ROD/R10-96/143](#).

In accordance with the plan and schedule included in the RDR/RAWP ([DOE/RL-2014-13-ADD2](#)), construction/implementation of all remedy components was expected to take several years and would be followed by several decades of O&M. The enhanced attenuation remedy was implemented in two sequential stages in accordance with the RDR/RAWP ([DOE/RL-2014-13-ADD2](#)). Stages A and B each included well/piezometer installations and phosphate injections to sequester uranium and preparation of installation and initial performance reports. The design for implementation of Stage A is documented in [DOE/RL-2014-42](#), *300-FF-5 Operable Unit Remedy Implementation Sampling and Analysis Plan*, and the design for implementation of Stage B is documented in [DOE/RL-2014-42-ADD1](#), *300-FF-5 Operable Unit Remedy Implementation Sampling and Analysis Plan Addendum for Stage B Uranium Sequestration*. The remedial action report documenting implementation of the enhanced attenuation remedy ([DOE/RL-2021-16](#), *Remedial Action Report for the 300 Area Application of Polyphosphate Solutions for Uranium Sequestration*) was issued in June 2021.

The performance monitoring plan contained in the remedy implementation SAP ([DOE/RL-2014-42](#)) identifies the well locations, sampling frequency, and analytes for the groundwater monitoring and MNA remedy components. The groundwater data are compared to the CULs in annual reports.

The IC component of the 300-FF-5 OU remedy is being managed under the [DOE/RL-2001-41](#), *Sitewide Institutional Controls Plan for the Hanford CERCLA Response Actions and RCRA Corrective Actions*. Table 2-31 presents an overview of the primary components of the 300-FF-5 OU remedy and their implementation status.

Table 2-31. Overview of 300-FF-5 Groundwater OU Remedy Implementation. (2 Pages)

Document Type	Date	Title						
ROD	11/2013	Record of Decision for 300-FF-2 and 300-FF-5, and Record of Decision Amendment for 300-FF-1 Hanford Site, Benton County, Washington (EPA and DOE 2013)						
RDR/RAWP	06/2015	Integrated Remedial Design Report/Remedial Action Work Plan for the 300 Area (300-FF-1, 300-FF-2 & 300-FF-5 Operable Units, DOE-2014-13, Rev. 0, Remedial Design Report/Remedial Action Work Plan for 300-FF-2 Soils, DOE/RL-2014-13-ADD1, Rev. 0, Remedial Design Report/Remedial Action Work Plan Addendum for the 300 Area Groundwater, DOE/RL-2014-13-ADD2, Rev. 0						
Remedy Implementation SAP and SAP ADD	09/2015	300-FF-5 Operable Unit Remedy Implementation Sampling and Analysis Plan, DOE/RL-2014-42, Rev. 0 and 300-FF-5 Operable Unit Remedy Implementation Sampling and Analysis Plan Addendum for Stage B Uranium Sequestration, DOE/RL-2014-42-ADD1, Rev. 0						
Applicable RAOs (brief description)	1. Prevent human exposure to groundwater containing COC concentrations above cleanup levels. 7. Restore groundwater impacted by Hanford Site releases to cleanup levels that include DWSs within a timeframe that is reasonable given the particular circumstances of the site.							
COCs	Cis-1,2-dichloroethene (DCE), gross alpha, nitrate, trichloroethene, tritium, and uranium (as metal)							
Remedy Component	Status (approximate percentage complete for implementing the remedy component as of December 2020) ^a						Duration of O&M (~years) ^b	Finish ^c (Est'd year)
	0	1-25	26-50	51-75	76-99	100%		
Monitored Natural Attenuation							28	2041
Groundwater Monitoring							28	2041
Enhanced Attenuation of Uranium (Stage A [implemented in 2015])							22-28	2035-2041
Enhanced Attenuation of Uranium (Stage B [implemented in 2018])							22-28	2035-2041
Institutional Controls							28	2041

^a Percentages reflect implementation status of the remedy component; post-startup upgrades and system performance optimization is considered part of O&M. 100% = fully implemented and now in O&M mode.

^b Approximate number of years to operate remedy component as estimated in ROD (shorter durations for certain COCs)

^c Estimated year when remedy component will be completed.

DOE/RL-2014-13, 2015, *Integrated Remedial Design Report/ Remedial Action Work Plan for the 300 Area (300-FF-1, 300-FF-2 and 300-FF-5 Operable Units)*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0081153H>.

DOE/RL-2014-13-ADD1, 2014, *Remedial Design Report/Remedial Action Work Plan for 300-FF-2 Soils*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0081152H>.

DOE/RL-2014-13-ADD2, 2015, *Remedial Design Report/Remedial Action Work Plan Addendum for the 300 Area Groundwater*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0081151H>.

DOE/RL-2014-42, 2015, *300-FF-5 Operable Unit Remedy Implementation Sampling and Analysis Plan*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0079669H>.

DOE/RL-2014-42, ADD1, 2018, *300-FF-5 Operable Unit Remedy Implementation Sampling and Analysis Plan Addendum for Stage B Uranium Sequestration*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <https://pdw.hanford.gov/document/0071642H>.

Table 2-31. Overview of 300-FF-5 Groundwater OU Remedy Implementation. (2 Pages)

EPA and DOE, 2013, *Hanford Site 300 Area Record of Decision for 300-FF-2 and 300-FF-5, and Record of Decision Amendment for 300-FF-1*, U.S. Environmental Protection Agency, Region 10, and U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <http://pdw.hanford.gov/arpir/pdf.cfm?accession=0087180>.

COC	= contaminant of concern	RAO	= remedial action objectives
O&M	= operation and maintenance	ROD	= record of decision
N/A	= not applicable	SAP	= sampling and analysis plan
OU	= operable unit		

Technical Assessments

Is the remedy functioning as intended by the decision documents?

Yes, the 300-FF-5 remedy is functioning as intended by the ROD ([EPA and DOE 2013](#)); remedy components include MNA, groundwater monitoring, enhanced attenuation of uranium, and ICs. Field construction of the remedy component for enhanced attenuation of uranium (supporting achievement of RAO 1 and RAO 7) began in 2015 for Stage A, documented in the Stage A completion report ([SGW-59614](#), Rev 0) published in December 2016. Stage B was implemented in 2018, documented in the enhanced attenuation completion report ([SGW-63113](#), *300-FF-5 Operable Unit Enhanced Attenuation Uranium Sequestration Completion Report* [Rev. 0]) published in September 2020. ICs (supporting achievement of RAO 1) are continuing to function as planned to prevent human exposure to the groundwater. As noted in [CPCC-00216](#), *300-FF-5 Enhanced Attenuation Area (EAA) Monitoring Well Data Assessment for Year 2020*, the predictions of uranium concentrations computed with the Stage B model compare reasonably well with the monitored data for the extended period through 2020. The simulated uranium concentrations follow the overall trends established prior to 2020 and compare with the concentrations measured in most of the wells, indicating that the model predictions continue to be adequate and representative of the aquifer conditions following the enhanced attenuation remedy. Therefore, remedial action continues to operate and function as designed and is expected to achieve cleanup levels. Additionally, monitoring activities being conducted are adequate to determine the protectiveness and effectiveness of the remedy.

Table 2-32 provides an overview of 300-FF-5 OU contaminant plume areas and associated changes to the areas during this 5-year review period. The network of wells and aquifer tubes sampled in 2020 is shown in Figure 2-27. Plume maps in Figures 2-28, 2-29, and 2-30 show the changes in plume shapes and areas during this 5-year review period. The plots in Figure 2-31 depict the estimated annual changes in contaminant plume areas over the past several 5-year periods with a generally decreasing trend for the period.

For more detailed information on the 300-FF-5 groundwater OU well locations (supporting the MNA remedy component, and achievement of RAO 7), distribution of contaminant concentrations within each plume, and historic trends associated with each 300-FF-5 OU COC, as well as for performance metrics associated with 300-FF-5 OU groundwater treatment, see the *Hanford Site Groundwater Monitoring Report* (published each summer for the previous calendar year): <http://www.hanford.gov/page.cfm/SoilGroundwaterAnnualReports>.

Table 2-32. Overview of 300-FF-5 Groundwater Contaminant Plumes.^a

Groundwater Contaminant	Cleanup Level ^b	Maximum Concentration (2020)	Plume Area ^c (km ²)			Shoreline Intersection ^d (m)		
			2015	2020	Change	2015	2020	Change
Uranium (300 Area, 618-10)	30 µg/L	1,440 µg/L	0.34	0.24	-0.10	1,480	217	-1,263
Gross Alpha (300 Area, 618-10)	15 pCi/L	45.2 pCi/L	N/C ^e	N/C ^e	N/A	N/C ^e	N/C ^e	N/A
<i>cis</i> -1,2-Dichloroethene (DCE) (300 Area)	16 µg/L	150 µg/L	U ^f	N/C ^f	U ^f	U ^f	U ^f	N/A
Trichloroethene (300 Area)	4 µg/L	1.70 J µg/L	U ^f	U ^f	U ^f	U ^f	U ^f	N/A
Tritium (618-11)	20,000 pCi/L	428,000 pCi/L	0.12 ^g	0.18	0.06	None	None	N/A
Nitrate (618-11)	45 mg/L ^h	164 mg/L	0.18 ^g	0.13	-0.05	None	None	N/A

^a Source: Hanford Annual Groundwater Monitoring Reports for 2015 and 2020. Available online at

<http://www.hanford.gov/page.cfm/SoilGroundwaterAnnualReports>.

^b Source: *Record of Decision for 300-FF-2 and 300-FF-5, and Record of Decision Amendment for 300-FF-1, Hanford Site 300 Area* (EPA and DOE 2013). The cleanup levels, as presented in the ROD, are include in Appendix C of this report.

^c Estimated area at a concentration greater than the cleanup level. Plume areas for uranium, tritium, and nitrate for 2015 and 2020 are based on Drinking Water Standards.

^d Length of Columbia River shoreline intersected by contaminant plumes.

^e Because gross alpha activity is associated with uranium, it will be addressed with the remediation of uranium.

^f Organics are locally present in deeper sediments. Plumes cannot be defined by current data.

^g Excludes tritium and nitrate in plume associated with the 200-PO-1 OU and nitrate from offsite.

^h 45 mg/L (expressed as the nitrate ion) is an equivalent concentration to the federal drinking water standard for nitrate of 10 mg/L (expressed as nitrate-nitrogen). To convert nitrate as the nitrate ion, the nitrate-nitrogen drinking water standard value is multiplied by 4.43.

EPA and DOE, 2013, *Hanford Site 300 Area Record of Decision for 300-FF-2 and 300-FF-5, and Record of Decision Amendment for 300-FF-1*, U.S. Environmental Protection Agency, Region 10, and U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <https://pdw.hanford.gov/document/0087180>.

J = laboratory estimated value

N/A = not applicable

N/C = not calculated

U = undefined

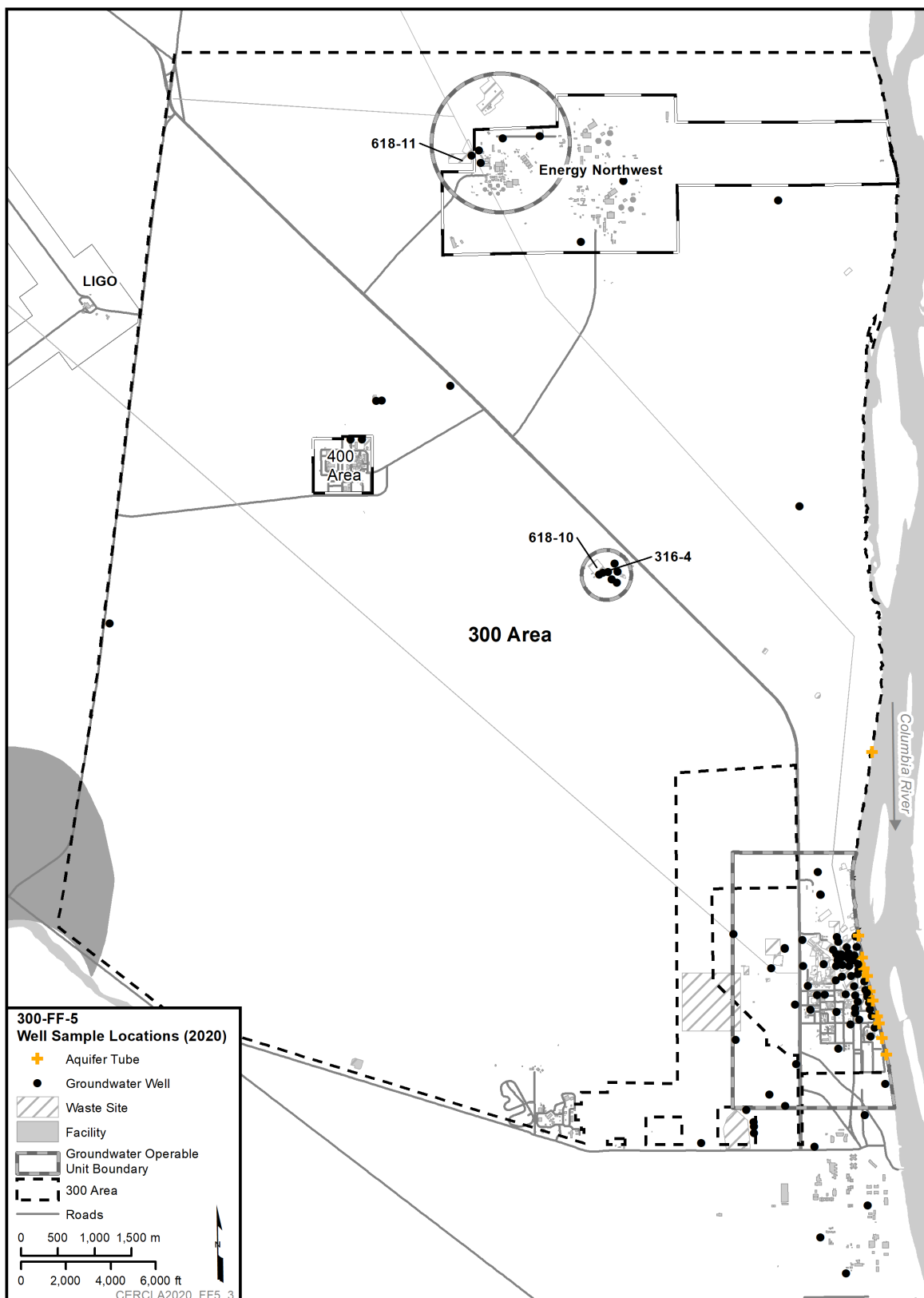


Figure 2-27. Locations of 300-Area Wells and Aquifer Tubes Sampled in 2020.

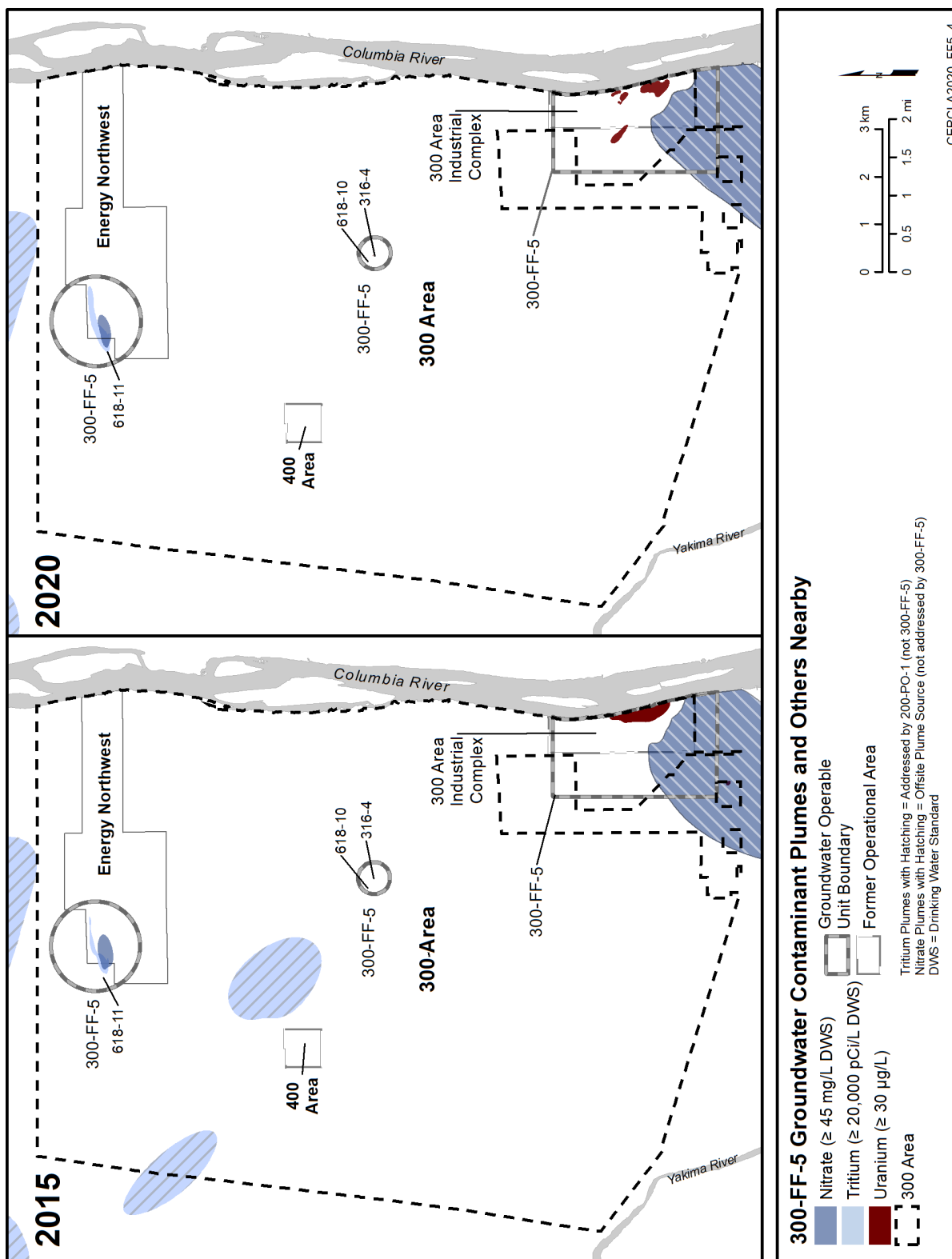


Figure 2-28. 300-FF-5 Groundwater Contaminant Plumes in 2015 (left) and 2020 (right).

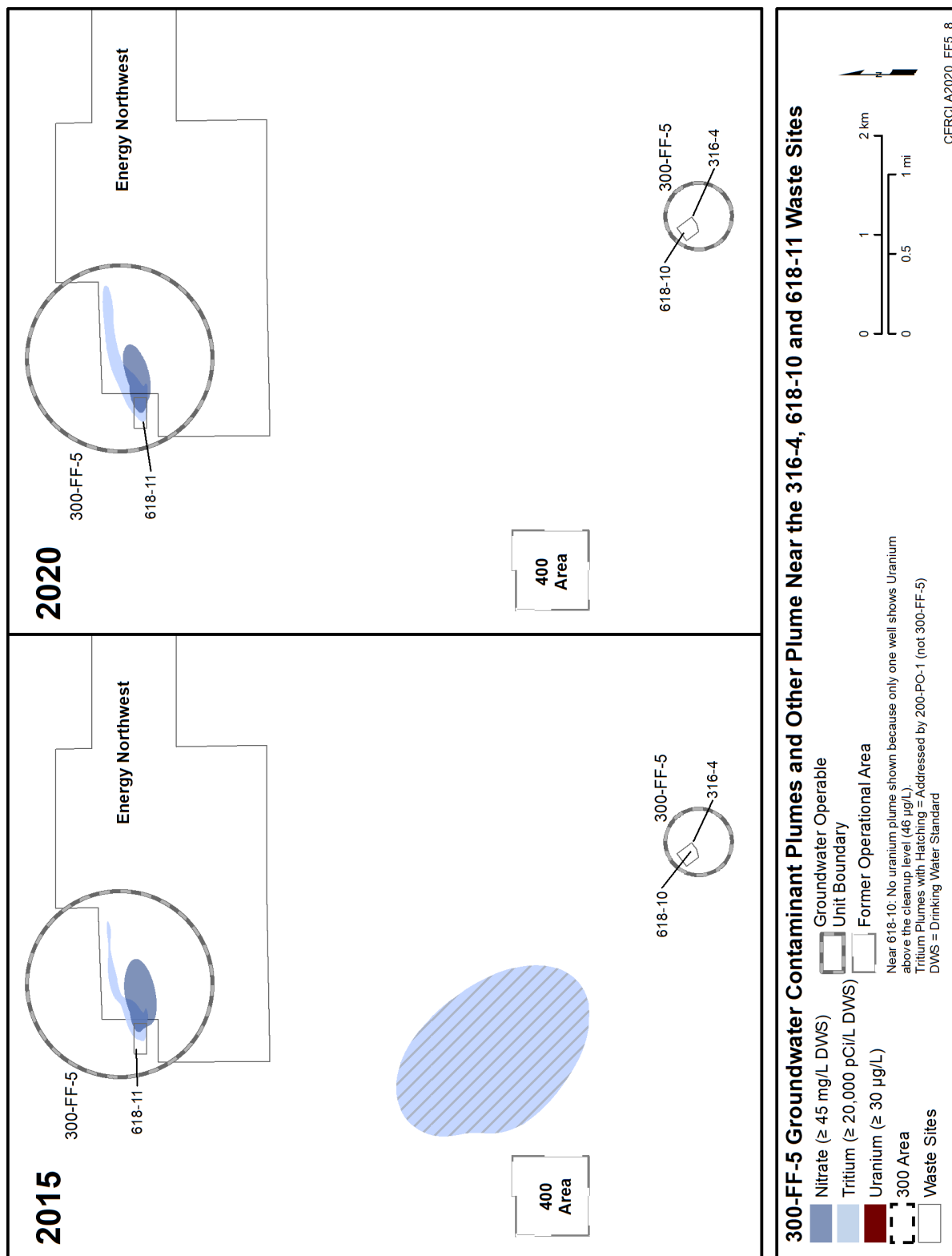


Figure 2-29. 300-FF-5 Groundwater Contaminant Plumes Near 316-4, 618-10, and 618-11 Waste Sites in 2015 (left) and 2020 (right).

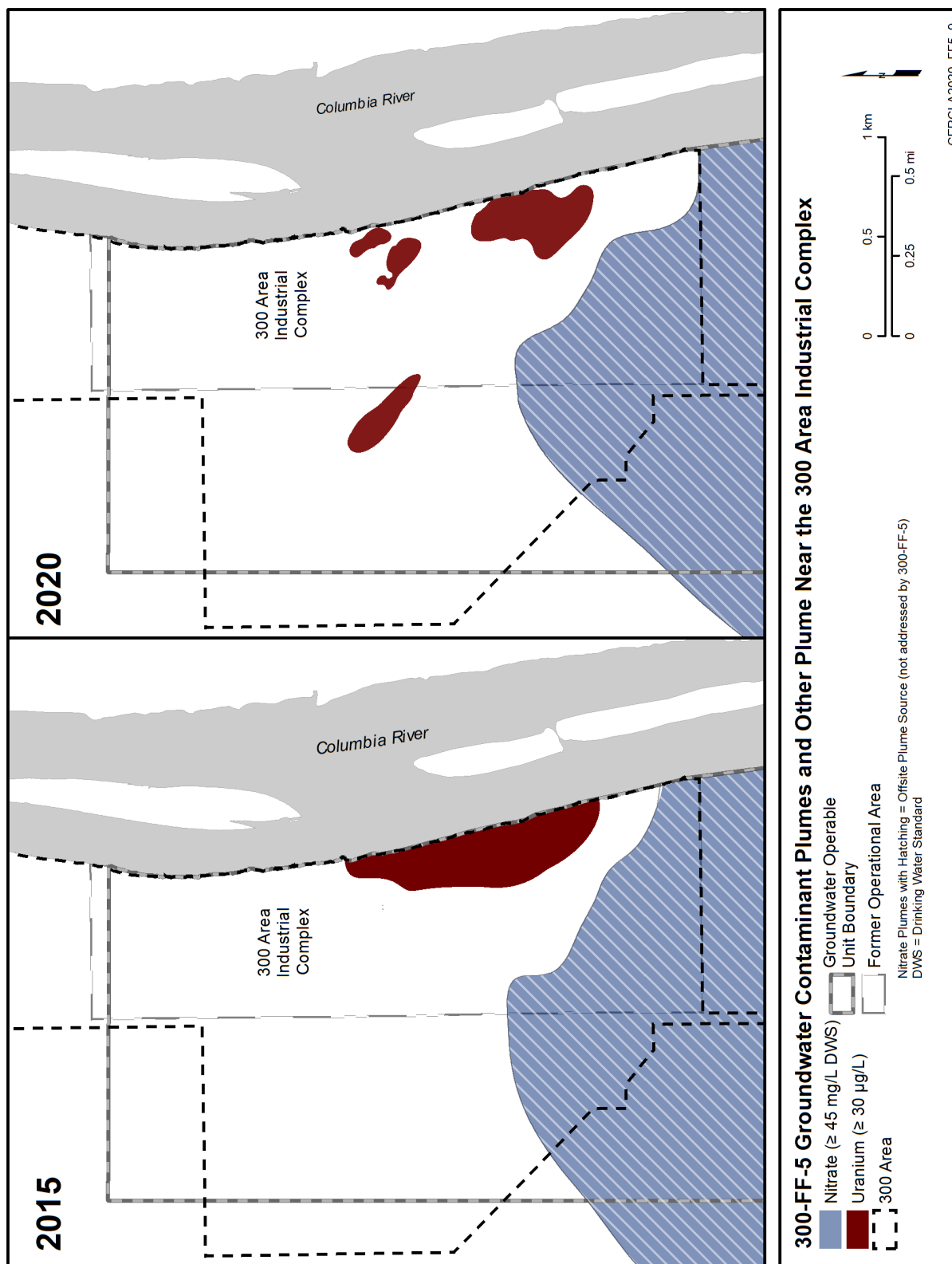


Figure 2-30. 300-FF-5 Groundwater OU and Nearby Plumes in 2015 (left) and 2020 (right).

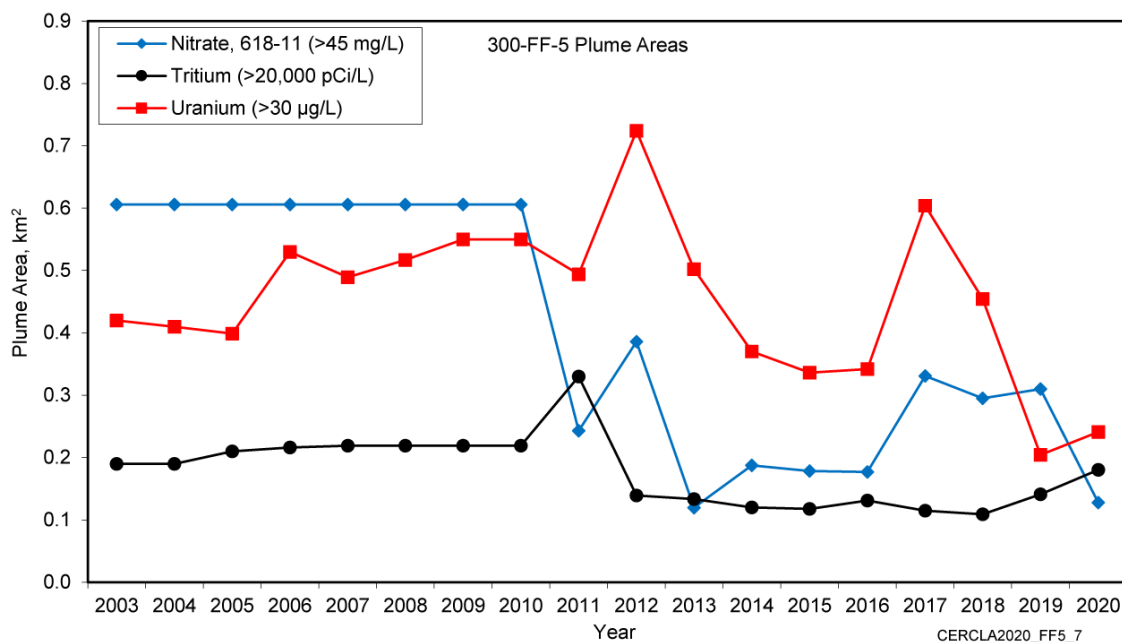


Figure 2-31. 300-FF-5 Trend Plots of Contaminant Plume Areas (2003-2020).

ICs, as required by the 2013 ROD ([EPA and DOE 2013](#)), are captured in [DOE/RL-2001-41](#) and are actively managed. ICs applicable within the entire 300 Area IC boundary area include applying deed restrictions in the event that land is transferred out of federal ownership, reporting of unauthorized access to the Benton County Sheriff's Office, prohibiting any activities that would disrupt or lessen the performance of any component of the remedy, and notifying EPA and Ecology on discovery of any activity inconsistent with the specific ICs. As further described in [DOE/RL-2001-41](#), DOE also has other administrative ICs (e.g., requirement for a site excavation permitting program) to limit the access and use of groundwater in a manner that protects human health where groundwater contamination is above the cleanup levels, protects environmental and cultural resources, and prevents enhanced recharge (e.g., no irrigation or landscape watering, controlling drainage from low permeability areas, and preventing bare gravel or bare sand covers). Assessments on these and other ICs applicable to the 300-FF-5 OU are performed annually and any noted issues or actions are presented by DOE to the Site regulators each fall and documented in meeting minutes, which are archived in the Hanford Site Administrative Record (see example in Attachments 4 and 6 at the following link: <https://pdw.hanford.gov/document/AR-04230>). The annual IC assessments are also now captured in an annual report (e.g., [HNF-65616, FY2020 Sitewide Institutional Control Assessment](#), Rev. 0). During the 5-year review period of 2016 through 2020, appropriate ICs for the 300-FF-5 groundwater OU were found to be in place and maintained, and the objectives for the ICs are being met.

Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of remedy selection still valid?

The exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of remedy selection (2013) are still valid for the OU. No changes were identified in the exposure assumptions, toxicity data, or drinking water standards that would result in a change to the 300-FF-5 OU cleanup levels. DOE regularly monitors toxicity data and applicable cleanup levels for chemicals as part of ongoing risk assessment and PRG development needs for other OUs. There have been no significant promulgated changes to relevant cleanup levels or to the sources of toxicity data underlying cleanup level development since the time of

the ROD. The groundwater cleanup levels, as presented in the ROD ([EPA and DOE 2013](#)), are included in Appendix C of this report.

Has any other information come to light that could call into question the protectiveness of the remedy?

No information has come to light that would call into question the protectiveness of the remedy.

Issues/Recommendations During this Review Period

Issues. No issues specific to the 300-FF-5 OU were identified during this 5-year review.

Corrective Actions. No corrective actions were identified.

Protectiveness Statements

300-FF-5 Groundwater OU –Protective.

The remedy for the 300-FF-5 groundwater OU is protective of human health and the environment.

The RAO to restore groundwater in the 300-FF-5 OU to cleanup levels that include drinking water standards within a timeframe that is reasonable, given the particular circumstances of the site (i.e., by 2041), is being met by implementation of remedy components involving MNA, groundwater monitoring, and enhanced attenuation of uranium. Construction of the remedy component involving enhanced attenuation of uranium was completed in 2018 and documented in 2020; this is expected to reduce the timeframe for achieving uranium cleanup levels. MNA and groundwater monitoring have been implemented and are ongoing. The RAO of preventing human exposure to groundwater containing COC concentrations above cleanup levels is being met by the implementation and the continued management of ICs.

2.5 1100 Area 1100-EM-1 Operable Unit (Horn Rapids Landfill)

Background

The 1100 Area was officially deleted from the NPL in 1996, as documented in [61 FR 51019](#), “National Oil and Hazardous Substances Pollution Contingency Plan; National Priorities List Update.” The 1100 Area contained four OUs: 1100-EM-1, 1100-EM-2, 1100-EM-3, and 1100-IU-1. Construction of the remedies selected for the 1100 Area OUs in its final ROD, *EPA Superfund Record of Decision: USDOE Hanford 1100-Area* ([EPA/ROD/R10-93/063](#)), as amended, was completed in 1995. The remedy components included offsite incineration of Bis (2-ethylhexyl) phthalate-contaminated soils, offsite disposal of polychlorinated biphenyl (PCB)-contaminated soils, installation of a landfill cap in accordance with the asbestos “National Emission Standards for Hazardous Air Pollutants” (NESHAP) ([40 CFR 61.151](#)), offsite disposal of contaminated soil and debris, natural attenuation and groundwater monitoring, and ICs.

Even though the RAOs were met years ago and the 1100 Area has been deleted from the NPL, one 1100-EM-1 OU waste site, the Horn Rapids Landfill, contains asbestos. As long as asbestos (a hazardous substance) remains at the landfill site and prevents the property from being released for unlimited use or unrestricted exposure, the landfill will be included in [CERCLA](#) 5-year reviews.

Chronology

Table 2-33 lists the remedial action decision documents relevant to the 1100-EM-1 source OU’s Horn Rapids Landfill as of December 31, 2020. Figure 2-32 shows an aerial view of 1100-EM-1 OU.

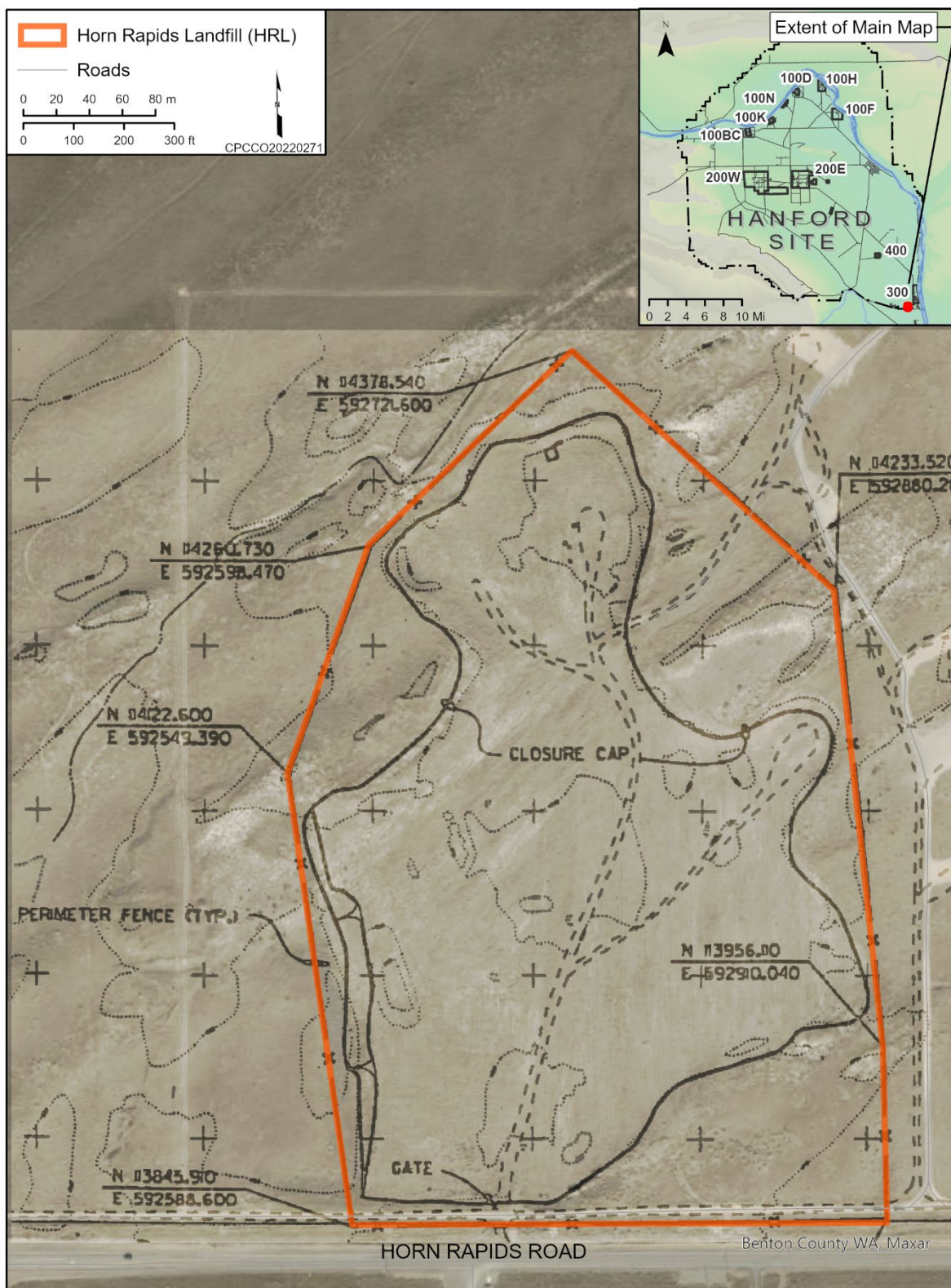
Table 2-33. Decision Documents for the 1100-EM-1 Source Operable Unit, Horn Rapids Landfill.

Date	Location	Title
9/1993	EPA/ROD/R10-93/063	<i>Record of Decision for the U.S. DOE Hanford 1100 Area Final Remedial Action for 1100-EM-1, 1100-EM-2, 1100-EM-3 and 1100-IU-1.</i> This ROD authorizes the construction of ERDF to provide waste disposal capacity for cleanup of contaminated areas on the Hanford Site.
7/1996	EPA 1996	<i>Superfund final Closeout Report U.S. Department of Energy 1100 Area.</i> This report documents the completion of all construction for the Hanford 1100 Area and concluded that the remedial action had been successfully completed.
9/2010	(Ecology 2010)	<i>Explanation of Significant Differences for the Record of Decision for the USDOE.</i> This ESD clarifies the institutional control requirements for the Horn Rapids Landfill including: to control access to the landfill property; maintaining the fencing and signs to prevent disturbance of the landfill contents; and to prevent the development and use of the landfill property for residential housing, elementary and secondary schools, or childcare facilities.

ERDF = Environmental Restoration Disposal Facility

ESD = Explanation of Significant Difference

See Appendix B for a consolidated list of decision documents for Hanford Site OUs.



Source: FY2020 Sitewide Institutional Controls Assessment [HNF-65616](#)

Figure 2-32. Aerial View of 1100-EM-1 OU, Horn Rapids Landfill.

Remedial Action

The Horn Rapids Landfill (1100-EM-1) was used as an Asbestos Landfill and was closed in accordance with the Asbestos NESHAP. Asbestos waste disposed of in the Horn Rapids Landfill is in place and remains secure. In September 2010, Ecology issued *Explanation of Significant Differences for the Record of Decision for the USDOE Hanford 1100 Area in Benton County, Washington* ([Ecology 2010](#)) for the 1100 Area ROD to modify the IC requirements to be consistent with the current EPA guidance. A fence, signage, and the existing cap are maintained and upgraded, as needed.

Remedy Components. Groundwater monitoring near the 1100-EM-1 OU continued into 2015, even though groundwater monitoring since 2001 had repeatedly demonstrated that TCE levels in compliance wells remained below the 5 mg/L cleanup level. On August 13, 2015, DOE and the lead regulatory agency (EPA) agreed, per [TPA-CN-679](#), “PNL-12220 -- Sampling and Analysis Plan for Groundwater Monitoring 1100-EM-1 Operable Unit,” that annual groundwater monitoring for 1100-EM-1 groundwater is no longer required and may be discontinued.

The remaining remedy components for the Horn Rapids Landfill involves the continued management of ICs (i.e., entry restrictions, notice in deed, land use management, and miscellaneous provisions) as well as the inspection and maintenance of the landfill cover.

Issues/Corrective Actions from the Previous 5-Year Review. No previous issues or actions were noted for the 1100-EM-1 Horn Rapids Landfill in the 2011-2015 [CERCLA](#) 5-year review.

Protectiveness Statement from the Previous (2011-2015) 5-Year Review Report ([DOE/RL-2016-01](#)). The 1100-EM-1 Horn Rapids Landfill protectiveness statement from the previous (2011-2015) 5-year review report was noted as follows:

***1100-EM-1 Source OU – Protective.** The remedy at the 1100-EM-1 OU is protective of human health and the environment. Elements of the remedy that protect human health and the environment involve continuing ICs to address the buried asbestos at the Horn Rapids Landfill. The RAOs were met at the landfill by offsite disposal of PCB-contaminated soils, capping of the landfill in accordance the Asbestos NESHAP ([40 CFR 61.151](#)), and providing adequate ICs to prevent future receptor exposure to contamination. The continuing ICs include entry restrictions, notice in deed, land use management, and miscellaneous provisions. Fencing, signage and the existing landfill cap are routinely inspected, maintained, and upgraded, as needed.*

Progress Since 2011-2015 Review

Accomplishments. ICs continued to be actively managed.

Remedy Implementation. See status summary under “Accomplishments.”

Technical Assessment

Is the remedy functioning as intended by the decision document?

Yes, the remedy for the Horn Rapids Landfill is functioning as intended by the ROD ([EPA/ROD/R10-99/039](#)), as amended.

The IC component for the Horn Rapids Landfill remedy was incorporated into [DOE/RL-2001-41](#). These ICs are assessed annually, and DOE presents a summary including any noted issues or actions to the Site regulators each fall at the unit managers’ meeting. The presentation is documented in the meeting minutes, which are archived in the Hanford Site Administrative Record (see examples in Attachments 4

and 6 at the following link: <https://pdw.hanford.gov/document/AR-04230>). The annual IC assessments, including the Horn Rapids Landfill, are also now captured in an annual report (e.g., see pages 3-59 to 3-63 in [HNF-65616](#), *FY2020 Sitewide Institutional Control Assessment*).

During this 5-year review period, no issues were noted with the fencing or signs. The landfill cover remains protective of human health and the environment. Inspection and maintenance of the Horn Rapids Landfill cover and ICs are the only remaining remedy components and will continue to be addressed in future [CERCLA](#) 5-year reviews unless a decision is made to clean-close the property.

Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of remedy selection still valid?

The exposure assumptions, toxicity data, cleanup levels, and interim RAOs used at the time of remedy selection are still valid.

Has any other information come to light that could call into question the protectiveness of the remedy?

No new information has come to light that could call into question the protectiveness of the interim remedy for the Horn Rapids Landfill.

Issues/Recommendations During this Review Period

Issues. No issues specific to the 1100-EM-1 Source OU (Horn Rapids Landfill) were identified during this 5-year review.

Recommendations. No corrective actions are recommended.

Protectiveness Statement

1100-EM-1 Source OU – Protective. The remedy at the 1100-EM-1 OU is protective of human health and the environment.

Elements of the remedy that protect human health and the environment involve continuing ICs to address the buried asbestos at the Horn Rapids Landfill. The RAOs were met at the landfill by offsite disposal of PCB-contaminated soils, capping of the landfill in accordance the Asbestos NESHAP ([40 CFR 61.151](#)), and providing adequate ICs to prevent future receptor exposure to contamination. The continuing ICs include entry restrictions, notice in deed, land use management, and miscellaneous provisions. Fencing, signage and the existing landfill cap are routinely inspected, maintained, and upgraded, as needed.

No further review for the 1100 Area is included in this report.

3.0 CENTRAL PLATEAU (200 AREA NATIONAL PRIORITIES LIST SITE)

3.1 Background

The 200 Area NPL Site comprises the 200-East and -West Areas and a smaller 200-North Area, all located on the Central Plateau, which covers approximately 195 km² (75 mi²). The 200-East Area is located 27 km (17 mi) north-northwest of the city of Richland. The 200-West Area is located 9.6 km (6 mi) farther west. The 200 Area was added to the NPL on October 4, 1989, and remedial investigations began in 1992. Unless specifically delineated, the 200 Area, as mentioned in this report refers to the 200-East, 200-West, and 200-North Areas.

Historical Perspective. The Central Plateau's 200 Areas were used primarily for waste management activities and reprocessing SNF to recover special nuclear materials for use in national defense. Approximately 1,000 facilities, structures, and buildings, including the Plutonium Finishing Plant and five large chemical processing or canyon facilities (T-Plant, B-Plant, U-Plant, REDuction-OXidation [REDOX] Plant, and the Plutonium/Uranium Extraction [PUREX] Plant) were built to support processing irradiated fuel from the plutonium production reactors. These processing activities generated large volumes of radioactive, hazardous, and mixed waste that either were stored in underground tanks; disposed of to the soil column as liquid effluent via engineered structures such as cribs, trenches, and french drains; or were discharged to the soil column using ponds. Some inadvertent releases resulted from spills and leaks. The liquid effluents were transported to the disposal waste sites or tank farms via single- and double-wall pipelines or unlined ditches. The processing activities also generated solid waste that was disposed of in landfills. The intentional disposal and inadvertent release of this waste created more than 800 waste sites in the Central Plateau.

Chemical processing of nuclear materials was terminated in the early 1990s but ongoing waste management activities are expected to continue into the future. Radioactive- and mixed-waste treatment and disposal are anticipated to continue until approximately 2050. The underground tank farms, buried solid waste, and contaminated inactive soil areas and groundwater are the legacy of the production mission and the primary focus of today's cleanup mission.

High-radioactivity liquid effluents generated during reprocessing operations at the canyons were sent to 177 single- and double-shell underground tanks in tank farms on the Central Plateau. These single-shell tanks (SST) and double-shell tanks (DST) range in size from 208,198 L (55,000 gal) to approximately 3.8 million L (1 million gal). The tanks received liquid waste from all the processing facilities.

DSTs are active [RCRA](#)-permitted TSD units, while SSTs are [RCRA](#) TSD units in varying stages of waste retrieval and closure planning. In some cases, leaks from SSTs are either known or suspected to commingle with soil contamination from liquid effluent disposal sites (e.g., cribs). The Tri-Party Agencies are beginning to characterize the commingled contamination in an integrated manner (e.g., at the B, BX, and BY tank farms and adjacent waste disposal sites).

Another key component of the 200 Area is ERDF, which was built to provide a safe disposal site for waste generated by the ongoing cleanup activities across the Site. ERDF is discussed in Section 3.4.2.3.

Cleanup Approach. As described in Revision 1 of [DOE/RL-2009-10](#), *Hanford Site Cleanup Completion Framework*, cleanup of the Central Plateau is a highly complex activity because of the large number of waste sites, surplus facilities, active treatment and disposal facilities, and areas of deep soil contamination.

Past discharges of more than 450 billion gal of liquid waste and cooling water to the soil on the Central Plateau and on the River Corridor have resulted in about 155 km² (60 mi²) of contaminated groundwater across the Hanford Site. Some plumes that resulted from releases from Central Plateau facilities extend far beyond the plateau. Containing and remediating these plumes remains a high priority. Near-term actions are being taken on the Central Plateau to control plume migration

DOE's goal is to minimize the area used for long-term waste management activities that require ICs to ensure protection of human health and the environment. At the completion of cleanup efforts, some residual hazardous and radioactive contamination will remain, both in surface disposal facilities and in subsurface media. To meet DOE's goal, the residual contamination will be confined within a portion of the Central Plateau called the Inner Area.

DOE's Central Plateau cleanup strategy includes the following elements:

- Implement groundwater treatment systems to contain contaminant plumes within near proximity to Central Plateau's continuing sources, thereby protecting the Columbia River
- Implement groundwater treatment alternatives, including active treatment, to restore the groundwater
- Make and implement cleanup decisions in a geographic approach analogous to the geographic approach applied to the River Corridor
- Apply deep vadose zone treatment technologies to protect the groundwater
- Make and implement cleanup decisions that are protective of human health and the environment and that support anticipated future land use
- Address residual contamination in the outer portion of the Central Plateau to further reduce the active cleanup footprint of the Hanford Site
- Remediate the inner portion of the plateau to make the area used for long-term waste management activities as small as practical.

Central Plateau Land Areas

The Central Plateau's Inner Area is currently defined by DOE ([DOE/RL-2009-10](#)) as the final footprint of the Hanford Site that will be dedicated to waste management and containment of residual contamination; the Inner Area will remain under federal ownership and control for the future. The final Inner Area boundary will be defined by current and future waste disposal decisions that will result in the requirement for continued waste management and containment of residual contamination.

In 2013-2014, the Tri-Party Agencies undertook an initiative to develop a set of cleanup principles for the Inner Area of the Central Plateau. The outcome of this initiative is the establishment of an overarching and consistent set of cleanup principles that the Tri-Parties have agreed are the foundation for evaluating waste sites and making cleanup decisions in each of the OUs within the Inner Area. The overarching goals of the principles are to (1) provide a consistent approach for assessment of risks to human health and the environment and evaluation of remedial alternatives within the Inner Area; and (2) identify and implement regulatory strategies that will optimize assessment resources, streamline documentation requirements, and promote consistency in decisions. The substantive components of these principles related to land use, baseline risk assessments, cleanup levels, points of compliance, and regulatory

strategies are defined below. The approved principles are documented in [DOE/RL-2019-46, *Central Plateau Inner Area Cleanup Principles and Parameters*](#).

The Outer Area is defined as all areas of the Central Plateau beyond the Inner Area boundary. The Tri-Party Agencies are planning to clean up this portion of the Site to a level comparable to the level agreed on for the River Corridor. Contaminated soil and debris from the Outer Area that exceeds cleanup standards will be remediated and sent to ERDF for final disposal. Completion of the Outer Area cleanup will shrink the active cleanup footprint to the approximately 16 km² (10 mi²) final Inner Area.

Land Use and Groundwater Use

Given that land use helps form the basis for exposure assessment assumptions and risk characterization conclusions under [CERCLA](#), the Central Plateau's current and reasonably anticipated future land use, current groundwater uses, and potential future beneficial uses of groundwater are described in the following subsections. The basis for the following narrative is the 200 Area NPL Site's most recent CERCLA interim ROD (*Interim Record of Decision Hanford 200 Area Superfund Site 200-BP-5 and 200-PO-1 Operable Units* [[EPA 2021b](#)]).

Current and Anticipated Future Land Use

Current land use on the Central Plateau is industrial, and public access to the site is restricted. Land use in the 200-West and 200-East Areas is anticipated to remain industrial for the foreseeable future and will be used for ongoing waste disposal operations, waste remediation activities, and infrastructure services. DOE worked for several years with cooperating agencies to define a land use plan for the Hanford Site. The cooperating agencies and stakeholders included the National Park Service, Tribal Nations, the states of Washington and Oregon, local county and city governments, economic and business development interests, environmental groups, and agricultural interests. [Drummond \(1992\)](#), *The Future for Hanford: Uses and Cleanup – The Final Report of the Hanford Future Site Uses Working Group*, was an early product of the efforts to develop land use assumptions. The report recognized that the Central Plateau would be used to some degree for waste management activities for the foreseeable future. Following the report, DOE issued DOE/EIS-0222-F, *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement*, see Section 4.0 for access to document (hereinafter referred to as the HCP-EIS) and the associated HCP-EIS ROD ([64 FR 61615](#), "Record of Decision: Hanford Comprehensive Land-Use Plan Environmental Impact Statement (HCP EIS)") in 1999.

The HCP-EIS analyzed the potential environmental impacts of alternative land use plans for the Hanford Site and considered the land use implication of ongoing and proposed activities. Under the preferred land use alternative selected in the HCP-EIS ROD, the Central Plateau was designated for industrial exclusive use, defined as areas suitable and desirable for treatment, storage, and disposal; and disposal of hazardous, dangerous, radioactive, and nonradioactive waste, as well as related activities.

EPA and Ecology agree with statements in the HCP-EIS ROD that state that Hanford's Central Plateau was designated for industrial use, (defined as areas suitable and desirable for TSD of hazardous, dangerous, radioactive, and nonradioactive wastes as well as related activities); corresponding cleanup levels have been identified in CERCLA decision documents for the Central Plateau's Inner Area.

The Central Plateau Outer Area is designated for conservation/mining land uses, as defined in the HCP-EIS (Figure 1-2). The conservation/mining land use area encompasses most of the Central Plateau Outer Area. CERCLA documents for Outer Area sites in the conservation/mining land use area will set exposure scenarios and cleanup levels that are consistent with cleanup done in the River Corridor.

Current Groundwater Use

Groundwater beneath the Central Plateau is currently contaminated, and withdrawal for any purpose other than research, monitoring, or treatment is prohibited as a result of ICs placed on its use by DOE. Under current Hanford Site use restrictions, there are no complete human exposures. There are no ecological exposure pathways since this groundwater does not discharge to surface water or reach the Columbia River at levels that present an unacceptable risk. Further, regardless of land use designations, the groundwater will not become a future source of drinking water until DWS are achieved.

Groundwater Beneficial Use

The NCP ([40 CFR 300.430\(a\)\(1\)\(iii\)\(F\)](#)) 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.” Washington State regulations contain a similar provision ([WAC 173-340-720\(1\)\(a\)](#)), “Model Toxics Control Act—Cleanup” [also referred to as the Model Toxics Control Act (MTCA)], “Groundwater Cleanup Standards”). When restoration of groundwater to beneficial uses is not practicable, programs will be implemented to prevent further migration of the plume, prevent exposure to the contaminated groundwater, and evaluate further risk reduction.

Given the nature of the groundwater in the Central Plateau, potential beneficial groundwater uses include drinking water, irrigation, and industrial uses. Drinking water use includes other domestic uses such as bathing and cooking. The Tri-Party agencies’ goal for Hanford Site groundwater is consistent with the NCP.

3.2 200 Area Operable Units

To support waste site remediation in the 200 Area, more than 15 source OUs have been established. These OUs comprise more than 800 waste sites in a wide range of types (e.g., ponds, cribs, ditches, trenches, pipelines, tanks, landfills, canyon buildings, and unplanned releases to soil). The general locations of the Central Plateau’s source OUs are shown in Figure 3-1. While the source OUs in the Central Plateau are in various stages of the [CERCLA](#) process, RODs have been published for interim or final remedial action at the 200-CU-1 (U-Plant), 200-CW-3, 200-DF-1 (ERDF), and the 200-PW-1/3/6 and 200-CW-5 OUs (a grouping of primarily plutonium- and cesium-contaminated waste site OUs). These OUs are addressed in this 5-year review document. As remedial action decisions are made for the other source OUs in the Central Plateau, the OUs will be added to future 5-year reviews.

To support groundwater remediation in the 200 Area, four groundwater OUs have been established: 200-BP-5, 200-PO-1, 200-UP-1, and 200-ZP-1. The 200 Area groundwater OUs are shown in Figure 3-2. This 5-year review covers two 200 Area groundwater OUs (200-UP-1 and 200-ZP-1, both in the 200-West Area) where remedial actions published in RODs are being implemented. As remedial action decisions are made for the other two groundwater OUs based in the Central Plateau, they will be included in future 5-year reviews.

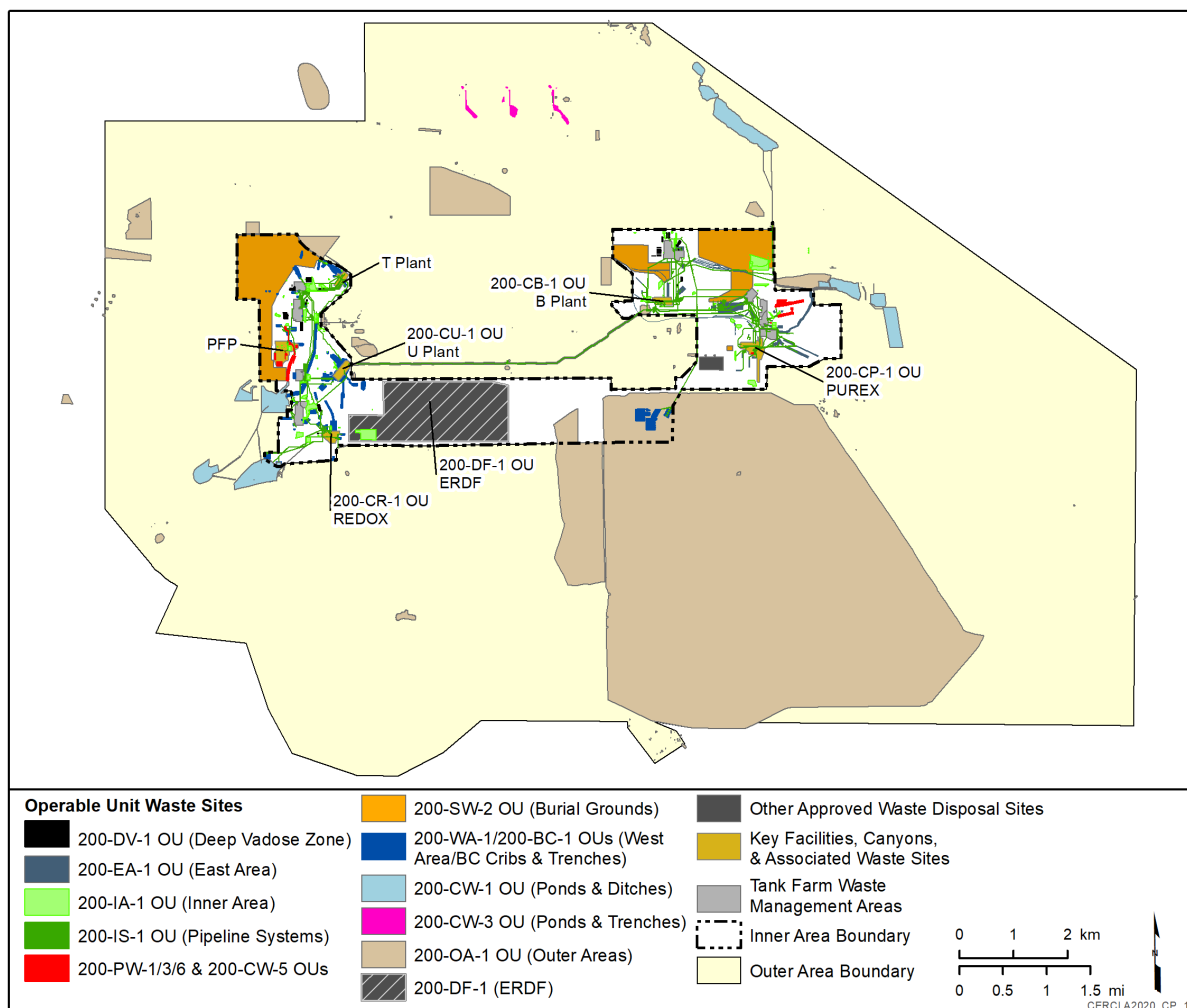


Figure 3-1. Source Operable Units in the Central Plateau.

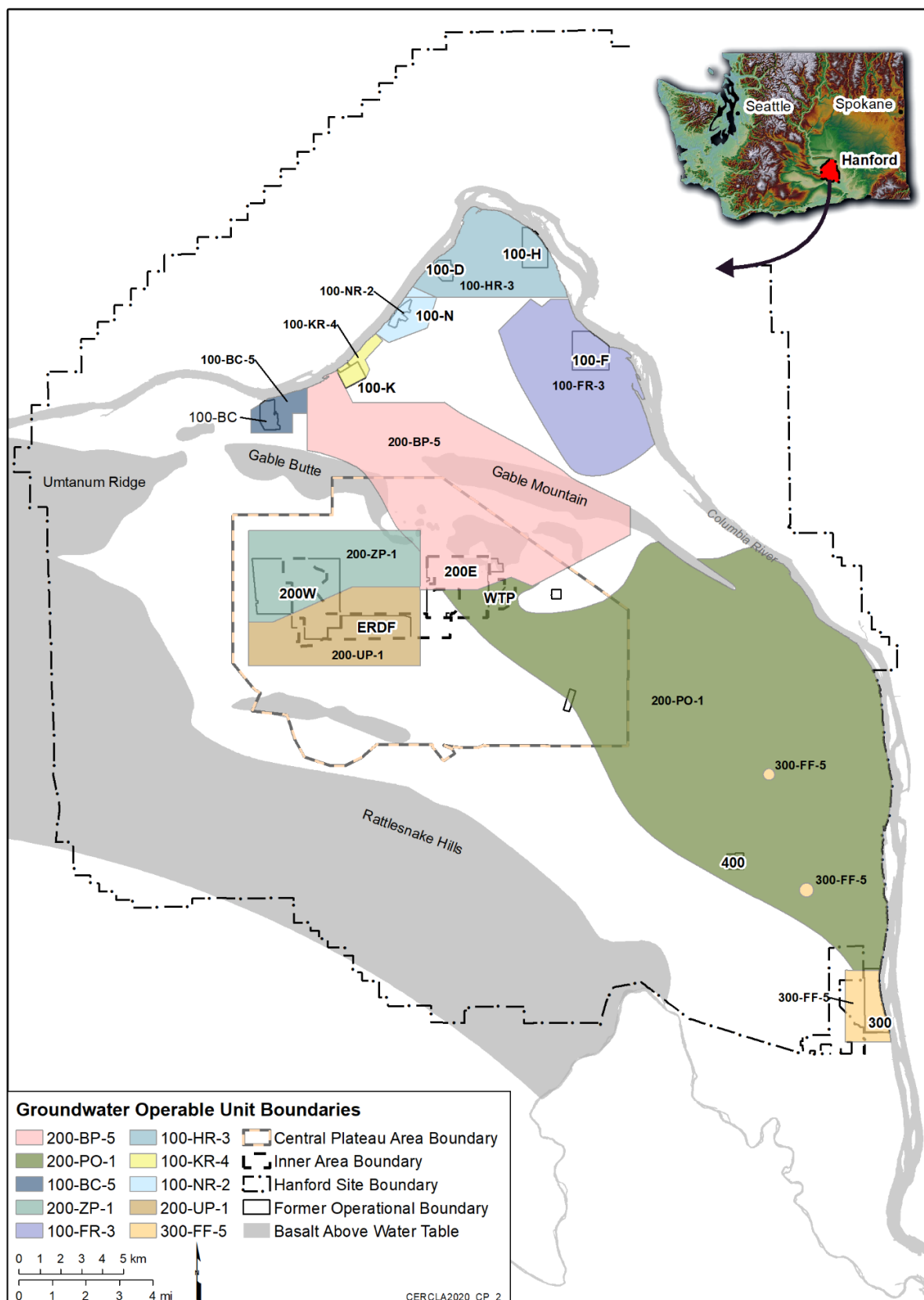


Figure 3-2. Hanford Groundwater Operable Units.

The following 12 source OUs and 2 groundwater OUs, which are based in the Central Plateau, are undergoing the RI/FS process and are out of scope for this 5-year review report but will be included in future 5-year reviews once remedial action decisions are published in RODs and implementation of the remedy has been initiated.

- Source OUs not included in this 5-year review:
 - 200-BC-1, cribs, trenches, and tank associated with uranium recovery and tank waste scavenging operations in the 200-East Inner Area
 - 200-CB-1, B-Plant canyon and service facility
 - 200-CP-1, PUREX canyon and service facility
 - 200-CR-1, REDOX canyon and service facility
 - 200-CW-1, cooling water ponds and ditches in 200 Area
 - 200-DV-1, cribs and trenches in the 200 Area that contributed to deep vadose-zone contamination
 - 200-EA-1, 200-East Inner Area waste sites
 - 200-IA-1, Inner Area shallow sites
 - 200-IS-1, pipelines and associated structures in Central Plateau
 - 200-OA-1, trenches, cribs, pits, ditches, dumping areas in Central Plateau Outer Area
 - 200-SW-2, radioactive solid waste landfills
 - 200-WA-1, 200-West Inner Area waste sites.
- Groundwater OUs not included in this 5-year review:
 - 200-BP-5, groundwater in northern portion of 200-East Area and adjacent northwest regions
 - 200-PO-1, groundwater in southern portion of 200-East Area and eastward regions.

3.3 200 Area Operable Units Included in this Review

3.3.1 200 Area Groundwater Operable Units Included in this Review

This section covers the following 200 Area groundwater OUs that, as of December 2020, had published RODs:

- 200-UP-1 groundwater OU
- 200-ZP-1 groundwater OU.

An interim ROD for the two other groundwater OUs in the 200 Area (200-BP-5 and 200-PO-1) was published in 2021 and will, therefore, be evaluated for protectiveness during the future (2021–2025) 5-year review.

3.3.1.1 200-UP-1 Groundwater Operable Unit

Background

The 200-UP-1 groundwater OU is 1 of 10 groundwater OUs on the Hanford Site, and 1 of 4 groundwater OUs located on the Central Plateau (Figure 3-2). The 200-UP-1 OU consists of the groundwater beneath the southern portion of the 200-West Area (Figure 3-3).

The 200-West Area contains waste management facilities and former irradiated fuel reprocessing facilities that have been grouped into four process areas: U-Plant, Z-Plant, REDOX Plant, and T-Plant. The major waste streams that contributed to 200-UP-1 OU groundwater contamination were associated with the plutonium-separation and uranium recovery operations at the REDOX Plant and U-Plant facilities, where liquid wastes were disposed of to the ground via ponds, cribs, ditches, and trenches. The REDOX Plant operated from 1952 to 1967 and U-Plant operated from 1952 to 1957. As effluent was discharged to these waste sites in the past, the more mobile contaminants migrated through the vadose zone to groundwater. Some groundwater contamination also resulted from SST leaks or unplanned releases associated with Waste Management Area (WMA) S-SX and WMA U. In addition, groundwater contamination has migrated from the adjacent 200-ZP-1 OU into the 200-UP-1 OU; this contamination originated from liquid waste disposed of to the ground at Z-Plant plutonium concentration and recovery facilities.

The waste sites and soil above the 200-UP-1 OU are the sources of the groundwater contamination in the OU and are or will be addressed as part of the cleanup of other source OUs through separate [CERCLA](#) or [RCRA](#) actions.

COCs for the 200-UP-1 OU include carbon tetrachloride, chromium (total and hexavalent), nitrate, iodine-129, technetium-99, tritium, and uranium.

Current land use on the 200-West Area portion of the Central Plateau where the 200-UP-1 groundwater OU is located is industrial, and public access is restricted. Land use is anticipated to remain industrial for the foreseeable future. The land is and, for the foreseeable future, will be used for ongoing waste disposal operations and infrastructure services.

A summary of the 200-UP-1 groundwater OU condition, as of 2020, is included in [DOE/RL-2020-60](#), *Hanford Site Groundwater Monitoring Report for 2020*. This report and similar reports for calendar years prior to 2020 can also be accessed online as noted below:

- *Hanford Site Groundwater Monitoring Reports* (published annually to address the previous calendar year): <http://www.hanford.gov/page.cfm/SoilGroundwaterAnnualReports>
- *Annual Summary Reports for the Pump and Treat Operations in the Hanford Central Plateau Operable Units* for each prior year can be accessed through the same link at <http://www.hanford.gov/page.cfm/SoilGroundwaterAnnualReports>.

Chronology

Table 3-1 lists the remedial action decision documents associated with the 200-UP-1 groundwater OU as of December 31, 2020.



Figure 3-3. Location of 200-UP-1 and 200-ZP-1 Groundwater Operable Units.

Table 3-1. Decision Documents for the 200-UP-1 Groundwater Operable Unit.

Date	Location	Title
2/1997	EPA/ROD/R10-97/048	<i>Declaration of Record of Decision for the U.S. DOE Hanford 200-UP-1 Operable Unit, 200 Area, Hanford Site, Benton County, Washington.</i> This document records the initial decision for this interim ROD: Extract groundwater from high-concentration zone of uranium and technetium-99 plumes and treat at the 200 Area Effluent Treatment Facility.
2/2009	Ecology et al. 2009	<i>Explanation of Significant Differences for the Interim Action Record of Decision for the 200-UP-1 Groundwater Operable Unit, Hanford Site, Benton County, Washington.</i> This revised decision adds the national MCL of 30 µg/L for uranium as an ARAR for treating extracted water, replaces 719 L/min (190-gal/min) pumping with a pumping requirement from existing and new wells consistent with an approved RD/RAWP until uranium and technetium-99 concentrations are less than 10 times the MCL for 4 consecutive quarters, adds sampling requirements, and updates cost estimates and IC requirements.
9/2012	EPA 2012	<i>Record of Decision For Interim Remedial Action, Hanford 200 Area Superfund Site, 200-UP-1 Operable Unit.</i> This revised decision supersedes the previous interim action ROD (February 1997) and ESD (February 2009). The remedial action includes groundwater extraction and treatment (with flow path control through injection of treated water) in combination with monitored natural attenuation for technetium-99, uranium, chromium (total and hexavalent), nitrate, and carbon tetrachloride; monitored natural attenuation for tritium; hydraulic containment and further treatment technology evaluation for iodine-129; remedy performance monitoring; and ICs.

ARAR = applicable or relevant and appropriate requirement O&M = operation and maintenance
ESD = explanation of significant differences OU = operable unit
IC = institutional control ROD = record of decision
MCL = maximum contamination level

See Appendix B for a consolidated list of decision documents for Hanford Site OUs.

Remedial Action

Goals and Objectives. In accordance with the NCP, “EPA expects to return useable ground waters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site” ([40 CFR 300.430\[a\]\[1\]\[iii\]\[F\]](#)). EPA generally defers to state definitions of groundwater classification provided under EPA-endorsed Comprehensive State Groundwater Protection Programs ([EPA/540/G-88/003](#)).

Groundwater from the 200-UP-1 OU is contaminated and is not currently withdrawn from the aquifer for beneficial use; however, the potential beneficial use of the groundwater is as a drinking water source. Consistent with the beneficial-use classifications of Washington State and the EPA, the goal for remediating 200-UP-1 OU groundwater is to reduce contamination to levels that will allow its use as a future drinking water source. Based on the expectations for groundwater restoration, the interim RAOs for the 200-UP-1 OU, as stated in the interim action ROD ([EPA 2012](#)), are as follows:

- RAO 1. Return the 200-UP-1 OU groundwater to beneficial use as a potential drinking water source.
- RAO 2. Prevent human exposure to contaminated 200-UP-1 OU groundwater that exceeds acceptable risk levels for drinking water.

Remedy Components. The *Record of Decision For Interim Remedial Action, Hanford 200 Area Superfund Site 200-UP-1 Operable Unit* (EPA 2012) provided the following summary-level description of the primary components of the selected remedy for the 200-UP-1 groundwater OU (see italicized text in the following box).

Excerpt from ROD (EPA 2012):

Groundwater Extraction and Treatment. The groundwater extraction and treatment component will use a pump-and-treat (P&T) system consisting of a network of groundwater extraction wells, conveyance piping (with transfer pump stations), and use of the existing groundwater treatment facility in the 200 West Area. The system will be modified to meet the 200-UP-1 OU selected remedy treatment requirements. Extraction wells will be designed and installed to remove contaminated groundwater from the aquifer and to reduce or prevent further plume migration.

The P&T system will be designed and implemented in combination with monitored natural attenuation to achieve cleanup levels for all COCs in the 200-UP-1 OU except I-129 within the following time frames: 15 years for Tc-99, 25 years for uranium, 25 years for chromium (total and hexavalent) through P&T, 35 years for nitrate through P&T and monitored natural attenuation (MNA), 125 years for carbon tetrachloride through P&T and MNA, and 25 years for tritium through MNA. Injection wells will be used to inject treated water back into the aquifer to provide flow path (gradient) control.

Monitored Natural Attenuation. The selected remedy relies on MNA for parts of the nitrate and carbon tetrachloride plumes and for the entire tritium plume. The parts of the nitrate plume that will be addressed through MNA are the diffuse (low-concentration) nitrate plume areas not captured by the P&T system. Carbon tetrachloride will require the longest MNA time frame (estimated to be 125 years), which is consistent with the MNA timeframe for carbon tetrachloride identified in the ROD for the adjacent 200-ZP-1 OU. The tritium plume will be addressed through MNA because of its short radioactive half-life (12.3 years) and lack of effective tritium groundwater treatment technology.

I-129 Hydraulic Containment and Treatment Technology Evaluation. The technology evaluation for I-129 that was completed as part of the feasibility study determined that no current treatment technology can achieve the federal DWS of 1 pCi/L for the I-129 concentrations present in the 200-UP-1 OU. DOE will evaluate potential treatment options for I-129 as part of the selected remedy through further technology evaluation. If one or more viable technologies is identified, treatability tests will be conducted for those technologies. Hydraulic containment of the I-129 plume will be implemented until a subsequent remedial decision for the I-129 plume is made. Hydraulic containment will be performed using injection wells placed at the leading edge of the I-129 plume.

The selected remedy requires an interim waiver of the federal DWS of 1 pCi/L for I-129, which is an ARAR. If a viable treatment technology is not available, the use of a technical impracticability waiver under 40 CFR 300.430(f)(1)(ii)(c) may need to be considered as part of the final remedy.

Remedy Performance Monitoring. Remedy performance monitoring must be conducted over the life of the interim remedial action to evaluate and confirm its performance and optimize its effectiveness. Performance monitoring for the extraction and injection well network will include groundwater sampling and analysis for COCs, extraction well flow rate assessments, and water level measurements. This will allow evaluation of each contaminant's mass removal rate as well as determine the effectiveness of the injection well network to hydraulically contain the I-129 plume. Because cleanup decisions for the soil OUs located above the 200-UP-1 OU have not yet been identified, monitoring will also be conducted for the final contaminants of potential concern (COPC), which include the COCs and the following contaminants: 1,4-dioxane, chloroform, tetrachloroethene, trichloroethene, and strontium-90. Monitoring for the final COPCs will help determine whether they are impacting groundwater at concentrations that may pose an unacceptable risk to human health and the environment.

Performance monitoring of the 200 West Groundwater Treatment Facility includes sampling and analysis to evaluate the effectiveness of the facility to remove or treat COCs in extracted groundwater to meet treatment

requirements before returning the water to the aquifer. Performance monitoring will also be used to confirm that the natural attenuation processes for carbon tetrachloride, tritium, and nitrate are performing as planned.

***Institutional Controls.** Institutional controls will be required for the 200-UP-1 OU as long as groundwater contamination precludes its use as a potential source of drinking water. These institutional controls include the requirement that DOE control access to groundwater to prevent exposure of humans to contaminated groundwater, except as otherwise authorized by EPA, and the requirement that DOE prohibit activities that would damage components of the remedy or disrupt or lessen performance of any component of the remedy, except as otherwise authorized in lead regulatory agency-approved documents. The DOE is responsible for implementing, maintaining, reporting on, and enforcing the institutional controls required under this ROD. Although DOE may later transfer these procedural responsibilities to another party by contract, property conveyance agreement, or other means, DOE shall retain ultimate responsibility for remedy integrity and institutional controls.*

Remedy Implementation Progress Prior to this Review Period. Remedy implementation before this 5-year review period, in accordance with the 1997 interim action ROD ([EPA/ROD/R10-97/048](#)) as amended, primarily involved pumping the highest concentration zone of the uranium and technetium-99 groundwater plumes at U-Plant in the 200-UP-1 groundwater OU followed by treatment using the existing 200 Area Effluent Treatment Facility (a state-permitted dangerous waste management unit). The effluent from the 200 Area Effluent Treatment Facility was then discharged to a state-permitted wastewater discharge facility. This interim remedial action reduced contaminant mass within the plume and minimized migration of uranium and technetium-99 from the 200-West Area. The 200-UP-1 (U-Plant) Pump and Treat System, located in the area of U-Plant, operated until 2011 when the RAOs within the capture zone were satisfied. ICs were also in place to restrict access to groundwater. Additional detail on this earlier period of 200-UP-1 groundwater remediation can be found in Appendix A of the 2011 annual pump-and-treat report ([DOE/RL-2012-03](#)).

During the previous review period of 2011-2015, implementation of the 2012 interim action ROD ([EPA 2012](#)) began. The WMA S-SX groundwater extraction system (for technetium-99) began operating in 2012 and continued to operate under the new ROD. Modifications were made to the 200-West Pump and Treat to add an ion-exchange treatment train for uranium. Design and construction of the groundwater extraction system for the U-Plant area was completed; the system began operating during September 2015. Design and construction for the iodine-129 hydraulic control remedy was completed and this system began operating during October 2015. The performance monitoring plan was released ([DOE/RL-2015-14](#), *Performance Monitoring Plan for the 200-UP-1 Groundwater Operable Unit Remedial Action*) and the draft iodine-129 treatment technology evaluation plan was released ([DOE/RL-2015-69](#), *UP-1 Evaluation Plan for Iodine – Draft A*).

Issues/Corrective Actions from the Previous (2011-2015) 5-Year Review. No previous issues or actions were noted for the 200-UP-1 OU in the 2011-2015 [CERCLA](#) 5-year review.

Protectiveness Statement from the Previous (2011-2015) 5-Year Review Report ([DOE/RL-2016-01](#)). The 200-UP-1 groundwater OU protectiveness statement from the previous (2011–2015) 5-year review report was noted as follows:

200-UP-1 Groundwater OU – Will Be Protective. *The remedy at the 200-UP-1 groundwater OU is expected to be protective of human health and the environment upon completion of the final remedy. Implementation of uranium treatment capability in the 200 West P&T was completed during this 5-year review period. Publication of a draft treatment technology evaluation plan for iodine-129 was also accomplished. Characterization of the chromium plume to support remedy design was initiated in late*

2015 and will be completed after this 5 year review period. The interim action remedy component of groundwater ICs is fully implemented and ensures that exposure pathways that could result in unacceptable risks to human health are being controlled.

Progress Since 2011-2015 Review

Accomplishments. The primary remedial action accomplishments for the 200-UP-1 groundwater OU during the past 5 years (2016-2020) can be summarized as follows:

- Continued operating the S-SX Tank Farms Groundwater Extraction System (interim action; startup in July 2012)
 - Removed 3.7 Ci technetium-99 since startup
 - Removed 56.5 kg (124.6 lb) total chromium since startup (a continuous record of hexavalent chromium analyses is not readily available but hexavalent chromium is included in total chromium analyses)
 - Removed 42,758 kg (94,265 lb) nitrate since startup
 - Removed 95.8 kg (211 lb) carbon tetrachloride since startup.
- Continued operating the U-Plant area groundwater extraction system (interim action; started in September 2015)
 - Removed 69.2 kg (152.6 lb) uranium since startup
 - Removed 1.31 Ci technetium-99 since startup
 - Removed 149,544 kg (329,688 lb) nitrate since startup
 - Removed 128.4 kg (283 lb) carbon tetrachloride since startup.
- Performance of the WMA S-SX groundwater extraction system was assessed and the remedy was found to be performing as expected ([ECF-200UP1-17-0094](#), *Fate and Transport Analysis for the WMA S-SX Groundwater Plumes in the 200-UP-1 Operable Unit*).
- Performance of the U-Plant area groundwater extraction system was assessed; it was found that the remedy is not performing as expected and optimization may be needed ([ECF-200UP1-17-0093](#), *Fate and Transport Analysis for the U Plant Groundwater Plumes in the 200-UP-1 Operable Unit*; [ECF-200UP1-18-0018](#), *200-UP-1 U Plant 2017 Uranium Plume Pump and Treat System Analysis*). Further details are provided in the “Technical Assessment” section below.
- The iodine-129 hydraulic control system continued to operate and assessments of this system indicate it is functioning as expected.
- Evaluated potential treatment options for iodine-129 ([PNNL-29148](#), *Assessment of Technologies for I-129 Remediation in the 200-UP-1 Operable Unit*). No viable treatment technologies were identified.
- Installed 24 additional extraction, monitoring, or characterization wells from 2016 through 2020.

- Characterization of the southeast chromium plume (total and hexavalent) was completed ([DOE/RL-2017-60](#), *Remedial Design Investigation Report for the 200-UP-1 Operable Unit Southeast Chromium Plume*). Remedial options were evaluated and a remedy decision is expected to be made following 5 years of monitoring and evaluation.

Remedy Implementation. Details on implementing the 2012 ROD are provided in the 200 UP-1 RD/RAWP ([DOE/RL-2013-07](#), *200-UP-1 Groundwater Operable Unit Remedial Design/Remedial Action Work Plan*, Rev. 1). This work plan includes detail on the basis for remedial action, remedial design approach, remedial action approach, remedial optimization, environmental management and controls, a cost estimate, and schedule through FY 2023.

While operations at the 200-West Pump and Treat are under way and currently anticipated to continue for more than 20 years, some components of the remedy (e.g., monitored natural attenuation and ICs) are planned to continue for more than 100 years. Table 3-2 presents an overview of the remedy's primary components and implementation status.

Table 3-2. Overview of 200-UP-1 Interim Action Remedy Implementation. (2 Pages)

Document Type	Date	Title						
Interim Action ROD	09/2012	EPA 2012, <i>Record of Decision for Interim Remedial Action Hanford 200 Area Superfund Site 200-UP-1 Operable Unit</i>						
RD/RA Work Plan	09/2013	DOE/RL-2013-07, <i>200-UP-1 Groundwater Operable Unit Remedial Design/Remedial Action Work Plan</i>						
RAO	1. Return the 200-UP-1 OU groundwater to beneficial use as a potential drinking water source 2. Prevent human exposure to contaminated 200-UP-1 OU groundwater that exceeds acceptable risk levels for drinking water.							
COCs:	Carbon tetrachloride, chromium (total and hexavalent), nitrate, iodine-129, technetium-99, tritium, uranium							
Remedy Component		Status (approximate percentage complete for implementing the remedy component as of December 2020) ^a					Duration of O&M (~years) ^b	Finish ^c (Est'd year)
		0	1-25	26-50	51-75	76-99		
Groundwater extraction and treatment ^d							25	2037
Monitored natural attenuation							125 ^e	2137
Characterization of the southeast chromium plume (total and hexavalent)							N/A	N/A
I-129 hydraulic containment and treatment technology evaluation							N/A	
Remedy performance monitoring							125	2137
Institutional controls							125	2137

^a Percentages reflect implementation status of the remedy component; post-startup upgrades and system performance optimization is considered part of O&M. 100% = fully implemented and now in O&M mode.

^b Approximate number of years to operate remedy component as estimated in ROD (shorter durations for certain COCs)

^c Estimated year when remedy component will be completed.

^d The S-SX WMA treatment has been operational since 2012; uranium treatment facility construction completed in 2015; the U-Plant groundwater extraction system began operating in September 2015.

^e Long duration is currently driven by MNA for carbon tetrachloride and does not yet consider I-129.

DOE/RL-2013-07, 2013, *200-UP-1 Groundwater Operable Unit Remedial Design/Remedial Action Work Plan*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0087671>.

Table 3-2. Overview of 200-UP-1 Interim Action Remedy Implementation. (2 Pages)

EPA, 2012, *Record of Decision For Interim Remedial Action, Hanford 200 Area Superfund Site 200-UP-1 Operable Unit*, U.S. Environmental Protection Agency, Washington, D.C. Available online at <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0091413>.

COC	= contaminant of concern	RAO	= remedial action objectives
MNA	= monitored natural attenuation	RD/RA	= remedial design/remedial action
N/A	= not applicable	ROD	= record of decision
O&M	= operation and maintenance	WMA	= waste management area
OU	= operable unit		

Technical Assessment

Is the remedy functioning as intended by the decision documents?

The WMA S-SX groundwater extraction system, the iodine-129 hydraulic control system, and monitored natural attenuation remedies as implemented under the ROD ([EPA 2012](#)) are performing as intended and are expected to achieve their remediation objectives. The U-Plant area groundwater extraction system is not performing as intended with respect to uranium and optimization of the remedy may be needed.

The WMA S-SX groundwater extraction system was evaluated by groundwater modeling in 2017 ([ECF-200UP1-17-0094](#)). The system was designed to remediate existing technetium-99 contamination in groundwater. The modeling results showed that without future contributions to the aquifer from contamination sources, technetium-99 is predicted to be below cleanup levels by the end of the 125-year cleanup timeframe in 2137. In addition, nitrate and chromium (total and hexavalent) concentrations are predicted to be below their respective cleanup levels by 2137. When approximations of the continuing contamination sources were included, model simulations indicate that contaminant plumes will re-form after the active remediation period unless near-field extraction wells are operated to contain the plumes or the sources are otherwise remediated. Thus, an updated strategy may be needed to address continuing contamination sources.

The U-Plant area groundwater extraction system was evaluated by groundwater modeling in 2017 ([ECF-200UP1-17-0093](#)) and 2018 ([ECF-200UP1-18-0018](#)). The system was designed to remediate existing uranium and technetium-99 plumes, and the high concentration portion of the nitrate plume, in the U-Plant vicinity. The modeling evaluated operation of the system on the uranium plume and the results showed that concentrations are predicted to remain above the 30 µg/L cleanup level after the end of the 125-year cleanup timeframe in 2137. Further, the modeling indicated that uncertainty in the extent of the uranium plume had a substantial effect on predictions of remedy performance. To reduce uncertainty in the plume extent, three additional wells were installed during 2019. One year of monitoring data from the new wells was collected during 2020 and the results indicate the uranium plume is smaller than previously interpreted. The uranium plume will be evaluated again by modeling to optimize the pump-and-treat system to achieve the RAOs.

In this [CERCLA](#) 5-year review period, treatment for technetium-99 and carbon tetrachloride continued at the 200-West Pump and Treat. Biological treatment for nitrate was suspended in October 2019 ([DOE/RL-2019-38](#), Rev. 0, *200-ZP-1 Operable Unit Optimization Study Plan*). The extraction and injection well network (as of 2020) is shown in Figure 3-4. Extraction well 299-W19-125 was added to the U-Plant groundwater extraction system in 2017.

Table 3-3 summarizes 200-UP-1 groundwater OU contaminants removed by the WMA S-SX groundwater extraction system during 2020 and cumulatively since startup in 2012. Table 3-4 summarizes 200-UP-1 groundwater OU contaminants removed by the U-Plant Area groundwater extraction system in 2020 and cumulatively since startup in 2015.

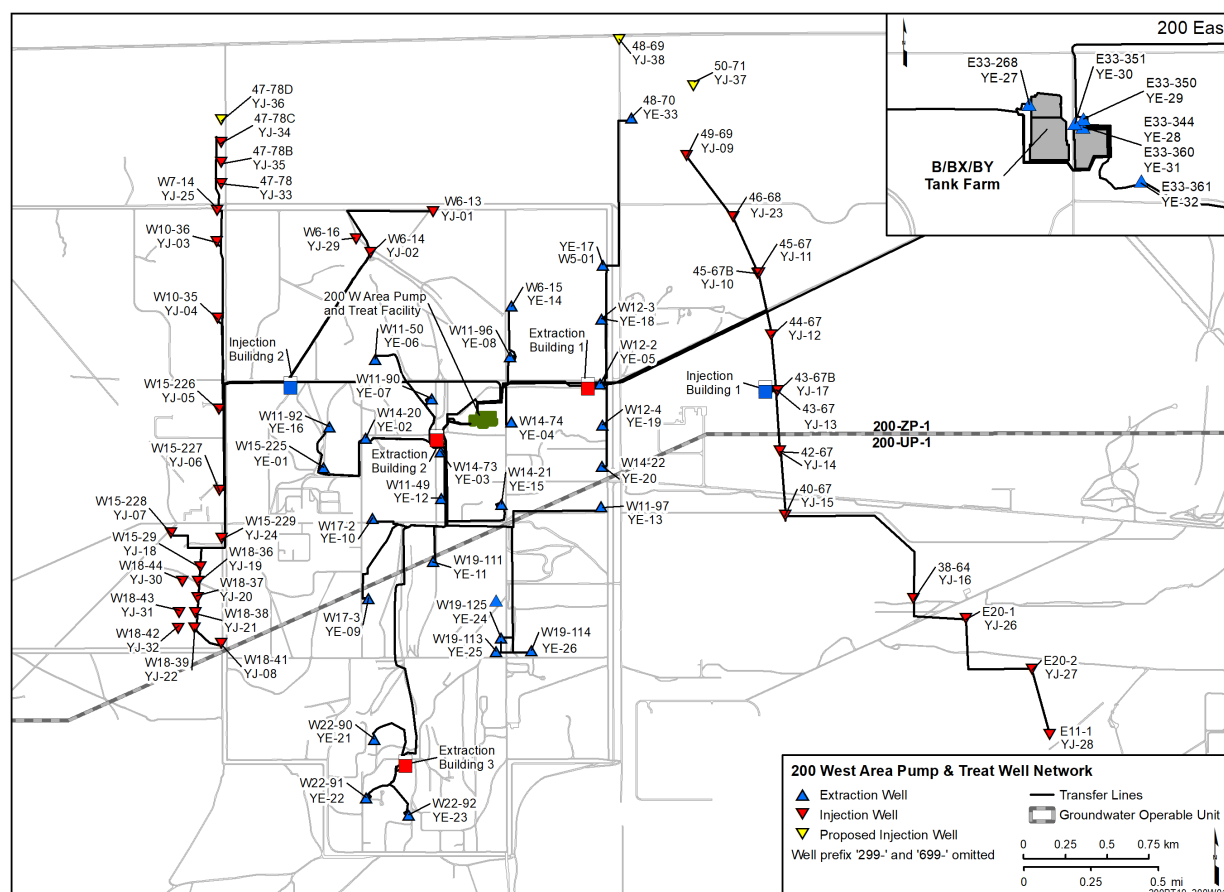


Figure 3-4. 200-West Pump and Treat System.

Table 3-3. Contaminant Mass (or Activity) Removed from Aquifer by the Waste Management Area S-SX Groundwater Extraction System^a.

Constituent	Mass (Activity) Removed During 2020	Mass (Activity) Removed Since Startup in 2012
Technetium-99, g (Ci)	14.97 (0.254)	217.8 (3.7)
Chromium (hexavalent), kg ^b	3.56	-- ^c
Chromium (total, unfiltered), kg ^b	3.52	56.5
Nitrate (as NO ₃), kg ^b	3,395	42,758
Carbon tetrachloride, kg	10.78	95.8

^a Source: DOE/RL-2020-62, *Calendar Year 2020 Annual Summary Report for Pump and Treat Operations in the Hanford Central Plateau Operable Units*, Table 4-4

^b Biological treatment for nitrate was suspended in October 2019

^c A continuous record of hexavalent chromium analyses is not readily available, but hexavalent chromium is included in total chromium analyses

DOE/RL-2020-62, 2021, *Calendar Year 2020 Annual Summary for Pump and Treat Operations in the Hanford Central Plateau Operations Unit*, Rev 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <http://www.hanford.gov/page.cfm/SoilGroundwaterAnnualReports>.

Table 3-4. Contaminant Mass (or Activity) Removed from Aquifer by the U-Plant Area Groundwater Extraction System^a.

Constituent	Mass (Activity) Removed During 2020	Mass (Activity) Removed Since Startup in 2015
Uranium, kg	10.3	69.2
Technetium-99, g (Ci)	5.7 (0.097)	77.2 (1.31)
Nitrate, kg ^b	14,118	149,544
Carbon tetrachloride, kg	23.1	128.4

^a Source: DOE/RL-2020-62, *Calendar Year 2020- Annual Summary Report for Pump and Treat Operations in the Hanford Central Plateau Operable Units*, Table 4-10

^b Biological treatment for nitrate was suspended in October 2019

DOE/RL-2020-62, 2021, *Calendar Year 2020 Annual Summary for Pump and Treat Operations in the Hanford Central Plateau Operations Unit*, Rev 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <http://www.hanford.gov/page.cfm/SoilGroundwaterAnnualReports>.

Remedy performance monitoring will be conducted over the duration of the interim remedial action to evaluate its performance and provide data for remedy optimization. The initial performance monitoring plan ([DOE/RL-2015-14](#), *Performance Monitoring Plan for the 200-UP-1 Groundwater Operable Unit Remedial Action*, Rev. 0) was released in August 2015 and implemented in January 2016. A revised plan was issued in 2020 ([DOE/RL-2015-14](#), *Performance Monitoring Plan for the 200-UP-1 Groundwater Operable Unit Remedial Action*, Rev. 1). Monitoring is performed to evaluate the pump-and-treat systems, hydraulic containment, and MNA components. The monitoring network has been enhanced by 24 additional wells that were constructed during the 2016 to 2020 review period. Figure 3-5 shows the location of groundwater monitoring, extraction, and injection wells associated for the 200-UP-1 OU in 2020.

Mapping of the water table indicates the iodine-129 plume hydraulic control remedy is functioning as intended. The system consists of three injection wells operating near the leading edge of the iodine-129 plume. Hydraulic gradient in this area has been reduced or reversed, which will slow the eastward migration of the plume ([DOE/RL-2020-62](#)).

Sampling data indicates that monitored natural attenuation of the tritium and nitrate plumes is proceeding as expected. The sample results are used to calculate the 95% upper confidence limit on plume concentrations; this metric shows good agreement with model predictions ([DOE/RL-2020-62](#)).

Because cleanup decisions for some source OUs located above the 200-UP-1 OU are pending (e.g., 200-WA-1 and 200-IA-1), monitoring is being conducted for the 200-UP-1 COCs noted earlier as well as waste site contaminants of potential concern (COPCs), which include the COCs and the following contaminants: 1,4-dioxane, chloroform, tetrachloroethene, TCE, and strontium-90. Monitoring for these COPCs will help determine whether they are impacting groundwater at concentrations that may pose an unacceptable risk to human health and the environment. Table 3-5 provides an overview of 200-UP-1 contaminant plume areas and associated changes to the areas during this 5-year review period. Plume maps in Figure 3-6 show the changes in plume shapes and areas during this 5-year review period. The Figure 3-7 trend plots depict the estimated annual changes in contaminant plume areas over the past several 5-year periods.

For more detailed information on the 200-UP-1 groundwater OU well locations, distribution of contaminant concentrations within each plume, historic trends associated with each of the 200-UP-1

COCs, as well as for performance metrics associated with 200-UP-1 OU groundwater treatment, visit the following links:

- *Hanford Site Groundwater Monitoring Report* (published each summer for the previous calendar year): <http://www.hanford.gov/page.cfm/SoilGroundwaterAnnualReports>
- *Annual Summary Report for Pump-and-Treat Operations in the Central Plateau* (published for each summer for the previous calendar year): <http://www.hanford.gov/page.cfm/SoilGroundwaterAnnualReports>.

The remedy components involving groundwater extraction and treatment, monitored natural attenuation, iodine-129 hydraulic control and treatment technology evaluation, and remedy performance monitoring are supporting achievement of RAO 1.

ICs for the 200-UP-1 groundwater OU, as required by the interim action ROD ([EPA 2012](#)), are described in the *200-UP-1 Groundwater Operable Unit Remedial Design/Remedial Action Work Plan*, ([DOE/RL-2013-07](#), Rev. 1), and are actively managed in support of RAO 2. Specific details associated with each IC also have been incorporated into *Sitewide Institutional Controls Plan for the Hanford CERCLA Response Actions and RCRA Corrective Actions* ([DOE/RL-2001-41](#)), this report is routinely updated within 180 days after publication of each decision document that addresses ICs.

Table 3-5. Overview of 200-UP-1 Groundwater Contaminant Plumes.^a

Groundwater Contaminant	Cleanup Level ^b	Maximum Concentration (2019)	Plume Area ^c (km ²)			Shoreline Intersection ^d (m)		
			2015	2020	Change	2015	2020	Change
Carbon tetrachloride	3.4 µg/L	390 µg/L	18.0 ^e	20.1 ^e	2.1	0	0	0
Chromium (hexavalent and total)	48 ^f /100 ^g µg/L	269/264 µg/L	5.7/0.5 ^h	11.7/3.9 ^h	6.0/3.4	0	0	0
Nitrate	45 mg/L	217 mg/L	5.7	7.0	1.3	0	0	0
Iodine-129	1 pCi/L	16.4 pCi/L	3.5	3.7	0.2	0	0	0
Technetium-99	900 pCi/L	18,600 pCi/L	0.3	0.14	-0.16	0	0	0
Tritium	20,000 pCi/L	210,000 pCi/L	5.4	3.5	-1.9	0	0	0
Uranium	30 µg/L	1,840 µg/L	0.3	0.09	-0.21	0	0	0

^a Source: Hanford Annual Groundwater Monitoring Reports for 2015 and 2020

<http://www.hanford.gov/page.cfm/SoilGroundwaterAnnualReports>

^b From Table 14 of *Record of Decision for Interim Remedial Action Hanford 200 Area Superfund Site 200-UP-1 Operable Unit* (EPA 2012).

^c Estimated area above the cleanup level, unless otherwise noted.

^d Length of Columbia River shoreline intersected by contaminant plumes.

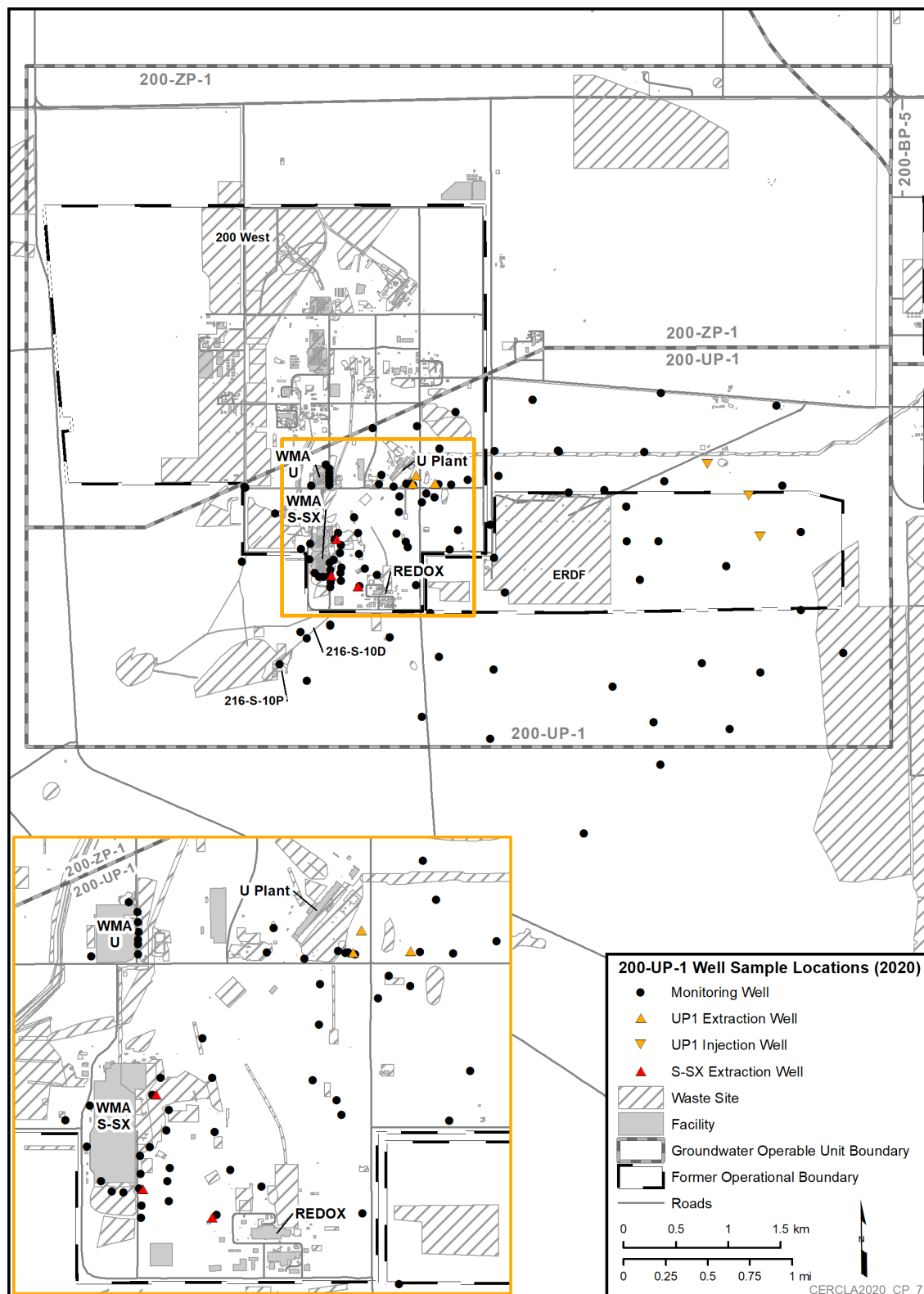
^e Represents the entire extent of the plume (including the 200-ZP-1 OU) above 3.4 µg/L.

^f WAC 173-340, “Model Toxics Control Act—Cleanup,” Method B groundwater cleanup level for hexavalent chromium.

^g Federal drinking water standard for total chromium.

^h Plume areas (0.5 and 3.9 km²) above the 100 µg/L federal drinking water standard for total chromium; 11.7 value represents plume area above 48 µg/L cleanup level for hexavalent chromium.

EPA, 2012, *Record of Decision For Interim Remedial Action, Hanford 200 Area Superfund Site 200-UP-1 Operable Unit*, U.S. Environmental Protection Agency, Washington, D.C. Available online at <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0091413>.



(Source: *Calendar Year 2019 Annual Summary Report for Pump and Treat Operations in the Hanford Central Plateau Operable Units* [DOE/RL-2019-68])

Figure 3-5. Locations of 200-UP-1 Wells Sampled in 2020.

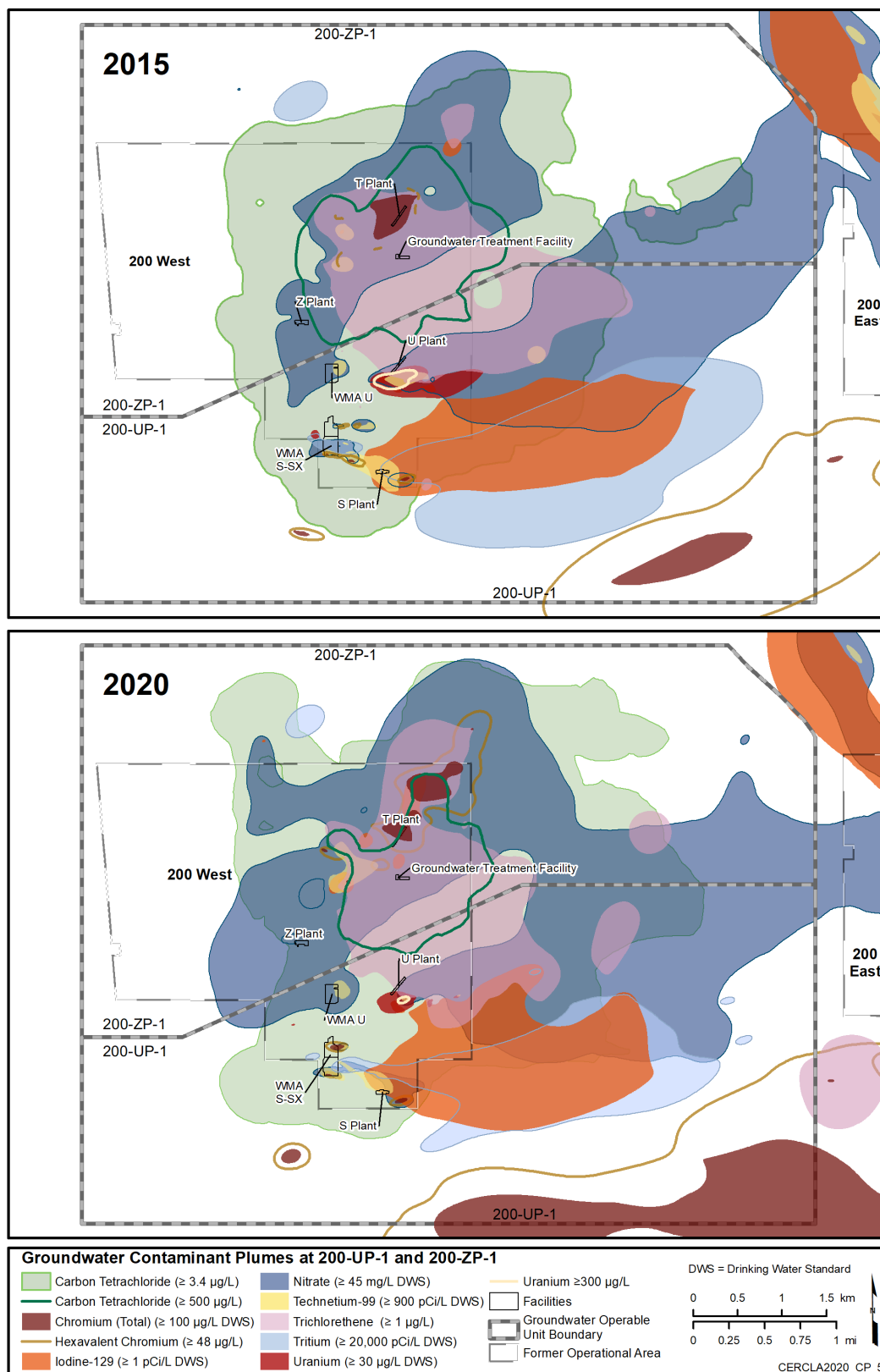


Figure 3-6. 200-UP-1 and 200-ZP-1 Groundwater Operable Unit Plumes in 2015 (top) and 2020 (bottom).

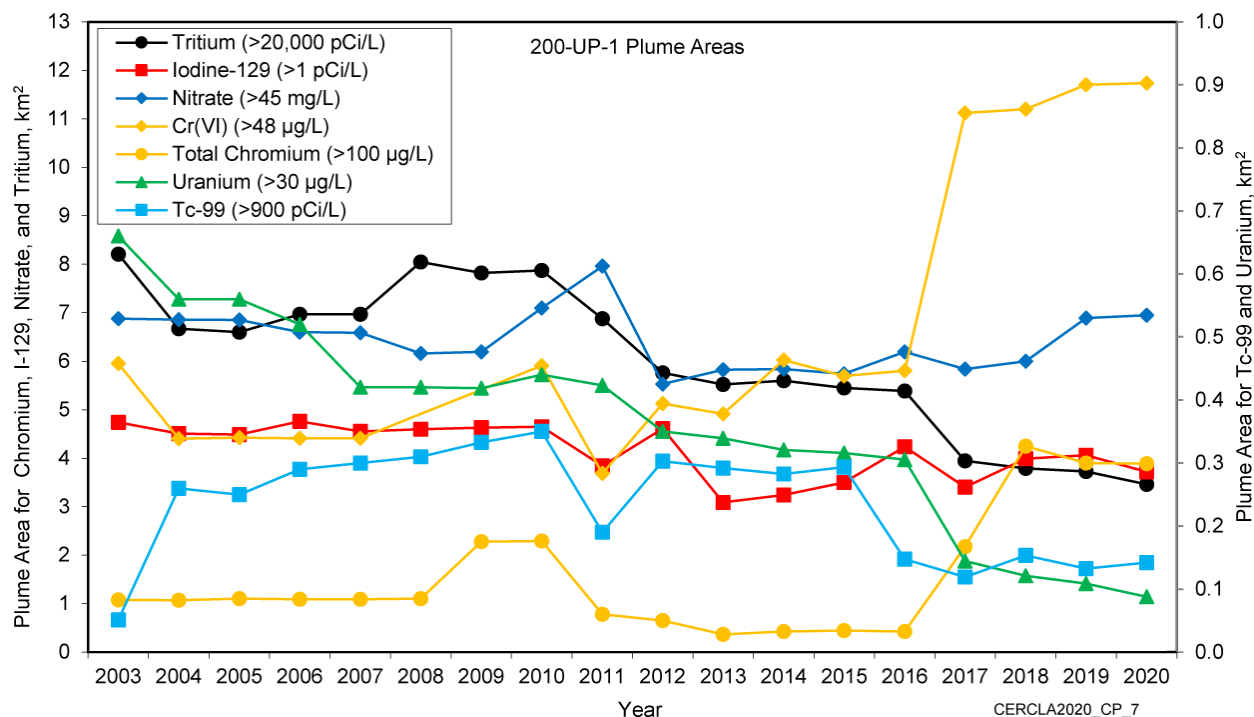


Figure 3-7. 200-UP-1 Trend Plots of Contaminant Plume Areas (2003-2020).

The ICs implemented for the 200-UP-1 OU are required to prevent human exposure to contaminated groundwater and include warning notices, entry restrictions, land-use management (land use), groundwater-use management (excavation permits), and miscellaneous provisions. These ICs are assessed annually and DOE presents a summary including any noted issues or actions to the Site regulators each fall at the unit managers' meeting. The presentation is documented in the meeting minutes attachments (e.g., [CHPRC-2003756](#)), which are archived in the Hanford Site Administrative Record. The annual IC assessments are also now captured in an annual report (e.g., [HNF-65616, FY2020 Sitewide Institutional Control Assessment](#), Rev. 0). During the 5-year review period of 2016 through 2020, appropriate ICs for the 200-UP-1 groundwater OU were found to be in place and maintained, and the objectives for the ICs are being met.

Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of remedy selection still valid?

The exposure assumptions, toxicity data, cleanup levels, and interim RAOs used at the time of remedy selection (2012) are still valid for the OU.

Has any other information come to light that could call into question the protectiveness of the remedy?

At the time of remedy selection in 2012, the peak technetium-99 concentration downgradient from the WMA U Tank Farm was 3,400 pCi/L. Since then, the peak concentration has increased to a level that may call into question the protectiveness of the remedy. The peak concentration during the current 5-year review cycle was 13,800 pCi/L in 2018. At the end of 2020, the peak concentration was 5,660 pCi/L. Modeling results indicate that WMA U is expected to continue to be a source of groundwater contamination in the future (ECF-HANFORD-20-0131, *Cumulative Impact Evaluation Vadose Zone Model for the U Farm Area, No Further Action Scenario*). Installation of characterization wells is planned to better define the extent of contamination. This will be followed by an assessment to determine if a groundwater extraction system for WMA U should be implemented.

No other information has come to light that would call into question the protectiveness of the remedy. Groundwater concentrations of chromium (total and hexavalent) in well 299-W26-13 near the 216-S-10 pond waste site increased during the previous 5-year period. During the current review period, concentrations for both total chromium and hexavalent chromium were stable at approximately 150 µg/L, which is about 3 times the 48 µg/L cleanup level. This situation will continue to be monitored during the next 5-year review period.

In accordance with the RD/RAWP ([DOE/RL-2013-07](#)), additional characterization of the chromium plume (total and hexavalent) southeast of the 200-West Area (Figure 3-6) was performed during 2016 and 2017 ([DOE/RL-2017-60](#)). Eleven characterization wells were drilled and the results showed the plume is about twice the size as previously mapped, extending farther west, south, and east. Several remedial options were evaluated as reported in [DOE/RL-2017-60](#). A remedy decision is expected to be made in the future after 5 years of additional monitoring and evaluation beginning in FY 2020.

Concentrations of technetium-99 are increasing downgradient of the northern part of the SX Tank Farm and outside of the groundwater extraction system capture zones. The peak concentration during 2020 was 4,120 pCi/L (well 299-W22-115). A possible source other than the S-SX Tank Farms is the nearby 216-S-1&2 Cribs. An updated strategy may be needed to address continuing contamination sources. Concentrations in this area will continue to be monitored and evaluated during the next 5-year review cycle (2021-2025).

The 2012 ROD ([EPA 2012](#)) required that potential iodine-129 treatment options be evaluated. The ROD further stated that if a viable treatment technology is not available, a technical impracticability waiver may need to be considered. An iodine-129 treatment technology evaluation plan was released in 2018 ([DOE/RL-2015-69](#), *UP-1 Evaluation Plan for Iodine*). It identified iodine-129 fate and transport processes and provided an overview of possible groundwater remediation options. From 2017 through 2019, PNNL evaluated potential treatment options for iodine-129 ([PNNL-29148](#), *Assessment of Technologies for I-129 Remediation in the 200-UP-1 Operable Unit*). The conclusion of these evaluations was that none of the candidate remediation technologies for the iodine-129 plume are practicable.

Issues/Recommendations During this (2016-2020) Review Period

One issue specific to the 200-UP-1 OU was identified during this 5-year review. Concentrations of technetium-99 have increased substantially downgradient from WMA U, peaking at 13,800 pCi/L during this review period. The peak concentration during 2012, when the interim ROD ([EPA 2012](#)) was issued, was 3,400 pCi/L. Modeling has indicated that WMA U is expected to continue to be a source of groundwater contamination in the future (ECF-HANFORD-20-0131). The interim ROD did not identify an active remedy for this area.

To address the increasing technetium-99 concentrations downgradient from WMA U, additional characterization/monitoring wells will be installed to better define the extent of technetium-99 contamination. At least four quarters of data will be collected from the new wells, and modeling will be performed to evaluate if active remediation is warranted for WMA U.

Issue UP1-1. Concentrations of technetium-99 downgradient from WMA U have increased substantially during this review period, and the interim ROD does not identify an active remedy for this area.

Recommendation UP1-1. Install additional characterization/monitoring wells to better define the extent of technetium-99 downgradient of WMA U, collect at least four quarters of data from the new wells, perform modeling to determine the current state of the contaminant and position of the plume(s), and determine if there is unacceptable risk due to this contaminant (Milestone Date: September 30, 2025).

Does this issue/action currently affect the protectiveness of the remedy? – NO.

Will this issue/action affect the protectiveness of the remedy in the future? – NO.

Protectiveness Statement

200-UP-1 Groundwater OU – Will Be Protective. The remedy at the 200-UP-1 groundwater OU is expected to be protective of human health and the environment upon completion of the final remedy. Further characterization of the U-Plant area uranium plume was completed during this 5-year review period. This will be followed by optimization of the uranium plume remedy. The final treatment technology evaluation plan for iodine-129 was released and treatment technologies were evaluated. A viable treatment technology was not identified. Characterization of the chromium plume (total and hexavalent) was completed during this 5-year review period. The plume will be monitored and evaluated for 5 years before a remedy decision is made, which is consistent with the approach identified in the interim ROD. Technetium-99 concentrations have increased downgradient from WMA U. Additional characterization will be performed and the need for a groundwater extraction system will be assessed. The interim action remedy component of groundwater ICs is fully implemented and ensures that exposure pathways that could result in unacceptable risks to these areas are being controlled.

3.3.1.2 200-ZP-1 Groundwater Operable Unit

Background

The 200-ZP-1 groundwater OU is 1 of 10 groundwater OUs on the Hanford Site, and 1 of 4 located on the Central Plateau (Figure 3-2). Collectively, these four OUs and their RODs will define the necessary groundwater cleanup actions across the Central Plateau. The 200-ZP-1 OU consists of the groundwater beneath the northern portion of the 200-West Area.

The 200-West Area contains waste management facilities and former irradiated fuel reprocessing facilities that have been grouped into four process areas: U-Plant, Z Plant, REDOX Plant, and T-Plant. The major waste streams that contributed to groundwater contamination in the 200-ZP-1 OU were associated with plutonium-separation operations at T-Plant (1944-1956) and plutonium concentration and recovery operations at Z-Plant (1949-1989) in the 200-West Area. Liquid waste disposal in the cribs and trenches near the T-Plant and Z-Plant facilities resulted in several groundwater contamination plumes in the 200-ZP-1 OU.

COCs for the 200-ZP-1 OU are carbon tetrachloride, chromium (total and hexavalent), nitrate, iodine-129, technetium-99, TCE, and tritium. Carbon tetrachloride is the primary risk driver forming a plume that covers more than 13 km² (5 mi²) extending north, south, and east from the source areas. During recent decades, groundwater in the northern 200-West Area flowed east-northeast, but flow is now influenced locally by ongoing remedial action activities.

Current land-use activities on the 200-West Area of the Central Plateau where the 200-ZP-1 groundwater OU is located are industrial and public access to the site is restricted. Land use is anticipated to remain industrial for the foreseeable future, with the land being used for ongoing waste disposal operations and infrastructure services.

A summary of the 200-ZP-1 groundwater OU condition, as of 2020, is included in [DOE/RL-2020-60, Hanford Site Groundwater Monitoring Report for 2020](#). This report and similar reports for calendar years prior to 2020 can also be accessed online as noted below::

- *Hanford Site Groundwater Monitoring Reports* (published annually to address the previous calendar year): <http://www.hanford.gov/page.cfm/SoilGroundwaterAnnualReports>

- *Annual Summary Reports for Pump and Treat Operations in the Hanford Central Plateau Operable Units* (published annually to address the prior calendar year's performance):
<http://www.hanford.gov/page.cfm/SoilGroundwaterAnnualReports>.

Chronology

Table 3-6 lists the remedial action decision documents associated with the 200-ZP-1 groundwater OU as of December 31, 2020.

Table 3-6. Decision Documents for the 200-ZP-1 Groundwater Operable Unit.

Date	Location	Title
5/1995	EPA 1995	<i>Declaration of the Interim Record of Decision for the 200-ZP-1 Operable Unit.</i> This interim action ROD involves pump-and-treat to address carbon tetrachloride, chloroform, and trichloroethylene; treatment with air stripping and vapor-phase activated carbon; and reinjection of treated water. The interim action continued until the final action was instituted in 2012.
9/2008	EPA 2008	<i>Record of Decision, Hanford 200 Area, 200-ZP-1 Operable Unit Superfund Site, Benton County, Washington.</i> This is a final action ROD involving pump-and-treat to address carbon tetrachloride, nitrate, chromium, trichloroethylene, iodine-129, technetium-99, and natural radioactive decay to address tritium; monitored natural attenuation; flow-path control through injection of treated water; and institutional controls.

O&M = operation and maintenance
OU = operable unit
ROD = record of decision

See Appendix B of this document for a consolidated list of decision documents for Hanford Site OUs.

Remedial Actions

Goals and Objectives. In accordance with the NCP, “*EPA expects to return useable ground waters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site*” (40 CFR 300.430[a][1][iii][F]). EPA generally defers to state definitions of groundwater classification provided under EPA-endorsed Comprehensive State Groundwater Protection Programs ([EPA/540/G-88/003](#)).

Groundwater from the 200-ZP-1 OU is contaminated and is not currently withdrawn from the aquifer for beneficial use; however, the potential beneficial use of the groundwater is as a drinking water source. Consistent with the beneficial-use classifications of Washington State and the EPA, the goal for remediating 200-ZP-1 OU groundwater is to reduce contamination to levels that will allow its use as a future drinking water source.

Based on the expectations for groundwater restoration, the RAOs, as stated in the 200-ZP-1 OU ROD ([EPA 2008](#)), are as follows:

- RAO 1. Return the 200-ZP-1 OU groundwater to beneficial use (restore groundwater to achieve domestic drinking water levels) by achieving the cleanup levels (provided later in Table 11 [of the ROD]). This objective is to be achieved within the entire 200-ZP-1 OU groundwater plume. The estimated timeframe to achieve cleanup levels is within 150 years.

- RAO 2. Apply ICs to prevent the use of groundwater until the cleanup levels (provided later in Table 11 [of the ROD]) have been achieved. Within the entire OU groundwater plumes, ICs must be maintained and enforced until the cleanup levels are achieved, which is estimated to be within 150 years.
- RAO 3. Protect the Columbia River and its ecological resources from degradation and unacceptable impact caused by contaminants originating from the 200-ZP-1 OU. This final objective is applicable to the entire 200-ZP-1 OU groundwater plume. Protection of the Columbia River from impacts caused by 200-ZP-1 OU contaminants must last until the cleanup levels are achieved, which is estimated to be within 150 years.

Remedy Components. The final action ROD ([EPA 2008](#)) signed in 2008 provided the following summary-level descriptions (see italicized text in the following box) of the primary components of the selected remedy for the 200-ZP-1 Groundwater OU (i.e., groundwater extraction and treatment, monitored natural attenuation, flow path control, and ICs).

Excerpt from ROD (EPA 2008):

Groundwater Extraction and Treatment. A groundwater pump-and-treat system will be designed, installed and operated in accordance with an approved remedial design/remedial action (RD/RA) work plan. The system will be designed to capture and treat contaminated groundwater to reduce the mass of carbon tetrachloride, total chromium (chromium III and chromium VI), nitrate, trichloroethylene, iodine-129, and technetium-99, throughout the 200-ZP-1 OU by a minimum of 95% in 25 years. The pump-and-treat component will be designed and implemented in combination with monitored natural attenuation to achieve cleanup levels listed in Table 11 for all COCs in 125 years. Carbon tetrachloride concentrations in the groundwater above 100 µg/L correspond to approximately 95% of the mass of carbon tetrachloride currently residing in the aquifer. The estimated pumping rate required to reduce the mass of COCs by 95% in 25 years is 1,600 gpm for this action. The fate and transport evaluation estimated that a system comprised of 27 extraction and 27 injection wells would be needed to achieve the design requirements.

Following extraction, the COCs in groundwater (except tritium) will be treated to achieve the cleanup levels listed in Table 11 of the ROD. The treated groundwater will then be returned to the aquifer through injection wells.

Specific extraction and injection well locations, treatment equipment design, operational requirements, and other system details will be determined during the remedial design phase and will be documented in the RD/RA work plan and its accompanying remedial design (the "RD/RA documents"). The RD/RA documents will be reviewed and approved by EPA.

The remedial design will also consider as necessary the need for treatment of other constituents (such as uranium) that may be captured by the 200-ZP-1 OU extraction wells. While not COCs for the 200-ZP-1 OU, such constituents may be encountered during restoration from sources related to the other adjacent groundwater OUs. There is no viable treatment technology to remove tritium from the groundwater. However, the half-life of tritium is sufficiently short, so the tritium will decay below the cleanup standard before it leaves the industrial land-use zone.

Monitored Natural Attenuation (MNA). In addition to the pump-and-treat system, natural attenuation processes will be used to reduce concentrations to below the cleanup levels.

Natural attenuation processes to be relied on as part of this component include abiotic degradation, dispersion, sorption, and, for tritium, natural radioactive decay. Monitoring will be employed in accordance with the approved RD/RA documents to evaluate the effectiveness of the pump-and-treat system and natural attenuation processes. Fate and transport analyses conducted as part of the FS (DOE/RL-2007-28) indicate that the timeframe necessary to reduce the remaining COC concentrations to acceptable levels through MNA will be

approximately 100 years. Modeling also indicates that this portion of the plume area will remain on the Central Plateau geographic area during this timeframe.

Monitoring is required to be conducted over the life of the action to evaluate its performance and optimize its effectiveness and shall be conducted in accordance with the approved RD/RA documents. For the MNA component, monitoring locations, points of compliance and specifications will be developed as part of the RD/RA documents that will provide data on performance, including data indicating whether the key mechanisms of natural attenuation are performing in a manner to satisfy selected remedy requirements and schedule.

The overarching requirement is to meet the groundwater cleanup levels identified in this ROD within 125 years. Monitoring shall be conducted to evaluate the performance of pump-and-treat system, flow path control and MNA and shall be designed and operated to:

- 1. Demonstrate whether or not the pump-and-treat system will remove at least 95% of the mass of COCs in 25 years or less and whether the remedial action being taken, including natural attenuation, will achieve cleanup levels for all COCs within 125 years,*
- 2. Detect changes in environmental conditions (e.g., hydrogeologic, geochemical, microbiological, or other changes) that may reduce the efficacy of the pump-and-treat system, natural attenuation processes, and the flow path control actions,*
- 3. Identify any potentially toxic and/or mobile transformation products,*
- 4. Verify that the contamination is not expanding downgradient, laterally or vertically subsequent to the period of time over which the pump-and-treat component has been functional,*
- 5. Detect new releases of contaminants of concern to the environment that could impact the effectiveness of the remedy,*
- 6. Verify attainment of remediation requirements*

Flow Path Control. Flow-path control is also required and shall be achieved by injecting the treated groundwater into the aquifer to the northeast and east of the groundwater contamination such that the treated injected water in these locations will slow the natural eastward flow of most of the groundwater and, as a result, keep COCs within the capture zone, as well as increase the time available for natural attenuation processes to reduce the contaminant concentrations not captured by the extraction wells.

Flow-path control shall also be used to minimize the potential for groundwater in the northern portion of the aquifer to flow northward through Gable Gap and toward the Columbia River. Injection wells will be located to re-direct the groundwater flow to the east, which is the longest groundwater flow path to the river (about 26 km [16 mi]).

Groundwater modeling is required to locate injection and extraction wells, to estimate required injection and extraction rates, and to determine the location of injection wells for flow-path control. This modeling and the design, installation and implementation of the flow path controls shall be conducted in accordance with the approved RD/RA documents.

Institutional Controls. 200-ZP-1 OU groundwater use will be restricted through institutional and land use controls for the foreseeable future until cleanup levels are achieved.

The DOE is responsible for implementing, maintaining, reporting on, and enforcing the institutional and land use controls required under this ROD. Although DOE may later transfer these procedural responsibilities to another party by contract, property transfer agreement, or through other means, DOE shall retain ultimate responsibility for remedy integrity and institutional controls. The current implementation, maintenance, and periodic inspection requirements for the institutional controls at the Hanford Site are described in approved work plans and in the Sitewide Institutional Controls Plan (DOE/RL-2001-41) that was prepared by DOE and approved by EPA and Ecology in 2002. One requirement listed in the Sitewide Institutional Controls Plan is the commitment

to notify EPA and Ecology immediately upon discovery of any activity that is inconsistent with the land use designation of a site.

No later than 180 days after the ROD is signed, DOE shall update the Sitewide Institutional Controls Plan to include the institutional controls required by this ROD and specify the implementation and maintenance actions that will be taken, including periodic inspections. The revised Sitewide Institutional Controls Plan shall be submitted to EPA and Ecology for review and approval as a Tri Party Agreement primary document. The DOE shall comply with the Sitewide Institutional Controls Plan as updated and approved by EPA and Ecology.

The following institutional control performance objectives are required to be met as part of this remedial action. Land-use controls will be maintained until cleanup levels are achieved and the concentrations of hazardous substances in groundwater are at such levels to allow for unrestricted use and EPA authorizes the removal of restrictions.

Institutional controls required through the time of completion of the remedy are:

1. The DOE shall control access to prevent unacceptable exposure of humans to contaminants in the 200-ZP-1 OU groundwater addressed in the scope of this ROD until the remedy is complete. Visitors entering any site areas of the 200-ZP-1 OU will be required to be badged and escorted at all times.
2. No intrusive work shall be allowed in the 200-ZP-1 OU unless EPA has approved the plan for such work and that plan is followed.
3. The DOE shall prohibit well drilling in the 200-ZP-1 OU, except for monitoring, characterization or remediation wells authorized in EPA approved documents.
4. Groundwater use in the 200-ZP-1 OU is prohibited, except for limited research purposes, monitoring, and treatment authorized in EPA approved documents. The Sitewide Institutional Controls Plan will contain the institutional controls and implementing details prohibiting well drilling and groundwater use in the 200-ZP-1 OU, as defined in the Decision document for the 200-ZP-1 OU.
5. The DOE shall post and maintain warning signs along pipelines conveying untreated groundwater that caution site visitors and workers of potential hazards from the 200-ZP-1 OU groundwater.
6. In the event of any unauthorized access to the site (e.g., trespassing), DOE shall report such incidents to the Benton County Sheriff's Office for investigation and evaluation of possible prosecution.
7. Activities that would disrupt or lessen the performance of the pump-and-treat, MNA, and flow-path control components of the remedy are to be prohibited.
8. The DOE shall prohibit activities that would damage the pump-and-treat, MNA, and flow-path control components (e.g., extraction wells, injection wells, piping, treatment plant, or monitoring wells).
9. The DOE shall report on the effectiveness of institutional controls for the 200-ZP-1 OU remedy in an annual report, or on an alternative reporting frequency specified by EPA. Such reporting may be for this OU alone or may be part of a Hanford sitewide report.
10. The DOE will provide notice to EPA at least six months prior to any transfer or sale of the any land above the 200-ZP-1 OU so EPA can be involved in discussions to ensure that appropriate provisions are included in the transfer terms or conveyance documents to maintain effective institutional controls. If it is not possible for DOE to notify EPA at least six months prior to any transfer or sale, then the DOE will notify EPA as soon as possible but no later than 60 days prior to the transfer or sale of any property subject to institutional controls. In addition to the land transfer notice and discussion provisions above, the DOE further agrees to provide EPA with similar notice, within the same time frames, as to federal-to-federal transfer of property. The DOE shall provide a copy of executed deed or transfer assembly to EPA.

11. The DOE will prevent the development and use of property above the 200-ZP-1 groundwater OU for residential housing, elementary and secondary schools, childcare facilities and playgrounds.

Land use controls will be maintained until cleanup levels are achieved and the concentrations of hazardous substances in groundwater are at such levels to allow for unrestricted use and exposure and EPA authorizes the removal of restrictions.

Remedy Implementation Progress Prior to this Review Period. Beginning in 1996, DOE operated a 200-ZP-1 groundwater OU interim remedial measure pump-and-treat system located near the middle of the 200-West Area and removed carbon tetrachloride as the primary COC along with chloroform and TCE. This pump-and-treat system operated until May 2012 and had removed a total of 13,720 kg (30,247 lb) of carbon tetrachloride ([DOE/RL-2013-14, Calendar Year 2012 Annual Summary Report for the 200-ZP-1 and 200-UP-1 Operable Unit Pump-and-Treat Operations](#)). This original pump-and-treat system limited movement of the shallow, high-concentration portion of the plume; however, it did not address contamination deeper in the aquifer and at the periphery of the plume. In 2009, under the ROD for final remediation ([EPA 2008](#)), DOE began constructing the 200-West Area Groundwater Treatment Facility to address the full plume; construction was completed in 2011 and operations began in mid-2012. Through 2015, the original 200-ZP-1 Groundwater OU Pump and Treat System and the new 200-West Area Groundwater Treatment facility had removed a combined total of 39,511 kg (87,106 lb) of carbon tetrachloride from the groundwater. Additional detail on this earlier period of 200-ZP-1 groundwater remediation can be found in the 2015 annual groundwater monitoring report ([DOE/RL-2016-09](#)).

Issues/Corrective Actions from the Previous (2011-2015) 5-Year Review.

No previous issues or actions were noted for the 200-ZP-1 OU in the 2011-2015 [CERCLA](#) 5-Year Review.

Protectiveness Statement from the Previous (2011-2015) 5-Year Review Report ([DOE/RL-2016-01](#)).

The 200-ZP-1 groundwater OU protectiveness statement from the previous 5-year review report was noted as follows:

***200-ZP-1 Groundwater OU – Protective.** The remedy at the 200-ZP-1 groundwater OU is protective of human health and the environment. The RAOs to restore groundwater in the return the 200-ZP-1 OU to achieve domestic drinking water levels within 150 years, and to protect the Columbia River and its ecological resources from degradation and unacceptable impact caused by contaminants originating from the 200-ZP-1 OU, are being met by the remedy components involving groundwater extraction and treatment, MNA, and flow path control. The RAO of applying ICs to prevent the use of groundwater until the cleanup levels have been achieved (estimated to be within 150 years) has been met by the implementation and continued management of ICs.*

Progress Since the Previous Review

Accomplishments. The primary remedial action accomplishments for the 200-ZP-1 groundwater OU during the past 5 years can be summarized as follows:

- Successfully remediated groundwater from streams that have been approved for treatment (200-BP-5, Perched Water from 200-DV-1 Source OU, ERDF Leachate, and Modular Storage Unit Purge Water).

- Treated 25,642.7 million L (6,769.7 million gal) of groundwater through the 200-West Pump and Treat System.
- Performance of the 200-ZP-1 OU Pump and Treat activities through the first 5 years of operation has demonstrated that overall flow rates, plume containment, and mass extraction are consistent with targets established in the 200-ZP-1 Pump and Treat RD/RAWP ([DOE/RL-2008-78](#), Rev. 0)
 - Continuously operated the 200-West Pump and Treat System from 2012 through 2020
 - Removed 19,038 kg (41,972 lb) of carbon tetrachloride since startup
 - Removed 5124 kg (1,127 lb) of chromium (total and hexavalent) since startup
 - Removed 242,000,000 pCi of iodine-129 since startup
 - Removed 2,186,276 kg (4,819,913.5 lb) of nitrate since startup
 - Removed 15.06 Ci (885.7 g) of technetium-99 since startup
 - Removed 87.0 kg (192 lb) of TCE since startup
 - Removed 702.2 kg (1,548 lb) of uranium since startup.
- Removed (as of the end of 2020) a combined total of 130,096 kg (286,812 lb) of carbon tetrachloride from the vadose zone (200-PW-1 soil vapor extraction [SVE] system [1992 – 2012]) and groundwater (200-ZP-1 interim action system [1995 – 2012]), and the final action system (i.e., the 200-West Pump and Treat) [2012 – 2020]) through source and groundwater actions.

Additional narrative on 200-ZP-1 OU accomplishments (as of 2020) can be viewed in [DOE/RL-2020-62](#), *Calendar Year 2020 Annual Summary Report for the Pump and Treat Operations in the Hanford Central Plateau Operable Units*.

Remedy Implementation. Construction of the 200-West Pump and Treat balance of the plant began in late 2009; construction of the radiological building and biological process facility began in 2010. Commissioning and startup of the facility took place in 2011 and early 2012; operations began in July 2012.

Details on implementing the final action ROD are provided in *200-West Area 200-ZP-1 Pump-and-Treat Remedial Design/Remedial Action Work Plan* ([DOE/RL-2008-78](#), Rev. 1). This document describes and assess the 200-ZP-1 OU remedy performance during the initial remedy operation period since the start of operations in 2012. This document extrapolates likely future remedy performance using groundwater model simulations based on current data, identifies remedy performance challenges and data gaps, and identifies work plan tasks to address data gaps and information decisions for optimizing or modifying the remedy. The *200-West Area Groundwater Pump and Treat Remedial Design Report* ([DOE/RL-2010-13](#)) outlines the design basis of the 200-West Pump and Treat. Two primary documents that support the remedial design report are an O&M plan and a performance monitoring plan. The *200 West Pump and Treat Operations and Maintenance Plan*, ([DOE/RL-2009-124](#)) outlines the activities necessary to operate, maintain, and monitor operation of the 200-West Pump and Treat from construction completion through system decommissioning. This document was revised in 2016 to add the treatment of additional feed streams, which included 200-BP-5, Perched Water from 200-DV-1 Source OU, ERDF Leachate, and MSU Purge Water. A performance monitoring plan (PMP), [DOE/RL-2009-115](#), *Performance Monitoring Plan for the 200-ZP-1 Groundwater Operable Unit Remedial Action*, was prepared in a data quality objective-type format and presents the types of data to be collected, the well networks to be monitored, the frequency for data collection, and analysis of the data to satisfy the 200-ZP-1 requirements of the ROD. This PMP was revised during 2019 and was issued in 2020 ([DOE/RL-2009-115](#)). The revision includes data collection and installation details for proposed 200-ZP-1 OU injection, extraction, and monitoring wells in the remediation well installation SAP (Appendix G of the PMP). A major update to the data quality objectives for the PMP, which becomes the basis for data collection and analysis as well

as the reporting efforts performed under the PMP. The sampling schedule for the contaminant monitoring network was evaluated for potential spatial and temporal monitoring redundancies per the 200-ZP-1 OU redundancy analysis ([SGW-60527](#)).

Table 3-7 presents an overview of primary components of the remedy and implementation status.

Table 3-7. Overview of 200-ZP-1 Groundwater Operable Unit Remedy Implementation.

Document Type	Date	Title						
Final Action ROD	09/2008	EPA 2008, <i>Record of Decision, Hanford 200 Area, 200-ZP-1 Operable Unit Superfund Site, Benton County, Washington</i>						
RD/RA Work Plan	07/2009	DOE/RL-2008-78, <i>200-West Area 200-ZP-1 Pump-and-Treat Remedial Design/Remedial Action Work Plan</i>						
RAO (brief description)	1. Return the 200-ZP-1 OU groundwater to beneficial use (restore groundwater to achieve domestic drinking water levels) within 150 years 2. Apply institutional controls to prevent the use of groundwater until the cleanup levels have been achieved (estimated to be within 150 years) 3. Protect the Columbia River and its ecological resources from degradation and unacceptable impact caused by contaminants originating from the 200-ZP-1 OU							
COCs	Carbon tetrachloride, chromium (total and hexavalent), nitrate, iodine-129, technetium-99, trichloroethene, tritium							
Remedy Component	Status (approximate percentage complete for implementing the remedy component as of December 2020) ^a						Duration of O&M (~years) ^b	Finish ^c (Est'd year)
	0	1-25	26-50	51-75	76-99	100%		
Groundwater extraction and treatment							TBD	TBD
Monitored natural attenuation (also includes performance monitoring)							TBD	TBD
Flow path control							TBD	TBD
Institutional controls							125	2137

^a Percentages reflect implementation status of the remedy component; post-startup upgrades and system performance optimization is considered part of O&M. 100% = fully implemented and now in O&M mode.

^b TBD based on the results of the data collection during implementation of the 200-ZP-1 Optimization Study Plan evaluation (5 to 7 years).

^c Estimated year when remedy component will be completed.

DOE/RL-2008-78, 2020, *200 West Area 200-ZP-1 Pump-and-Treat Remedial Design/Remedial Action Work Plan*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <https://pdw.hanford.gov/document/AR-04507>.

EPA, 2008, *Record of Decision Hanford 200 Area 200-ZP-1 Superfund Site, Benton County, Washington*, U.S. Environmental Protection Agency, Washington, D.C. Available online at <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=00098825>.

COC	= contaminant of concern	RD/RA	= remedial design/remedial action
O&M	= operation and maintenance	ROD	= record of decision
OU	= operable unit	TBD	= to be determined
RAO	= remedial action objectives		

Technical Assessment

Is the remedy functioning as intended by the decision documents?

No, the remedy identified in the final action ROD ([EPA 2008](#)) involving extraction of groundwater from the 200-ZP-1 OU area and treatment at the 200-West Pump and Treat, monitored natural attenuation, flow-path control via injection of treated groundwater (all supporting achievement of RAO 1 and RAO 3),

and ICs has not been functioning as intended since 2017. However, the remedy did operate as intended in the first 5 years of operation (2012-2017).

Recent developments have occurred that are challenging the ability to meet the year 2137 target end date for restoring groundwater to achieve domestic drinking water levels as specified in the ROD. A PNNL study, *Abiotic Degradation Rates for Carbon Tetrachloride* ([PNNL-22062](#)) performed after the ROD was signed concluded that the half-life for carbon tetrachloride is much longer than understood during the preparation of the *Feasibility Study for the 200-ZP-1 Groundwater Operable Unit* ([DOE/RL-2007-28](#)) and the original version (Rev. 0) of the RD/RAWP ([DOE/RL-2007-28](#)). Also, data collected in recent years during the drilling and installation of new extraction and injection wells has shown the carbon tetrachloride plume to be much larger in size than originally understood. Furthermore, biological treatment processes contributed to injection well fouling that diminished injection well capacity, which necessitated frequent well cleaning, constructing new injection wells, installing an effluent chlorination system, and making changes to facility amendments and operational conditions. The diminished well capacity due to well fouling limited the flow through the treatment plant and increased operational costs. Groundwater modeling is currently being performed to evaluate options for meeting the 2137 target end date.

Combined, the final remedial action system, the interim remedial action system, and SVE systems have removed 130,096 kg (286,812 lb) of carbon tetrachloride from the subsurface as of 2020. Since startup of the 200-West Pump and Treat System in 2012, over 19,038 kg (41,972 lb) of carbon tetrachloride has been removed. As further explained in [DOE/RL-2020-62](#), carbon tetrachloride concentrations in groundwater are declining in all of the 200-ZP-1 and 200-UP-1 OU monitoring wells to less than 2,000 µg/L, except one, 299-W18-87, which exhibited a maximum concentration of 2,420 µg/L. Of the 103 monitoring wells sampled in 2020 in the 200-West Area, 27 wells were below the cleanup level of 3.4 µg/L. The effectiveness of the 200-West Pump and Treat is demonstrated by declining carbon tetrachloride concentrations in over one-half of the monitoring wells (65 of the 103 wells).

Table 3-8 summarizes the mass or activity removed at the 200-West Pump and Treat both during 2020 and cumulatively since startup in July 2012.

Remedy performance monitoring will be conducted over the duration of the remedial action to evaluate its performance and optimize its effectiveness. Monitoring is under way to evaluate the performance of the pump-and-treat systems, hydraulic containment, and MNA components. Seven monitoring wells to enhance monitoring capability, as proposed in the *Performance Monitoring Plan for the 200-ZP-1 Groundwater Operable Unit Remedial Action* ([DOE/RL-2009-115](#)), have been installed between 2016 and 2019. No monitoring wells were installed in 2020. The wells were prioritized based on balancing the need to improve the understanding of plume distribution in the Ringold Formation member of Wooded Island - Unit A (Rwia) within the core of the plume and the needs for pump-and-treat remedy optimization in the Ringold Formation member of Wooded Island - Unit E (Rwie). Between 2016 and 2019, five injection wells and one extraction well have been added to the 200-ZP-1 OU well network in 2020. A total of 10 new extraction wells were planned to be installed to support the optimization study, but due to funding constraints and the partial sitewide Coronavirus 2019 pandemic (COVID-19) shutdown March through June 2020, 5 extraction wells began drilling and will not complete until fall 2021. The remaining five will be drilled and constructed in CY 2022.

In 2020, remedy performance of the 200-West Pump and Treat and 200-ZP-1 OU have been evaluated and the results documented in Chapters 2 and 3 of [DOE/RL-2020-62](#). The 200-West Pump and Treat operated at an average flow rate of 8,156 L/min (2,162 gal/min) above the nominal operating flow rate of 7,600 L/min (2,000 gal/min). The injection well capacity also increased compared to 2019. Improvements were in part due to the suspension of nitrate treatment (as part of an optimization study) and the

implementation of the chlorination system. When the 200-West Pump and Treat is operating at or above the nominal design capacity, the OU injection and extraction well network is effectively hydraulically containing carbon tetrachloride present in groundwater at concentrations less than 100 µg/L as targeted. Summary statistics indicate that the contaminant monitoring is demonstrating that carbon tetrachloride and other COCs concentrations are declining, consistent with expectations and projections.

In FY 2017, 2018, and 2019, remedy performance of the 200-West Pump and Treat and 200-ZP-1 OU have been evaluated. The results of the evaluations are documented in the annual 200-West Area Pump and Treat reports. The evaluations have demonstrated that system-wide flowrates, plume hydraulic containment, and mass recovery rates are less favorable and highly unlikely to allow carbon tetrachloride to reach the cleanup level under the current remedy configuration in the timeframe specified in the ROD due to the following:

- Updated estimates of carbon tetrachloride abiotic degradation rate via chemical hydrolysis is about an order of magnitude slower than previously estimated since the time of the ROD issuance. Current estimate half-life of about 630 years versus the 41.3-year half-life used in the 200-ZP-1 RD/RAWP, Rev. 0.
- Improved knowledge of the carbon tetrachloride distribution suggest that over a third more carbon tetrachloride contamination is present in the Rwie than identified in the 200-ZP-1 OU FS.
- Updated information also suggests that a greater proportion (about 25% compared to 12% estimated in the 200-ZP-1 OU FS) of carbon tetrachloride mass lies deep within the unconfined aquifer within the Rwia.

To evaluate a basis for modifying the current remedy configuration, a formal remedy optimization study is needed and was implemented in October 2019. Remedy reconfiguration is required if remediation of the most significant risk driver, carbon tetrachloride, is to meet final RAOs. Specifically, increased system-wide capacity accompanied by a larger number of extraction and injection wells would facilitate more rapid flushing of contaminated groundwater, which is necessary to accelerate carbon tetrachloride mass removal.

Most nitrate in groundwater is currently present at concentrations that are less than an order of magnitude above the cleanup level. Considering current nitrate concentration trends and assuming there is not continuing source of nitrate, sufficient nitrate may have already been removed from the aquifer (resulting in substantial concentration reductions) to enable a transition to the MNA phase of the remedy that will still allow the nitrate cleanup level to be reached within the timeframe specified in the ROD. Suspension of biological treatment would allow the treatment capacity for carbon tetrachloride to increase up to approximately 14,200 L/min (3,750 gal/min) maximum throughput capacity with installation of a third air stripper. The 200-ZP-1 Optimization Study (per [DOE/RL-2019-38](#), Rev. 0, *200-ZP-1 Operable Unit Optimization Study Plan*), began in October 2019 and is expected to continue through the end of FY 2026 ([TPA-CN-1102](#)) due to delays associated with the COVID-19-related shutdown during March through June 2020. The study has a duration of 5 years with an option of 2 additional years, if needed.

In parallel with the implementation of the 200-ZP-1 Optimization Study, Ringold Unit A is being characterized further in accordance with [DOE/RL-2019-23](#), *200-ZP-1 Operable Unit Ringold Formation Unit A Characterization Sampling and Analysis Plan*, with the installation of eight monitoring wells; of which two Rwia monitoring wells were installed in 2021. The network of wells sampled in 2020 is shown in Figure 3-8.

Table 3-8. 200-West Area Pump and Treat Performance.^a

Constituent	Mass (Activity) Removed During 2020	Mass (Activity) Removed Since Startup in 2012
Carbon tetrachloride, kg	1,999	19,039
Chromium, (total and hexavalent) kg	6.55	512
Iodine-129, pCi	N/A ^b	N/A
Nitrate (as NO ₃), kg	0 ^c	2,186,276
Technetium-99, Ci (g)	1.897 Ci (111.6 g)	15.06 Ci (884 g)
Trichloroethene, kg	10.9	86.99
Tritium	N/A ^b	N/A
Uranium ^d (kg)	71.54	702.2

^a Source: Calendar Year 2020 Annual Summary Report for Pump and Treat Operations in the Hanford Central Plateau Operable Units, Table 2-2 (DOE/RL-2020-62).

^b No treatment of tritium; mass removal for iodine-129 not calculated.

^c Biological treatment for nitrate was suspended in October 2019 and nitrate and chromium (total and hexavalent) were no longer treated as a component of the 200-ZP-1 Optimization Study Plan implementation...

^d Uranium is not a COC in 200-ZP-1; contaminant is background contamination removed from wells in the 200-ZP-1 OU.

DOE/RL-2020-62, 2021, *Calendar Year 2020 Annual Summary for Pump and Treat Operations in the Hanford Central Plateau Operations Unit*, Rev 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <http://www.hanford.gov/page.cfm/SoilGroundwaterAnnualReports>.

COC = contaminant of concern

N/A = not applicable

OU = operable unit

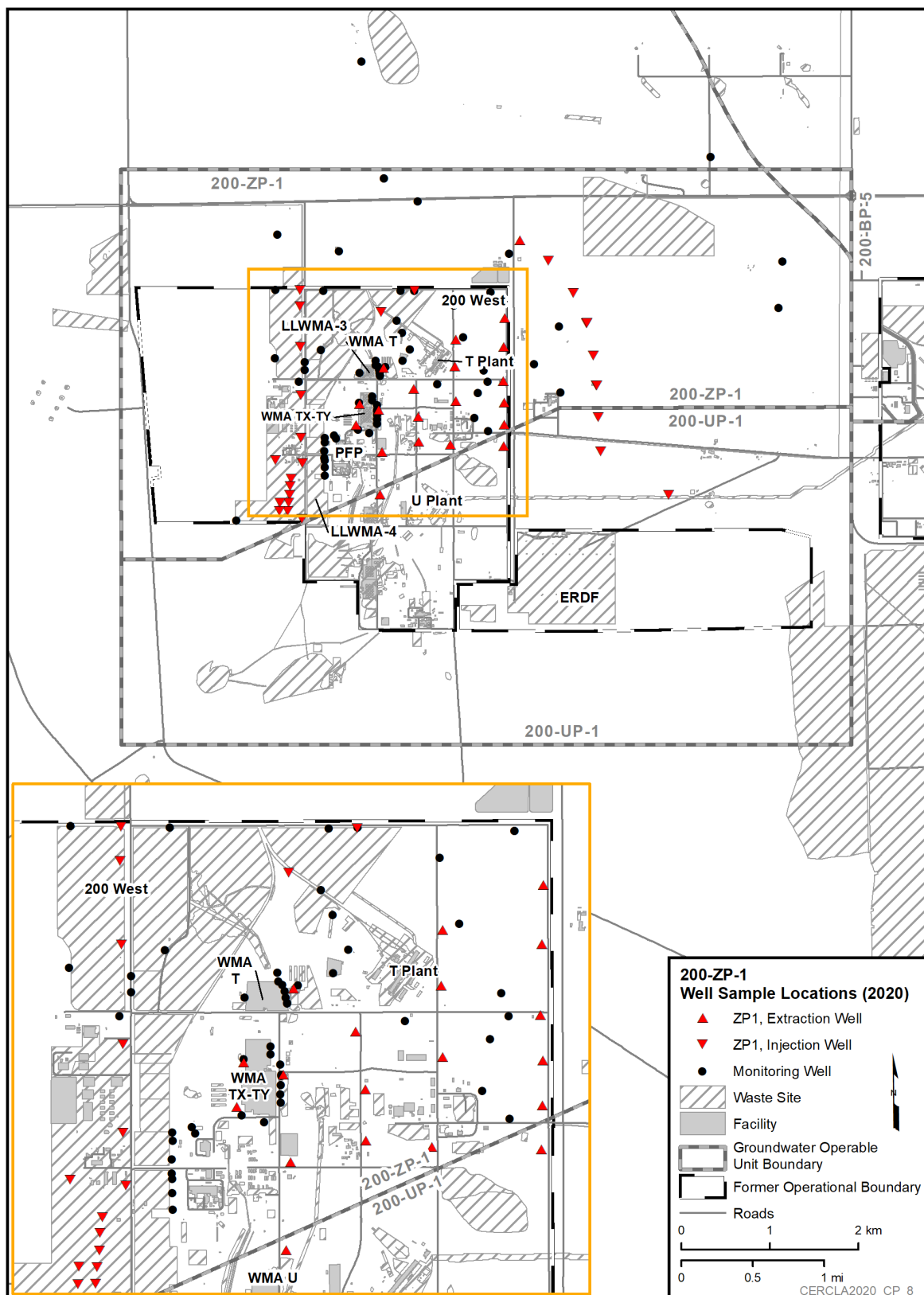


Figure 3-8. Locations of 200-ZP-1 Wells Sampled in 2020.

In addition to the implementation of the optimization study plan and the Ringold A SAP ([DOE/RL-2019-23](#)), activities were initiated for the development of a Central Plateau Comprehensive Plume Evaluation (CPE) and Implementation Plan. The intent is to perform a comprehensive evaluation to further evaluate the cleanup potential for other COCs to take place concurrently with the optimization study plan and Ringold A characterization activities. The comprehensive evaluation is planned to complete in FY 2021.

Table 3-9 provides an overview of the 200-ZP-1 contaminant plume areas and associated changes to the areas during this 5-year review period. Plume maps in Figure 3-9 shows the changes in plume shapes and areas during this 5-year review period. The Figure 3-10 trend plots depict the estimated annual changes in contaminant plume areas over the past several 5-year periods.

While concentrations of carbon tetrachloride in most wells continued to decline between 2016 and 2020, plume area increase during this time (Figure 3-10) are attributed to sample data collected during the drilling of new wells and model updates. Data compiled show that more carbon tetrachloride contamination in the Rwie is over one-third more mass than previously estimated in the FS ([DOE/RL-2007-28](#)). Additionally, a greater proportion (about 25% compared to 12% estimated in the 200-ZP-1 OU FS) of carbon tetrachloride mass lies deep within the unconfined aquifer within the Rwia. Rwia is being characterized further in accordance with [DOE/RL-2019-23](#), *200-ZP-1 Operable Unit Ringold Formation Unit A Characterization Sampling and Analysis Plan*, which was implemented in FY 2020.

The increases shown in Figure 3-10 for nitrate and TCE during 2010 through 2012 also are attributed to new wells established before the pump-and-treat startup in 2012 and contributed to the improved definition of plume extent for certain COCs shown in Figure 3-9. Chromium (total and hexavalent) concentrations are relatively stable, although high unfiltered chromium along with the presence of high nickel concentrations may be an indication of well corrosion products rather than increases in concentrations. The plume size remains relatively the same from 2016 through 2019 and will further be captured in the northeast region due to the installation of extraction well 699-48-70 in 2019.

For more detailed information on the 200-ZP-1 groundwater OU well locations, distribution of contaminant concentrations within each plume, historic trends associated with each 200-ZP-1 COC plume area, as well as for performance metrics associated with 200-ZP-1 OU groundwater treatment, visit the following websites:

- *Hanford Site Groundwater Monitoring Report* (published each summer for the previous calendar year): <http://www.hanford.gov/page.cfm/SoilGroundwaterAnnualReports>
- *Calendar Year 2019 Annual Summary Report for Pump and Treat Operations in the Hanford Central Plateau Operable Units*: <http://www.hanford.gov/page.cfm/SoilGroundwaterAnnualReports>.

ICs for the 200-ZP-1 groundwater OU, as required by the ROD ([EPA 2008](#)) are described in the latest version of *200-West Area 200-ZP-1 Pump-and-Treat Remedial Design/Remedial Action Work Plan* ([DOE/RL-2008-78](#)) and are actively managed. Specific details associated with each IC also have been incorporated into [DOE/RL-2001-41](#), *Sitewide Institutional Controls Plan for the Hanford CERCLA Response Actions and RCRA Corrective Actions*, this report is routinely updated within 180 days after publication of each decision document that addresses ICs. The ICs implemented for the 200-ZP-1 OU support achievement of RAO 2 and include warning notices, entry restrictions, land-use management (land use), groundwater-use management (excavation permits), and miscellaneous provisions. These ICs

are assessed annually and DOE presents a summary including any noted issues or actions to the Site regulators each fall at the unit managers' meeting. The presentation is documented in the meeting minutes attachments (e.g., [CHPRC-2003756](#)), which are archived in the Hanford Site Administrative Record. The annual IC assessments are also now captured in an annual report (e.g., [HNF-65616](#), *FY2020 Sitewide Institutional Control Assessment*, Rev. 0). During the 5-year review period of 2016 through 2020, appropriate ICs for the 200-ZP-1 groundwater OU were found to be in place and maintained, and the objectives for the ICs are being met.

Table 3-9. Overview of 200-ZP-1 Groundwater Contaminant Plumes.^a

Groundwater Contaminant	Cleanup Level ^b	Maximum Concentration (2020)	Plume Area ^c (km ²)			Shoreline Intersection ^d (m)		
			2015 ^k	2020	Change	2015	2020	Change
Carbon tetrachloride	3.4 µg/L	2,420 µg/L	18.0	19.5 ^j	1.5	0	0	0
Chromium (hexavalent/total)	48 ^f /100 ^g µg/L	506.8/484 µg/L ^h	0.64/0.17	0.88/0.23	0.24/0.06	0	0	0
Iodine-129	1 pCi/L	6.76 pCi/L	0.09	0.20	0.11	0	0	0
Nitrate	45 ⁱ mg/L	1,860 mg/L	7.2	10.2	3.0	0	0	0
Technetium-99	900 pCi/L	24,800 pCi/L	0.06	0.15	0.09	0	0	0
Trichloroethene	1 µg/L	13.3 µg/L	2.9	5.5 ^j	2.6	0	0	0
Tritium	20,000 pCi/L	170,000 pCi/L	0.20	0.12	-0.08	0	0	0

^a Primary source: Hanford Annual Groundwater Monitoring Reports for 2015 and 2020 available at

<http://www.hanford.gov/page.cfm/SoilGroundwaterAnnualReports>

^b From Table 14 of *Record of Decision Hanford 200 Area 200-ZP-1 Superfund Site, Benton County, Washington* (EPA 2008).

^c Estimated area above the cleanup level, unless otherwise noted

^d Length of Columbia River shoreline intersected by contaminant plumes. 200-ZP-1 plumes are approximately 7 miles from the Columbia River shoreline

^e Represents the entire extent of the plume (including the 200-UP-1 OU) above 5 µg/L

^f WAC 173-340, "Model Toxics Control Act—Cleanup," Method B groundwater cleanup level for hexavalent chromium

^g Federal drinking water standard for total chromium

^h 2011 area value is for unfiltered total chromium, and 2015 value is for hexavalent chromium

ⁱ Nitrate as nitrate; 10 mg/L nitrate as nitrogen

^j Area of full plume footprint (includes area within 200-UP-1 and 200-ZP-1 combined, all depths in unconfined aquifer, at greater than cleanup level

^k Source: ECF-Hanford-16-0061

EPA, 2008, *Record of Decision Hanford 200 Area 200-ZP-1 Superfund Site, Benton County, Washington, U.S.*

Environmental Protection Agency, Washington, D.C. Available online at

<http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=00098825>.

WAC-173-340, "Model Toxics Control Act – Cleanup," *Washington Administrative Code*, as amended. Available online at <http://apps.leg.wa.gov/WAC/default.aspx?cite=173-340>.

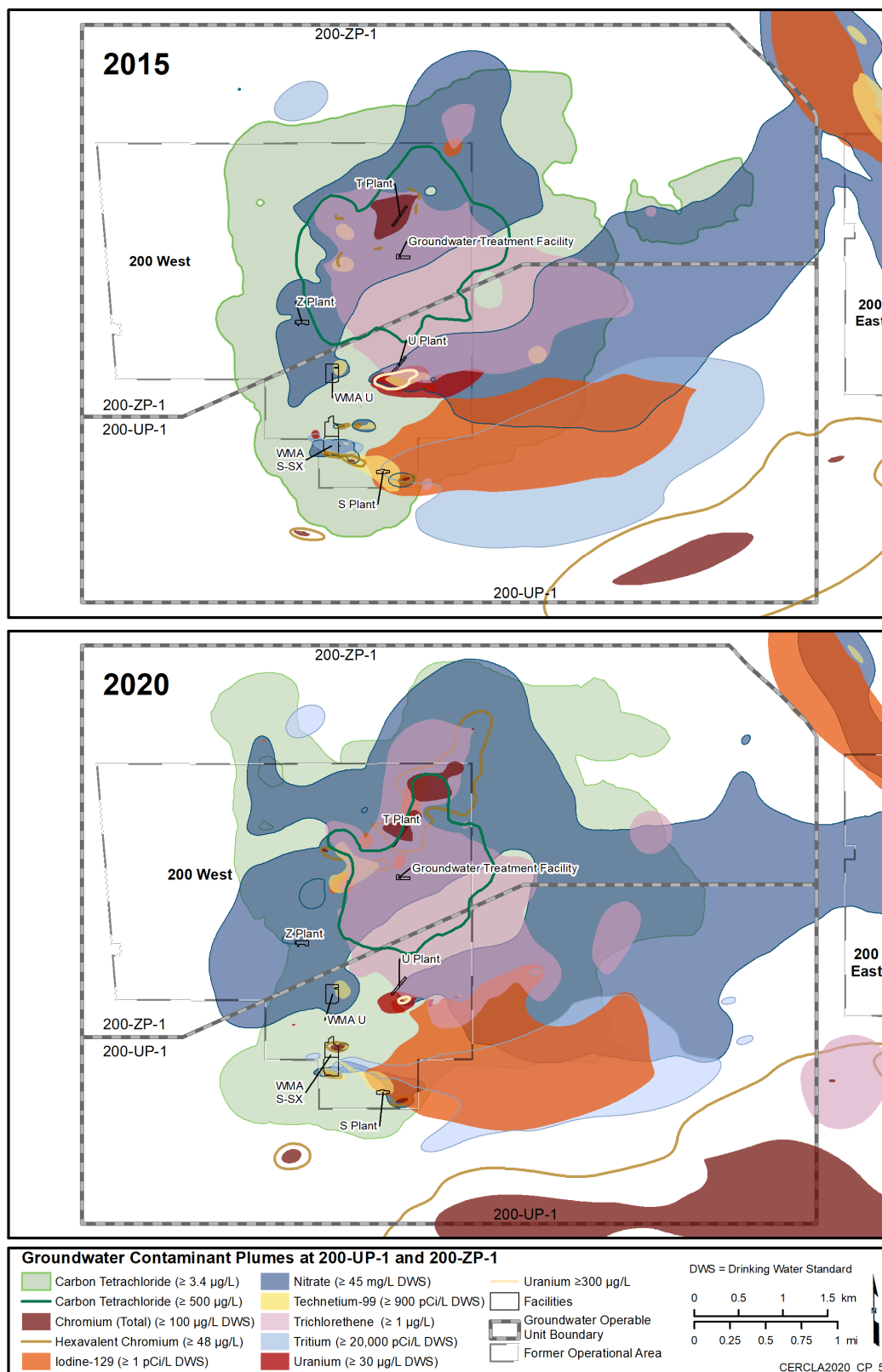
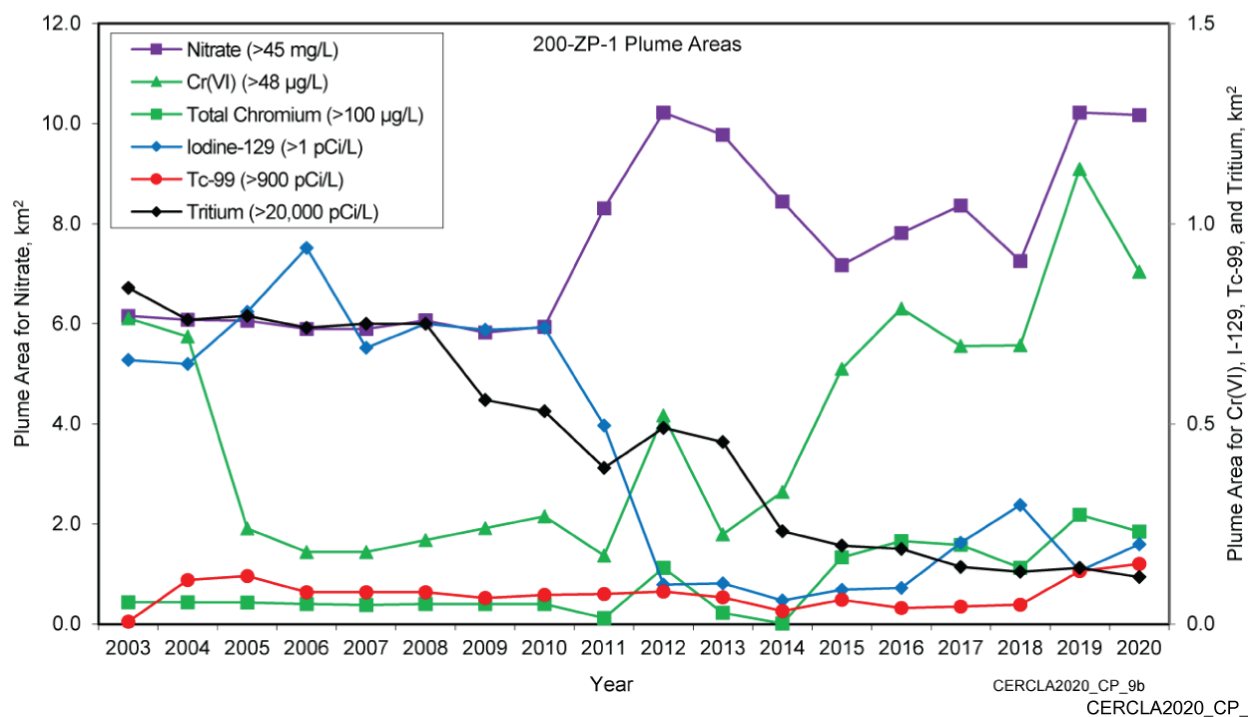
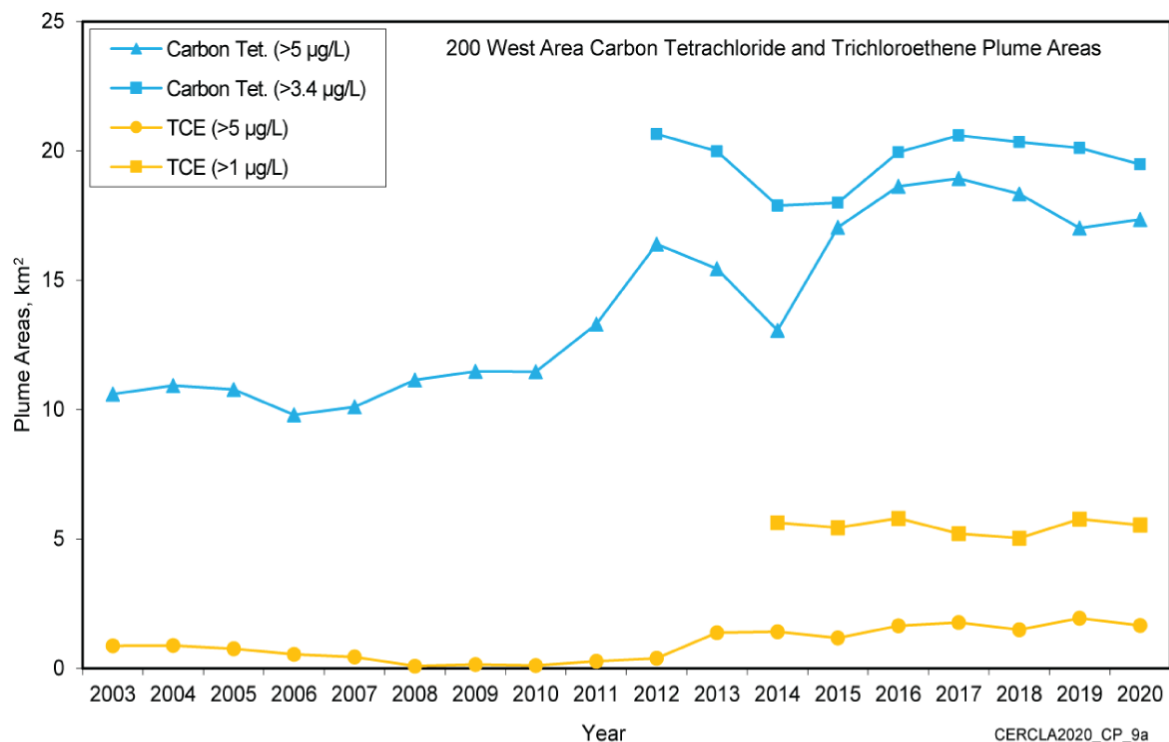


Figure 3-9. 200-UP-1 and 200-ZP-1 Groundwater Operable Unit Plumes in 2015 (top) and 2020 (bottom).



The actual cleanup level for carbon tetrachloride is 3.4 ppb and for TCE is 1 ppb.
Figure 3-10. 200-ZP-1 Trend Plots of Contaminant Plume Areas (2003-2020).

Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of remedy selection still valid?

The exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of remedy selection (2008) are still valid for the OU. However, the time required for pumping (25 years), the assumption of less than 100 µg/L of carbon tetrachloride to remove 95% of all COCs and a 41.3-year half-life (carbon tetrachloride), as stated in the FS ([DOE/RL-2007-28](#)) and the RD/RAWP ([DOE/RL-2008-78](#), Rev. 0), are no longer valid as stated above.

Has any other information come to light that could call into question the protectiveness of the remedy?
No information has come to light that would call into question the protectiveness of the remedy.

Issues/Recommendations During this Review Period

Data and information acquired following issuance of the 200-ZP-1 OU ROD and since the previous 5-year review period (2011-2015), suggest that conditions are less favorable and highly unlikely to allow carbon tetrachloride to reach the cleanup level under the current remedy configuration in the timeframe specified in the ROD. The RD/RAWP revision ([DOE/RL-2008-78](#), Rev. 1) in conjunction with the *200-ZP-1 Operable Unit Optimization Study Plan* ([DOE/RL-2019-38](#), Rev. 0) identify and address the data gaps and serve as the basis for addressing the remedy implementation challenges identified during initial operations and over the past 5-year operational period. In combination, these two documents provide the framework to implement and optimize the remedy, modify remedy decision documents (e.g., ROD amendment), and implement changes to the remedy to ensure the goals specified in the 200-ZP-1 ROD or ROD modification are achieved.

The data also indicate lower hydraulic conductivity in Rwia compared to Rwie is being further characterized in parallel with the 200-ZP-1 Optimization Study in accordance with [DOE/RL-2019-23](#), *200-ZP-1 Operable Unit Ringold Formation Unit A Characterization Sampling and Analysis Plan*, which was implemented in 2020. The information resulting from data collection specified in the Rwia SAP will be combined with the data from the optimization study results and will help evaluate remedy performance.

A new remedy analysis initiative, referred to as the CPE, commenced in fall 2020 and continued into 2021, with an anticipated completion date of fall 2021. This activity is evaluating the remediation status and evidence for potential continuing sources of several COCs and/or COPCs that – though exhibiting smaller geographic extents than the carbon tetrachloride – have the potential to impact remedy decisions. The CPE compiles available data and modeling results for Central Plateau groundwater plumes to help optimize the remediation approach(es), ensure that current and pending regulatory commitments can be met, and identify future treatment needs. Specific objectives of the CPE include:

- Developing strategies to optimize mass recovery and source containment by identifying areas/COCs/COPCs that warrant optimization strategies (i.e., technetium-99, hexavalent chromium, cyanide)
- Identify approximate pump-and-treat targets to transition from active treatment to MNA for the 200-ZP-1 OU
- Evaluate current capabilities against future treatment needs
- Identify opportunities to improve the integrated approach to groundwater remedy optimization across the Central Plateau.

The CPE is the first step towards an integrated evaluation across all the groundwater OUs in order to optimize the remediation approach, both from an operational perspective as well as from the treatment capabilities. The CPE is intended to provide recommendations that can be implemented in the near-term (less than 1 year) to enhance remedy efficiency as well as provide long-term recommendations that will reduce the cleanup duration and cost.

Issue ZP1-1. Restoration of groundwater to drinking-water levels within the RAO-specified timeframe of 150 years may not be achieved without additional system changes.

Recommendation ZP1-1. Implement the 200-ZP-1 Optimization Study Plan combined with implementing the Ringold Formation Unit A Sampling and Analysis Plan (Milestone Date: September 30, 2026).

Does this issue/action currently affect the protectiveness of the remedy? – NO.

Will this issue/action affect the protectiveness of the remedy in the future? – YES.

Protectiveness Statement

200-ZP-1 Groundwater OU – Short-Term Protective.

The remedy at the 200-ZP-1 groundwater OU is currently protective of human health and the environment because the remedy components involving groundwater extraction and treatment, MNA, flow path control, and ICs have been implemented and are being managed. However, in order to meet the long-term RAOs of achieving domestic drinking water levels within 150 years and protecting the Columbia River and its ecological resources from degradation and unacceptable impact caused by contaminants originating from the 200-ZP-1 OU, the 200-ZP-1 Optimization Plan and the Ringold Formation Unit A Sampling and Analysis Plan need to be implemented over the next 5 years. The optimization study began in 2019 and will continue through FY 2026 (per [TPA-CN-1102](#)) due to delays associated with the COVID-19-related shutdown during March through June 2020 and has an option of 2 additional years, if needed.

3.3.2 200 Area Source Operable Units Included in this Review

This section covers the following four 200 Area source OUs that have published RODs for remedial action:

- 200-CU-1 (U-Plant Canyon Building)
- 200-CW-3
- 200-DF-1 (ERDF)
- 200-PW-1, 200-PW-3, 200-PW-6, and 200-CW-5.

As clean-up decisions are made for the other 200 Area source OUs, the decisions are documented in a ROD and field construction of the remedy is initiated, those OUs will be evaluated for protectiveness and included in a future 5-year review report. Future cleanup decisions are anticipated for the following 200 Area source OUs: 200-BC-1, 200-CB-1, 200-CP-1, 200-CR-1, 200-CW-1, 200-DV-1, 200-EA-1, 200-IA-1, 200-IS-1, 200-OA-1, 200-SW-2, and 200-WA-1.

3.3.2.1 200-CU-1 Source Operable Unit

Background

The Central Plateau contains five large defense production facilities, referred to as canyons, which were originally designed for fuel reprocessing operations: T-Plant, B-Plant, U-Plant, REDOX Plant, and PUREX Plant. The canyon buildings range from approximately 244 m (800 ft) long to over 305 m (1,000 ft) long and are constructed of thick, reinforced concrete. Approximately half of each structure was constructed below grade level for shielding purposes. The below-grade portion of the structure is

divided into cells that contain equipment and piping used for reprocessing operations. Thick concrete cover blocks protect the cells and form the surface of the canyon deck.

Primary waste streams from canyon facilities included process waste, decontamination wastewater, and aqueous process waste that were discharged to tanks, cribs, and trenches. The nonradioactive, low-volume chemical sewer waste was generally sent to ponds and ditches. Very low-volume radioactive waste streams were sent to French drains.

Only T-Plant continues to support Hanford Site waste management. B-Plant, U-Plant, REDOX Plant, and PUREX Plant are no longer in use and are targeted for remediation within the [CERCLA](#) 200-CB-1, 200-CU-1, 200-CR-1, and 200-CP-1 OUs, respectively. The U-Plant (also noted herein as 221-U Facility or U-Plant) is the first canyon building to get a ROD for final disposition. Implementation of *Record of Decision 221-U Facility Canyon Disposition Initiative* Hanford Site, Washington ([EPA 2005b](#)) is viewed as a pilot project to provide a blueprint for the disposition of the remaining four canyon buildings and lessons learned for dealing with similar facilities at the Idaho National Laboratory and Savannah River Site. This pilot project also is known as the Canyon Disposition Initiative.

The 221-U Facility is approximately 244 m (800 ft) long, 21 m (70 ft) wide, and 24 m (80 ft) high, and was built to extract plutonium from fuel rods irradiated in Hanford Site production reactors. However, it was never used for this purpose because existing canyon buildings met the Site's production needs. Instead, the facility was used to train operators for B-Plant and T-Plant until 1952. At that time, it was modified to include a uranium recovery process for waste from other canyon facilities. Process equipment was transferred from other canyon facilities to process remote-handled materials and materials contaminated with TRU isotopes.

Chronology

Table 3-10 lists the remedial action decision documents associated with the 200-CU-1 source OU as of December 31, 2020.

Table 3-10. Decision Documents for the 200-CU-1 Source Operable Unit.

Date	Location	Document Title
10/2005	EPA 2005b	<i>Record of Decision 221-U Facility (Canyon Disposition Initiative), Hanford Site, Washington.</i> This final action ROD includes removing waste from facility vessels and equipment with levels of transuranic isotopes greater than 100 nCi/g and eventual disposal at WIPP, removing or treating to remove liquids from the facility, and partial removal of contaminated equipment and piping from the gallery side of the facility and disposal at ERDF. It also includes demolition and subsequent stabilization of the railroad tunnel; the 271-U, 276-U, 291-U, and 292-U structures; and the 291-U-1 and 296-U-10 stacks and their disposal at ERDF. Final ROD activities consist of constructing an engineered barrier, planting semiarid-adapted vegetation on the barrier, initiating ICs, providing post-closure care, and ensuring ongoing barrier performance and groundwater monitoring.

ERDF = Environmental Restoration Disposal Facility

IC = institutional control

ROD = record of decision

WIPP = Waste Isolation Pilot Plant

See Appendix B for a consolidated listing of decision documents for Hanford Site OUs.

Remedial Actions

Goals and Objectives. The RAOs for the 200-CU-1 OU are as follows:

- RAO 1. Prevent unacceptable health and occupational risks to workers from physical, chemical, and radiological hazards posed by the 221-U Facility.
- RAO 2. Prevent unacceptable risk to human health, ecological receptors, or natural resources associated with external exposure to, ingestion of, inhalation of, and dermal contact with 221-U Facility contents at levels that exceed applicable or relevant and appropriate requirements or risk-based criteria.
- RAO 3. Prevent migration of contaminants to surface waters and through the soil column to groundwater such that no further degradation of groundwater occurs due to leaching from the 221-U Facility.
- RAO 4. Minimize physical, ecological, or cultural impacts caused by remediation of the 221-U Facility or by use of the 221-U Facility as a disposal facility.

Remedy Components. The selected remedy in this final ROD ([EPA 2005b](#)) includes the following components.

Excerpt from ROD (EPA 2005b):

- *Removal of waste from vessels and equipment in the facility that, if stabilized in place, would contain levels of transuranic isotopes greater than 100 nCi/g, in accordance with an approved Remedial Design/Remedial Action (RD/RA) work plan, and eventual disposal of that waste at the Waste Isolation Pilot Plant (WIPP) in Carlsbad, New Mexico.*
- *Removal of liquids from the facility or treatment to remove liquids.*
- *Partial removal of contaminated equipment and piping from the gallery side of the facility, as needed to facilitate demolition activities, and disposal of this waste at the Environmental Restoration Disposal Facility (ERDF) located on Hanford's Central Plateau between the 200 West and 200 East Areas or other disposal facilities approved in advance by the U.S. Environmental Protection Agency (EPA).*
- *Treatment, as necessary, to meet waste acceptance criteria at an acceptable disposal facility.*
- *Consolidation of contaminated equipment on the deck into the below-grade cells for disposal.*
- *Grouting of internal vessel spaces, as well as cell, gallery, pipe trench, drain header, and other spaces within the facility.*
- *Demolition of the railroad tunnel, 271-U, 276-U, 291-U, and 292-U structures and the 291-U-1 and 296-U-10 stacks, and disposal of the resulting waste at the ERDF or other disposal facilities approved in advance by the EPA, followed by stabilization of the former locations of these structures to support construction of the engineered barrier.*
- *Removal of roof and wall sections of the 221-U Facility down to the deck level and placement on or near the deck.*
- *Construction of an engineered barrier over the remnants of the canyon building (with the possible inclusion of inert rubble from the demolition of ancillary facilities as fill material).*
- *Planting of semiarid-adapted vegetation on the barrier to enhance evapotranspirative design of the barrier.*
- *Institutional controls to ensure that the remedy is protected and changes in land use do not occur that could result in unacceptable exposures to residual contamination.*
- *Post-closure care, including barrier inspection and maintenance.*

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

Remedy Implementation Progress Prior to this (2016-2020) Review Period ([DOE/RL-2016-01](#), Rev. 0). Work on the 200-CU-1 OU remedy began after issuance of the ROD ([EPA 2005b](#)) in 2005. Before 2011, the following tasks were completed: U Canyon Building cell loading and deck cleaning; demolishing the above-ground tanks (211-U/UA) and the 203-UX process facility; debris from both structures was disposed of in ERDF. The 224-U/UA process facilities also were demolished. ICs have been in place since remedial activities commenced in 2008 and have been effective to prevent exposure to contamination by unauthorized personnel or the public.

Issues/Corrective Actions from the Previous (2011-2015) 5-Year Review. No issues or actions were noted for the 200-CU-1 source OU in the 2011 [CERCLA](#) 5-year review.

Protectiveness Statement from the Previous (2011-2015) 5-Year Review Report ([DOE/RL-2016-01](#)). The 200-CU-1 OU protectiveness statement from the previous (2011-2015) 5-year review report was noted as follows:

***200-CU-1 Source OU – Will Be Protective.** The remedy at the 200-CU-1 OU (221-U Facility (U Plant) is expected to be protective of human health and the environment upon completion of the final remedy actions. Implementation of the final remedy for the 200-CU-1 OU has been put in hiatus. Once implementation is restarted and the remedy is complete, it is expected to be protective of human health and the environment. The remedial actions completed to date, along with implementation of ICs, ensure that exposure pathways that could result in unacceptable risks are being controlled.*

Progress Since 2011-2015 Review

Accomplishments. The tasks associated with the 221-U Facility remedy include the following:

- Equipment size reduction
- Cell 30, Tank-D10 contents disposition
- Canyon void space grouting, including equipment in the cells
- Canyon demolition
- Engineered barrier construction.

Remediation has been mostly in hiatus during this review period, limited asbestos abatement was conducted in the operating gallery in late 2020. During the previous review period (2011-2015), the first three remedy components listed above were completed, as documented in [DOE/RL-2011-80](#), *Interim Completion Report for the 221-U Facility*. Canyon demolition and construction of the engineered barrier remains.

Remedy Implementation. Implementation of remedial action at the 221-U Facility has been conducted under [DOE/RL-2006-21](#), *Remedial Design/Remedial Action Work Plan for the 221-U Facility*. The following remedial activities are still to be implemented:

- Demolish the railroad tunnel; 271-U, 276-U, 291-U, and 292-U structures; and the 291-U-1 and 296-U-10 stacks and disposal of the resulting waste at the ERDF or other disposal facilities approved in advance by the EPA; stabilize the sites to support engineered barrier construction

- Remove facility roof and wall sections down to the deck level and place on or near the deck
- Construct an engineered barrier over the remnants of the canyon building, possibly including inert rubble from the demolition of ancillary facilities as fill material
- Plant semiarid-adapted vegetation on the barrier to enhance evapotranspiration
- Implement ICs to ensure that the remedy is protected and changes in land use do not occur that could result in unacceptable exposures to residual contamination
- Begin post-closure care, including barrier inspection and maintenance
- Monitor ongoing barrier performance and groundwater to ensure effectiveness of the remedial action and to support 5-year remedy reviews.

Reasonably anticipated future land use for the 200 Area is industrial; the 221-U Facility remedy will result in protection of human health and the environment based on the exposure assumptions contained in the 200 Area industrial use scenario.

Technical Assessment

The 5-year review determines whether the remedy at a site is, or upon completion will be, protective of human health and the environment. The following is the response to the technical assessment questions provided in the EPA guidance for the 200-CU-1 OU remedy. These questions also establish a framework for organizing and evaluating data and ensuring that all relevant issues are considered when determining the remedy's protectiveness.

Is the remedy functioning as intended by the decision document?

Construction has not been completed for the entire remedy; therefore, no final decision can be made to determine whether the remedy is functioning as intended. However, as the final remedial designs are completed, approved, and implemented, there is no indication that the remedy will not function within the specified RAOs.

ICs for the 200-CU-1 OU, as required by the ROD ([EPA 2005b](#)), are described in the latest version of [DOE/RL-2006-21](#), *Remedial Design Report/Remedial Action Work Plan for the 221-U Facility*. Specific details associated with each IC also have been incorporated into [DOE/RL-2001-41](#), *Sitewide Institutional Controls Plan for the Hanford CERCLA Response Actions and RCRA Corrective Actions*, this report is routinely updated within 180 days after publication of each decision document that addresses ICs. There are two periods of ICs for the 200-CU-1 OU: (1) ICs required through the time of completion of remedy construction, and (2) ICs required after the construction of the remedial action. The initial phase of ICs have been implemented for the 200-CU-1 OU and include access control (i.e., warning notices, entry restrictions), land-use management (i.e., land use, and excavation permits), groundwater use management (i.e., excavation permits), and miscellaneous provisions. The ICs are assessed annually and DOE presents a summary including any noted issues or actions to the Site regulators each fall at the unit managers' meeting. The presentation is documented in the meeting minutes attachments (e.g., [CHPRC-2003756](#)), which are archived in the Hanford Site Administrative Record. During the 5-year review period of 2016 through 2020, no deficiencies were noted for the 200-CU-1 OU. The annual IC assessments are also now captured in an annual report (e.g., [HNF-65616](#), *FY2020 Sitewide Institutional Control Assessment*, Rev. 0). During the 5-year review period of 2016 through 2020, appropriate ICs for the 200-CU-1 OU were found to be in place and maintained, and the objectives for the ICs are being met. After construction of the remedial action, ICs will include land-use management

(industrial use, irrigation controls, excavation permits), groundwater use management, information controls, information controls (notice in deed), and access control (warning notices).

Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of remedy selection still valid?

Yes. The exposure assumptions, toxicity data, cleanup levels, and interim RAOs used at the time of remedy selection are still valid for this canyon remedy.

Has any other information come to light that could call into question the protectiveness of the remedy?

No additional information has come to light since the 2011-2015 5-year review that calls into question the protectiveness of the final remedy, once constructed.

Issues/Recommendations During this Review Period

Issues. No issues specific to the 200-CU-1 OU were identified during this 5-year review.

Recommendations. No corrective actions are recommended.

Protectiveness Statement

200-CU-1 Source OU – Will Be Protective. The remedy at the 200-CU-1 OU (221-U Facility (U-Plant)) is expected to be protective of human health and the environment upon completion of the final remedy actions. Implementation of the final remedy for the 200-CU-1 OU has been put in hiatus. Once implementation is restarted and the remedy is complete, it is expected to be protective of human health and the environment. In the interim, remedial actions completed to date, along with implementation of the pre-construction-completion ICs, ensure that exposure pathways that could result in unacceptable risks in this area are being controlled.

3.3.2.2 200-CW-3 Source Operable Unit

Background

The 200-CW-3 OU is located between the 200-East and -West Areas on the Hanford Site, in the 200-North Area. Operations in the 200-North Area were primarily related to irradiated nuclear fuel rod storage. Fuel rods were stored in water-filled basins while the decay of short-lived radioisotopes occurred (also known as "cooling"). The 200-CW-3 OU includes areas of contamination resulting from the release of cooling water from the fuel storage basins into liquid disposal sites.

The waste sites in the 200-CW-3 source OU include trenches, ponds, pits, pipelines, and unplanned releases of shallow contamination generally less than 4.6 m (15 ft) deep. They also include unplanned release sites where chemical and radioactive contaminants were released during material transfers and routine operations. Locations of the 200-CW-3 OU waste sites are shown in Figure 3-1.

Chronology

Table 3-11 lists the remedial action decision documents relevant to the 200-CW-3 source OU as of December 31, 2020.

Table 3-11. Decision Documents for the 200-CW-3 Source Operable Unit.

Date	Location	Title
7/1999	EPA/ROD/R10-99/039	<i>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 Remaining Sites.</i> This interim action ROD requires RTD for 46 sites; the plug-in approach for the remaining 100 Area and 200-North sites and the newly identified 100 Area sites; disposal of debris from B, D, H, and K Reactors to ERDF; and provides the decision framework for leaving waste in place, generally below 4.6 m (15 ft) depth.
2/2004	EPA 2004	<i>Explanation of Significant Difference for the 100 Area Remaining Sites Interim Remedial Action Record of Decision.</i> The ESD adds 28 sites to the ROD; adds 10 CFR 1022 and 40 CFR 6 , Appendix A as ARARs to the ROD; and revises the annual ICs report date to coincide with the due date for the sitewide IC Plan for Hanford CERCLA response actions.
8/2009	EPA et al. 2009	<i>Explanation of Significant Difference for the 100 Area Remaining Sites Interim Remedial Action Record of Decision.</i> This ESD authorizes adding 200-CW-3 OU wastes sites, 99 newly discovered waste sites, and 87 candidate sites using the plug-in approach in the ROD and any newly discovered waste sites documented in the Administrative Record and an annual fact sheet.
2/2012	DOE et al. 2012	<i>Tri-Party Agreement Fact Sheet: 100 Area “Plug-In” and Candidate Waste Sites For Calendar Year 2011, Annual listing of waste sites plugged into the remove, treat and dispose remedy in the 1999 interim action Record of Decision for the 100 Area Remaining Sites.</i> This is the annual listing of candidate waste sites for confirmatory sampling and waste sites plugged into the RTD remedy in the 1999 interim action ROD for the 100 Area Remaining Sites.

ESD = explanation of significant difference
 OU = operable unit
 ROD = record of decision
 RTD = removal, treatment (as required), and disposal

See Appendix B for a consolidated list of decision documents for Hanford Site OUs.

Remedial Action

Goals and Objectives. The RAOs set forth in [EPA/ROD/R10-99/039](#) are narrative statements that define the extent to which the waste sites require cleanup to protect human health and the environment.

The following RAOs identified in the interim action ROD apply to contaminants in soils, structures, and debris.

- RAO 1. Protect human and ecological receptors from exposure to contaminants in soil, structures, and debris by dermal exposure, inhalation, or ingestion of radionuclides, inorganics, or organics.
- RAO 2. Control the sources of groundwater contamination to minimize the impacts to groundwater resources, protect the Columbia River from further adverse impacts, and reduce the degree of groundwater cleanup that may be required under future actions.

Remedy Components. The 1999 ROD ([EPA/ROD/R10-99/039](#)), as amended, includes the following basic interim action remedy components applicable to 200-CW-3 waste sites:

- Remove contaminated soil, structures, and debris using the observational approach, which uses field data and analytical screening during remediation to guide the extent of excavation. Remediation proceeds until it can be demonstrated through a combination of field screening and verification sampling that cleanup goals have been achieved.
- Treat the waste as required to meet applicable waste disposal criteria.
- Dispose of contaminated materials at ERDF.
- Backfill excavated areas and revegetate.
- Implement ICs.

Remedy Implementation Progress Prior to this (2016-2020) Review Period ([DOE/RL-2016-01](#)). Work, on the 200-CW-3 OU remedy began after issuance of the ROD in 1999. Before 2016, interim remedial actions for the 13 waste sites in the 200-CW-3 OU had been completed.

Issues/Corrective Actions from the Previous (2011-2015) 5-Year Review. No previous issues or actions were noted for the 200-CW-3 OU in the 2011-2015 [CERCLA](#) 5-year review.

Protectiveness Statement from the Previous (2011-2015) 5-Year Review Report ([DOE/RL-2016-01](#)). The 200-CW-3 source OU protectiveness statement from the previous (2011-2015) 5-year review report was noted as follows:

***200-CW-3 Source OU - Will Be Protective.** The remedy for the 200-CW-3 source OU is expected to be protective of human health and the environment upon completion of the final remedy. Implementation of the interim remedy (primarily involving RTD, backfilling, recontouring, revegetation, and ICs) at 200-CW-3 OU waste sites has demonstrated that exposure pathways that could result in unacceptable risks are being controlled.*

Progress Since 2011-2015 Review

Accomplishments. Since the 2011-2015 5-year review, no additional remediation was performed since all 13 waste sites with 200-CW-3 were remediated as of the previous review period. In September 2011, DOE-RL published [DOE/RL-2011-58](#), *200-CW-3 Operable Unit Interim Remedial Action Report*. The report verifies that the remedial actions at all of the 200-CW-3 waste sites meet the interim action RAOs.

Table 3-12 summarizes the cleanup status for the 200-CW-3 source OU.

Remedy Implementation. All interim remedial actions were conducted under DOE/RL-2007-55, *Remedial Design/Remedial Action Work Plan for 200 North Area Waste Sites Located in the 200-CW-3 Operable Unit*. The 200-CW-3 waste sites were to have been addressed in a future, final ROD along with the 200-OA-1 and 200-CW-1 OUs. However, as an option, a 2020 plan has been proposed for inclusion of the 200-CW-3 sites in an ESD to the *Record of Decision Hanford 100 Area Superfund Site 100-FR-1 100-FR-2 100-FR-3 100-IU-2 and 100-IU-6 Operable Units*, issued in September 2014 ([EPA 2014](#)).

Table 3-12. 200-CW-3 Source Operable Unit Cleanup Status.

Source OU	Number of Waste Sites ^a	Sites Dispositioned ^b			
		Pre-2016	2016 - 2020	Total	Percent
200-CW-3	13	13	0	13	100
Total	13	13	0	13	100%

^a Number of waste sites within the OU, according to WIDS, as of December 2020. Actual numbers can and do change if sites are added to or moved from a given OU in accordance with DOE and regulatory agency approvals.

For example, the guard house sewer lines, 2607-N, -P, and -R are listed in DOE/RL-2011-58, however, they were rejected as wastes sites in 2017. No sites are expected to be added or removed from the 200-CW-3 OU.

^b Number of sites dispositioned as of December 2020; includes the number of sites that have been reclassified in WIDS, as of December 2020, as either interim closed, or interim no-action in accordance with the guideline TPA-MP-14.

DOE/RL-2011-58, 2011, *200-CW-3 Operable Unit Interim Remedial Action Report*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0093638>.

TPA-MP-14, 2011, *Maintenance of the Waste Information Data System (WIDS)*, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1109271360>.

DOE = U.S. Department of Energy

OU = operable unit

Technical Assessment

Is the remedy functioning as intended by the decision documents?

The interim remedy (primarily involving RTD, backfilling, revegetation and ICs) is functioning as intended by the interim action ROD (as amended). As of December 2020, all 13 200-CW-3 OU waste sites had been remediated and ICs are in place. Evaluation for a final action ROD may address additional exposure scenarios and additional models for evaluating contaminant migration pathways.

In accordance with [TPA-MP-14](#), *Maintenance of the Waste Information Data System (WIDS)*, the 200-CW-3 remediated waste sites are documented in the WIDS as either interim closed or interim no-action. Cleanup verification packages (including sampling data and other technical information) to support the reclassification to interim closed and/or no-action are included in the Hanford Site Administrative Record for the 200-CW-3 OU. The RAGs (contaminant-specific soil cleanup criteria developed to ensure that remedial actions to be implemented will achieve the RAOs) are described in Chapter 2 of the RD/RAWP ([DOE/RL-2007-55](#)).

The RAOs for 200-CW-3 remediated waste sites, and the methods used for achieving the RAOs through the interim remedial actions are summarized in the following list:

- RAO 1. Protect human and ecological receptors from exposure to contaminants in soil, structures, and debris by dermal exposure, inhalation, or ingestion of radionuclides, inorganics, or organics.
 - Achieved by reducing concentrations of, or limiting exposure pathways to, contaminants in the upper 4.6 m (15 ft) of the soil exposure scenario. The levels of reduction will be such that, for radionuclides, the EPA [CERCLA](#) risk range of 10^{-4} to 10^{-6} increased excess lifetime cancer risk will be achieved. To address this objective, the total dose for radionuclides shall not exceed 15 mrem/yr above Hanford Site background for 1,000 years following remediation and MTCA Method B levels for inorganics and organics.

- RAO 2. Control the sources of groundwater contamination to minimize the impacts to groundwater resources, protect the Columbia River from further adverse impacts, and reduce the degree of groundwater cleanup that may be required under future actions.
 - Achieved through protection such that contaminant levels in soil after remediation do not result in an adverse impact to groundwater that could exceed any nonzero MCLs and non-zero MCL goals under the [Safe Drinking Water Act of 1974](#).
 - Protection of the Columbia River from adverse impacts of contaminants remaining in the soil after remediation that do not result in an impact to groundwater and, therefore, the Columbia River, that could exceed the ambient water quality criteria under the [Clean Water Act](#) for protection of fish. Because no ambient water quality criteria have been established for radionuclides, MCLs will be used.

ICs for the 200-CW-3 source OU, as required by the interim action ROD ([EPA/ROD/R10-99/039](#), as amended) are described in the latest version of the RD/RAWP ([DOE/RL-2007-55](#)). No site-specific ICs were identified following remediation. Specific details associated with each IC also have been incorporated into [DOE/RL-2001-41](#), *Sitewide Institutional Controls Plan for the Hanford CERCLA Response Actions and RCRA Corrective Actions*, this report is routinely updated within 180 days after publication of each decision document that addresses ICs. The ICs implemented for the 200-CW-3 source OU include access control (warning notices and entry restrictions), land-use management (excavation permits), and miscellaneous provisions. These ICs are assessed annually and DOE presents a summary including any noted issues or actions to the Site regulators each fall at the unit managers' meeting. The presentation is documented in the meeting minutes attachments (e.g., [CHPRC-2003756](#)), which are archived in the Hanford Site Administrative Record. The annual IC assessments are also now captured in an annual report (e.g., [HNF-65616](#), *FY2020 Sitewide Institutional Control Assessment*, Rev. 0). During the 5-year review period of 2016 through 2020, appropriate ICs for the 200-CW-3 source OU were found to be in place and maintained and the objectives for the ICs are being met.

Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of remedy selection still valid?

The exposure assumptions, toxicity data, cleanup levels, and interim RAOs used at the time of remedy selection are still valid.

Has any other information come to light that could call into question the protectiveness of the remedy?

No new information has come to light that could call into question the protectiveness of the interim remedy for the 200-CW-3 OU.

Issues/Recommendations During this Review Period

Issues. No issues specific to the 200-CW-3 OU were identified during this 5-year review.

Recommendations. No corrective actions are recommended.

Protectiveness Statement

200-CW-3 Source OU -- Will Be Protective. The remedy at the 200-CW-3 source OU is expected to be protective of human health and the environment upon completion of the final remedy. Implementation of the interim remedy (primarily involving RTD, backfilling, recontouring, and revegetation) at the 200-CW-3 OU has been completed. In the interim, remedial activities completed to date, including ICs, have adequately addressed all exposure pathways that could result in unacceptable risks in these areas.

3.3.2.3 200-DF-1 Source Operable Unit

Background

The 200-DF-1 OU comprises the ERDF, shown in Figure 3-11. The ERDF is a large [CERCLA](#) waste disposal facility located just southeast of the 200-West Area on the Central Plateau (previously noted in Figure 3-1). It was constructed using a double-liner and a leachate collection system that meets [RCRA](#), Subtitle C, minimum technological requirements. The ERDF is used to dispose of hazardous and dangerous waste, low-level radioactive waste, and mixed waste that meets, or has been treated to meet, land disposal restrictions and ERDF waste acceptance criteria.

Designed to be expanded, as needed, the ERDF consists of 10 disposal areas called cells. Each pair of cells is 21 m (70 ft) deep, 152 m (500 ft) wide, and 305 m (1,000 ft) long at the base. Cells 1 through 8 can hold 2.5 million metric tons (2.8 million tons) of material per pair, Cells 9 and 10 are super cells that can hold 2.7 million metric tons (3.0 million tons) each. As each pair of cells is filled to capacity, an interim cover is installed to prevent water infiltration. A permanent cap will be placed over the facility when Hanford Site cleanup is completed. Currently, ERDF is being evaluated for future expansion efforts to support the Hanford Site cleanup mission.



Figure 3-11. Aerial View of 200-DF-1 OU, Environmental Restoration Disposal Facility.

Chronology

Table 3-13 lists the remedial action decision documents relevant to the 200-DF-1 source OU as of December 31, 2020.

Table 3-13. Decision Documents for the 200-DF-1 Source Operable Unit. (2 Pages)

Date	Location	Title
1/1995	EPA et al. 1995	<i>Record of Decision for the U.S. DOE Hanford Environmental Restoration Disposal Facility, Hanford Site, Benton County, Washington.</i> This ROD authorizes the construction of ERDF to provide waste disposal capacity for cleanup of contaminated areas on the Hanford Site.
8/1996	EPA/ESD/R10-96/145	<i>USDOE Environmental Restoration Disposal Facility (ERDF), Hanford Site Benton County Washington Explanation of Significant Difference (ESD).</i> This ESD allows for disposal of investigation-derived waste, deactivation and demolition waste, waste from RCRA past-practice OUs and closures, and non- RCRA waste from inactive TSD units. The ESD also authorized the conditional use of ERDF leachate for dust suppression and waste compaction.
9/1997	EPA/AMD/R10-97/101	<i>Amended Record of Decision for the U.S. DOE Hanford Environmental Restoration Disposal Facility, Hanford Site – 200 Area, Benton County, Washington.</i> This first ROD amendment authorizes facility expansion by constructing disposal cells 3 and 4 and allows for limited waste treatment at ERDF.
3/1999	EPA/AMD/R10-99/038	<i>Amended Record of Decision for the U.S. DOE Hanford Environmental Restoration Disposal Facility, Hanford Site – 200 Area, Benton County, Washington.</i> This second ROD amendment authorizes the delisting of ERDF leachate, which allows for implementation of more cost-effective and appropriate leachate handling techniques. The basis for delisting is that leachate analytical results showed contaminants were not present at a significant level.
3/2002	EPA/AMD/R10-02/030	<i>Amended Record of Decision for the U.S. DOE Hanford Environmental Restoration Disposal Facility, Hanford Site – 200 Area, Benton County, Washington.</i> This third ROD amendment authorizes the second ERDF expansion to disposal cells 5 through 8, and allows the staging of remediation waste at ERDF while awaiting treatment.
5/2007	EPA 2007	<i>Amended Record of Decision for the U.S. DOE Hanford Environmental Restoration Disposal Facility, Hanford Site – 200 Area, Benton County, Washington.</i> This fourth ROD amendment authorizes disposal of certain Hanford Site waste in storage and creates a ‘plug-in’ approach for accepting Hanford-only generated waste in storage for ERDF disposal.
8/2009	(09-AMRC-0179).	<i>Amended ROD and Explanation of Significant Differences for the U.S. DOE Hanford Environmental Restoration Disposal Facility, Hanford Site – 200-Area, Benton County, Washington.</i> This fifth ROD amendment authorizes construction of super cells 9 and 10, including modification of the cell design to allow a single super cell to be used in place of the double-cell, side-by-side configuration described in the initial ROD. The amendment also authorizes the addition of future ERDF cells upon EPA approval through the issuance of a fact sheet by DOE, rather than using the ROD amendment process required by the original ERDF ROD.
10/2015	EPA 2015	<i>Explanation of Significant Differences for the U.S. Department of Energy Environmental Restoration Disposal Facility Hanford Site – 200 Area, Benton County, Washington.</i> This ESD allows ERDF leachate to be transferred to either the ETF located in the 200-East Area or the 200-West Area Pump and Treat for treatment. Previously, excess leachate from ERDF operations was collected and transferred by pipeline to the ETF.

Table 3-13. Decision Documents for the 200-DF-1 Source Operable Unit. (2 Pages)

Date	Location	Title
12/2015	EPA et al. 2015	<i>Amended Record of Decision and Responsiveness Summary ERDF-Hanford Site-200 Area, Benton County Washington.</i> This sixth ROD amendment authorizes placement of certain long, large, and/or heavy hazardous waste items in an ERDF trench prior to completing the required land disposal restriction treatment because treatment prior to placement results in greater risk to human health and the environment.

DOE = U.S. Department of Energy.
ERDF = Environmental Restoration Disposal Facility
ESD = explanation of significant difference
ETF = Effluent Treatment Facility
ROD = record of decision
RCRA = *Resource Conservation and Recovery Act of 1976*
TSD = treatment, storage, and disposal

See Appendix B for a consolidated list of decision documents for Hanford Site OUs.

Remedial Action

The RAOs set forth in the ERDF ROD are as follows:

- *RAO 1. Prevent unacceptable direct exposure to waste in accordance with applicable or relevant and appropriate requirements (ARARs) and health-based criteria. Direct exposure to the types of waste received at the ERDF could result in unacceptable health risks. Direct exposure of workers and biota to waste could occur during operation of the ERDF (i.e., during waste transport and filling operations). Because of access control at the Hanford Site, the direct exposure pathway does-not-apply-to the public during operations. Once the ERDF is closed, direct exposure to waste is only possible if institutional controls fail and the surface cover is breached.*
- *RAO 2. Prevent unacceptable contaminant releases in accordance with ARARs and health based criteria. Inhalation exposure to the types of waste received at the ERDF could result in unacceptable health risks. Similar to the direct exposure pathway, inhalation of waste by workers and biota could occur during operation of the ERDF (i.e., during waste transport and filling operations). Airborne transport of waste off the Hanford Site could result in exposures to the public, but these exposures would be negligible compared with worker risks. Once the ERDF is closed, air releases are only possible if institutional controls fail and the surface cover is breached.*
- *RAO 3. Prevent contaminant releases to groundwater above ARARs and health-based criteria. Migration of contaminants through the vadose zone to groundwater could result in unacceptable human exposure to contaminants. This RAO has been acknowledged in the fourth amendment to the Tri-Party Agreement, which states: "the point of [risk] assessment will be the intersection of the groundwater and the vertical line drawn from the edge of the disposal facility". The Tentative Agreement on Tri-Party Agreement Negotiations, which was circulated for public comment in 1993, and formed the basis for the Fourth Amendment to the Tri-Party Agreement, further provided the time of assessment (10,000 years) and the compliance standard (10^{-5} for the first 100 years and 10^{-4} thereafter). Since the risk assessment indicates that the risk associated with the groundwater pathway should remain below 10^{-5} for the first 100 years, the relevant compliance standard is 10^{-4} .*

- *RAO 4. Minimize Ecological Impacts. Construction of the ERDF will result in harmful impacts to the ecology of the ERDF site and possibly to the borrow sites (if needed) that provide materials for ERDF construction. Significant value is attached to the ecology at these sites. Mitigation measures to reduce ecological impacts have been incorporated into the alternatives. Potential options for additional mitigation measures will be evaluated by DOE.*

Mitigation measures included in the alternatives are (i) clearing of the site in preparation for construction prior to nesting season to ensure that wildlife is not destroyed, only displaced; (ii) constructing the landfill in a sequential fashion on an as-needed basis, which may minimize ultimate habitat loss; (iii) use of the deep area-fill trench configuration to minimize the amount of land disturbed at the ERDF; (iv) initiating site clearing activities in the southern corner, progressing to the north, to buffer the shrub-steppe habitat immediately south of the ERDF site from ongoing construction activities; (v) revegetation. Additional mitigation measures to be evaluated include restoration of the site, creation or enhancement of similar habitat, and actions to acquire or provide protection for similar habitat.

Remedy Components. Components of the 200-DF-1 (ERDF) remedy (i.e., disposal cell construction, leachate collection and storage, surface-water runoff control, air monitoring, groundwater monitoring, protection of workers, development of waste acceptance criteria, [RCRA](#)-complaint landfill-closure covers, and ICs) are described on pages 38 and 39 of the original ROD ([EPA et al. 1995](#)) and subsequently modified as noted in the five ROD amendments ([EPA/AMD/R10-97/101](#), [EPA/AMD/R10-99/038](#), [EPA/AMD/R10-02/030](#), [EPA 2007](#), [09-AMRC-0179](#)).

Issues/Corrective Actions from the Previous 5-Year Review. No previous issues or actions were noted for the 200-DF-1 OU in the 2011 [CERCLA](#) 5-year review.

Protectiveness Statement from the Previous (2011-2015) 5-Year Review Report ([DOE/RL-2016-01](#)). The 200-DF-1 OU protectiveness statement from the previous (2011-2015) 5-year review report was noted as follows:

***200-DF-1 Source OU – Will Be Protective.** The remedy at the 200-DF-1 OU (ERDF landfill) is expected to be protective of human health and the environment upon completion. In the interim, remedial activities completed to date have adequately addressed all exposure pathways that could result in unacceptable risks in these areas. ERDF is an operating landfill; operation is envisioned to continue for at least another 30 years.*

Progress Since 2011-2015 Review

Accomplishments. Since beginning operation on July 1, 1996, more than 18 million tons of remediation waste have been disposed of at ERDF. Approximately 84.8 million L (22.4 million gal) of ERDF leachate have been treated or recycled, and approximately 202,300 metric tons (223,000 tons) of waste have been treated (stabilized or encapsulated) at ERDF before disposal. Cells 1 through 10 are near capacity. ERDF is currently being evaluated for expansion (Super Cell 11) to accommodate the continuation of the River Corridor cleanup and Hanford Site disposal activities.

Remedy Implementation. See status summary under “Accomplishments.”

Technical Assessment

Is the remedy functioning as intended by the decision document?

Yes, the remedy is functioning as intended by the ROD (as [EPA/ROD/R10-99/039](#), amended).

The IC required by the ROD ([EPA et al. 1995](#)) is to restrict public access to the landfill. This is accomplished through Hanford Site access controls.

Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of remedy selection still valid?

The exposure assumptions, toxicity data, cleanup levels, and interim RAOs used at the time of remedy selection are still valid.

Has any other information come to light that could call into question the protectiveness of the remedy?

No new information has come to light that could call into question the protectiveness of the interim remedy for the 200-DF-1 OU.

Issues/Recommendations During this Review Period

Issues. No issues specific to the 200-DF-1 OU were identified during this 5-year review.

Recommendations. No corrective actions are recommended.

Protectiveness Statement

200-DF-1 Source OU – Will Be Protective. The remedy at the 200-DF-1 OU (ERDF landfill) is expected to be protective of human health and the environment upon completion. In the interim, remedial activities completed to date have adequately addressed all exposure pathways that could result in unacceptable risks in these areas. ERDF is an operating landfill; operation is envisioned to continue for at least another 25 years.

3.3.2.4 200-CW-5, 200-PW-1, 200-PW-3, and 200-PW-6 Source Operable Units

In September 2011, EPA published *Record of Decision for USDOE Hanford 200 Area, 200-CW-5, 200-PW-1, 200-PW-3, and 200-PW-6 Operable Units, Benton County, Washington* ([EPA 2011b](#)). *Remedial Design/Remedial Action Work Plan for the 200-CW-5, 200-PW-1, 200-PW-3, and 200-PW-6 Operable Units* ([DOE/RL-2015-23](#), Rev. 0) was drafted in 2015 and approved in 2016. Because field implementation of the remedy for this entire group of OUs had not started during this five-year review period of 2016-2020, this report provides only a brief narrative. ICs (including warning notices, entry restrictions, land use, and groundwater use management) have been implemented and are maintained. These ICs are assessed annually and DOE presents a summary including any noted issues or actions to the Site regulators each fall at the unit managers meeting. The presentation is documented in the meeting minutes attachments (e.g., [CHPRC-1503264](#)), which are archived in the Hanford Site Administrative Record. The annual IC assessments are also now captured in an annual report (e.g., [HNF-65616, FY2020 Sitewide Institutional Control Assessment](#), Rev. 0). During the 5-year review period of 2016 through 2020, appropriate ICs for the 200-CU-1 OU were found to be in place and maintained, and the objectives for the ICs are being met.

The following information is excerpted primarily from the introductory pages of the ROD ([EPA 2011b](#)) and serves as background on the remedial action decision.

This ROD...presents the selected final remedial action for the 200-CW-5, 200-PW-1, 200-PW-3, and 200-PW-6 OUs which are part of the overall soil remediation effort in the Central Plateau's Inner Area. The 200-CW-5, 200-PW-1, and 200-PW-6 OUs are located in the 200-West Area and the 200-PW-3 OU is

located in the 200-East Area. The locations of waste sites associated with these OUs was shown earlier in Figure 3-1. Groundwater located beneath these OUs in the 200-West Area is being addressed through separate CERCLA processes for the 200-ZP-1 and 200-UP-1 groundwater OUs.

In these OUs, the soils contaminated with significant concentrations of plutonium or cesium radionuclides are considered principal threat wastes since they are highly toxic contaminants. The NCP Section 300.430(a)(1)(iii)(A) establishes an expectation that EPA will use treatment to address the principal threats posed by a site wherever practicable. However, there is no feasible technology to practicably treat radionuclides that will not result in larger volumes, creating greater impracticability for disposal. The amount of waste disposed is a limiting factor since plutonium waste generated at 200-PW-1 and 200-PW-6 waste sites will include TRU waste, which will be disposed at the Waste Isolation Pilot Plant (WIPP), a half-mile deep repository in southern New Mexico that has limited capacity. The contaminated soils will be packaged appropriately for on-site disposal at the ERDF or for offsite disposal at the (WIPP), as appropriate. DOE and EPA have determined that the waste remaining in place will not pose an unacceptable risk to human health or the environment.

The selected remedy for the 200-CW-5, 200-PW-1, 200-PW-3, and 200-PW-6 OUs addresses soils and subsurface disposal structures, two settling tanks, and associated pipelines contaminated primarily with plutonium and cesium. Also, structures and other debris that must be removed in order to conduct required remediation will be excavated.

The major components of the selected remedy, as described in the ROD ([EPA 2011b](#)), are as follows:

- **Removal, Treatment, and Disposal of Contaminated Soil and Debris** – RTD of soil and debris to the specified depths or specified cleanup levels will be used to address plutonium-contaminated soils and subsurface structures and debris. This consists of: (1) removing a portion of contaminated soil, structures, and debris; (2) treating these removed wastes as required to meet disposal requirements at ERDF, which is located on the Hanford Site, or waste acceptance criteria for offsite disposal at the Waste Isolation Pilot Plant (WIPP); and (3) disposal at ERDF or WIPP. The selected pipelines associated with these OUs will also be excavated and disposed at ERDF. Cleanup levels have been selected which are protective of groundwater and the current and reasonably expected future industrial land use. The remedy is summarized further in the bullets below.
 - The 200-CW-5 OU, also known as the Z-ditches, will use the RTD approach to excavate contaminated soils and debris exceeding cleanup levels to a depth of 4.6 m [15 ft bgs]) with disposal at ERDF or WIPP, as appropriate.
 - Three of the six 200-PW-1 waste sites, also known as the “High-Salt Waste Group,” will use the RTD approach to excavate contaminated soils and debris located to a minimum of .6 m (2 ft) below the bottom of the disposal structure (6 – 7 m [20 – 23 ft] bgs), with disposal at WIPP or ERDF, as appropriate. After the excavations are filled, an evapotranspiration barrier will be constructed over the remaining waste in these waste sites.
 - The 200-PW-6 OU and three of the six 200-PW-1 waste sites, also known as the “Low-Salt Waste Group,” will use the RTD approach to excavate contaminated soils and debris to a depth of 6.7 to 10 m (22 to 33 ft) bgs, with disposal at ERDF or WIPP, as appropriate. After the excavations are filled, an evapotranspiration barrier will be constructed over remaining waste in these waste sites.
- **Soil Vapor–Extraction** -- An SVE system was implemented as an expedited response action to remove and treat carbon tetrachloride contamination in the vadose zone at waste sites in the High-

Salt Waste Group. The system has been operating since 1992 and has been effective in removing and treating carbon tetrachloride. SVE is being incorporated into the selected remedy. The system will continue to be used until vadose zone cleanup levels are met.

- **Soil Covers**-- Soil covers will be used to provide coverage to a depth of at least 4.6 m (15 ft) over cesium-contaminated soils. This consists of enhancing the existing soil cover with additional backfill where necessary to provide a minimum of 4.6 m (15 ft) of soil cover at each of the waste sites and then maintaining the soil cover. The 200-PW-3 OU, also known as the Cesium-137 Waste Group, will require that three of the five waste sites receive additional backfill to achieve coverage of at least 4.6-m (15-ft) depth. Contamination at the other two waste sites is deeper than 4.6 m (15 ft) from the ground surface and will not require additional backfill.
- **Institutional Controls** -- ICs and long-term monitoring will be required for waste sites in the 200-CW-5, 200-PW-1, 200-PW-3, and 200-PW-6 OUs where contamination is left in place and precludes an unrestricted land use. These institutional and land use controls will be required to ensure that activities are consistent with and restricted to the reasonably anticipated future industrial land uses for the Inner Area of the Central Plateau. The DOE is responsible for implementing, maintaining, reporting on, and enforcing the institutional and land use controls required under this ROD. Although DOE may later transfer these procedural responsibilities to another party by contract, property transfer agreement, or through other means, DOE shall retain ultimate responsibility for remedy integrity and ICs.

The 2011 ROD ([EPA 2011b](#)) selected SVE as the final remedial action for carbon tetrachloride and methylene chloride in the vadose zone. As indicated in the ROD narrative, the SVE system had been operating since 1992 under an expedited response action per “Action Memorandum: Expedited Response Action Proposal for 200-West Area Carbon Tetrachloride Plume” ([EPA and Ecology 1992](#)). Over several decades, the SVE system had removed over 90 tons of contamination. Because contaminant concentrations and SVE mass removal rates declined in recent years to minimal levels, Response Action Report for the 200-PW-1 Operable Unit Soil Vapor Extraction Remediation ([DOE/RL-2014-48](#)) was published in August 2016. Based on this history, DOE and EPA approved closure of the SVE remedy and permanently discontinuing SVE operations and vadose zone monitoring.

In 2018, DOE evaluated a selection of underground structures across the Hanford Site to identify risk of collapse. Three underground liquid waste disposal structures in the 200-PW-1 OU (216-Z-1 Crib, 216-Z-9 Trench, and 241-Z-361 Settling Tank) were determined to represent the highest risk, requiring stabilization to prevent a collapse and the potential to spread contamination. DOE implemented a time critical removal action to stabilize the structures by filling them with engineered grout to mitigate the risk. The stabilization action was initiated in 2020 and will not affect implementation of the future remedial actions selected in the final ROD.

While this group of OUs will be further described and assessed in the next 5-year review (covering the period of 2021-2025), the following protectiveness statements are provided at this time:

- **200-CW-5 – Will Be Protective.** The remedy at the 200-CW-5 source OU is expected to be protective upon completion of the final remedy. While the remedy component involving RTD (with disposal at ERDF or WIPP, as appropriate) has not started, ICs are in place to ensure that exposure pathways that could result in unacceptable risks are being controlled.
- **200-PW-1 Source OU – Will Be Protective.** The remedy at the 200-PW-1 source OU is expected to be protective upon completion of the final remedy. While the remedy components involving RTD (with disposal at ERDF or WIPP, as appropriate) has not started, the remedy

component involving soil vapor extraction has been successfully completed, and ICs are in place to ensure that exposure pathways that could result in unacceptable risks are being controlled.

- **200-PW-3 Source OU – Will Be Protective.** The remedy at the 200-PW-3 source OU is expected to be protective upon completion of the final remedy. While the remedy component involving enhancement of the existing soil cover has not started, ICs are in place to ensure that exposure pathways that could result in unacceptable risks are being controlled.
- **200-PW-6 Source OU – Will Be Protective.** The remedy at the 200-PW-6 source OU is expected to be protective upon completion of the final remedy. While the remedy components involving RTD and installation of a soil cover have not started, the remedy component involving soil vapor extraction has been successfully completed and ICs are in place to ensure that exposure pathways that could result in unacceptable risks are being controlled.

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APPENDIX A

INSTITUTIONAL CONTROLS

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APPENDIX A

INSTITUTIONAL CONTROLS

Table A-1 summarizes the issues noted during the institutional control (IC) assessments for the 5-year review period of 2016 to 2020. The implementation and effectiveness of Hanford's ICs are assessed annually and the U.S. Department of Energy presents a summary, including any noted issues or actions, to the Site regulators each fall at the 100/300 Area unit managers' meeting and at the 200 Area project managers' meeting. The presentation is documented in the meeting minutes (e.g., [CHPRC-2003813](#)), which are archived in the Hanford Site Administrative Record (see examples in Attachments 4 and 6 at the following link for the 100/300 Area unit managers' meeting [[CHPRC-2003813](#)]; and see Attachments 4 and 5 at the following link for the 200 Area project managers' meeting: [[CHPRC-2003756](#)]). The annual IC assessments are also now captured in an annual report (e.g., [HNF-65616](#), *FY2020 Sitewide Institutional Control Assessment*).

Specific details on ICs to be applied at Hanford Site boundaries, operable unit (OU) boundaries, individual waste sites, or individual contaminated groundwater plumes are provided in the [Comprehensive Environmental Response, Compensation, and Liability Act of 1980](#) decision documents for the individual OU. The detailed OU-specific ICs are conveniently consolidated and presented in the latest version of [DOE/RL-2001-41](#), *Sitewide Institutional Controls Plan for Hanford CERCLA Response Actions and RCRA Corrective Actions*. [DOE/RL-2001-41](#) is updated within 180-days after issuance of a record of decision.

A1.0 REFERENCES

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Table A-1. Summary of Institutional Control Assessment for 2016 to 2020. (2 Pages)

IC	2016	2017	2018	2019	2020
Warning Notice	All of the required “Hazardous Area” signs are in place. Approximately 80 “No Trespassing” signs along the Columbia River were damaged or missing and will be replaced in 2017.	All but three of the required “Hazardous Area” signs are in place. One of the damaged signs was repaired at the 300 Area within FY17. The other two signs in 100D and 100F are schedule to be replaced in FY18. Sixty-nine “No Trespassing” signs along the Columbia River were replaced. Over one hundred “No Trespassing” signs along SR 240 were found to be illegible due to fire damage. All signs were replaced in FY18.	All of the required “Hazardous Area” signs are in place. The two damaged signs identified from the previous year at 100D and 100F Areas were repaired. Fifty-four “No Trespassing” signs along the Columbia River were identified as needing replacement. Ninety “No Trespassing” signs along SR 240 were found to be illegible and were replaced in FY18.	All of the required “Hazardous Area” signs are in place. Two signs (one in the 100-H and one in the 300 Area) were found to be in poor condition and replaced. Approximately 160 damaged or missing “No Trespassing” signs along the Columbia River were replaced. Approximately 55 “no Trespassing Signs” were replaced along SR 240 were replaced in FY18.	All of the required “Hazardous Area” signs are in place. Five signs (one in the 100D Area, one in the 100H Area and two in the 100F Area) were down and repaired. Approximately 100 “No Trespassing” signs along SR 240 were found to be illegible and are scheduled to be replaced in FY21.
Entry Restrictions*	Seven trespassing incidents reported to Benton County Sheriff’s Office The fence along SR 240 was found to have broken wire strands in four places. The fence was repaired.	Eight trespassing incidents reported to Benton County Sheriff’s Office. The fence along SR 240 was found to be damaged in four locations due to wildfires. The fence was repaired.	Three trespassing incidents reported to Benton County Sheriff’s Office. The fence along SR 240 was found to be damaged in eight locations due to wildfires. The fence was repaired.	Ten trespassing incidents reported to Benton County Sheriff’s Office. Fencing along SR 240 was found to be damaged in eleven locations. The fence was repaired.	Nine trespassing incidents reported to Benton County Sheriff’s Office. Fencing along SR 240 was found to be damaged in seven locations.
Land-Use Management	No deficiencies noted.	No deficiencies noted. However, assessment of the enhanced recharge institutional control is ongoing into FY2018.	No deficiencies noted. Potential maintenance issues were identified and will be communicated to the responsible contractor(s)	No deficiencies noted. However, potential integrity issues were observed on temporary surface barriers near the 325 Building.	No deficiencies noted. Asphalt surrounding the 325 Building was resurfaced to support the enhanced recharge institutional control.
Groundwater -Use Management	No unauthorized groundwater use has occurred.	No unauthorized groundwater use has occurred.	No unauthorized groundwater use has occurred.	No unauthorized groundwater use has occurred.	No unauthorized groundwater use has occurred.

Table A-1. Summary of Institutional Control Assessment for 2016 to 2020. (2 Pages)

Waste Site Information	No deficiencies were noted.	No deficiencies were noted.	No deficiencies were noted.	No deficiencies were noted.	No deficiencies were noted.

NOTE: Thirty-seven reportable trespassing incidents took place during the period of 2016 to 2020. These incidents involved sitewide entry restrictions for unauthorized personnel, generally near the Hanford Site boundaries.

FY = fiscal year

IC = institutional control

RCC = River Corridor Closure

SR = state route

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APPENDIX B

HANFORD SITE EXISTING CLEANUP DECISIONS

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APPENDIX B

HANFORD SITE EXISTING CLEANUP DECISIONS

Table B-1 serves to provide an overview of cleanup decisions at the Hanford Site in chronological order. This table will be updated as decisions are made in the future.

Table B-1. CERCLA Records of Decision and Associated Changes. (9 Pages)

Record of Decision			
Title: <i>Record of Decision, USDOE Hanford 1100 Area</i> (EPA/ROD/R10-93/063) FINAL ROD Type: CERCLA Final ROD Area: 1100 Date Approved: September 1993 Initial Decision: Cap Horn Rapids Landfill; offsite disposal of PCB-contaminated soils; offsite incineration of bis (2-ethylhexyl) phthalate contaminated soils; monitored natural attenuation of groundwater contamination.			
Revision Title	Type	Date	Revised Decision
Explanation of Significant Differences for the Record of Decision for the USDOE Hanford 1100 Area Benton County, Washington	ESD	09/2010	Documents significant differences to selected remedies in the ROD. This ESD clarifies the IC requirements for the Horn Rapids Landfill.
Record of Decision			
Title: <i>Declaration of the Record of Decision for the Environmental Restoration Disposal Facility</i> (EPA/ROD/R10-95/100) FINAL ROD Type: CERCLA Final ROD Area: 200 West Date Approved: January 1995 Initial Decision: Initial construction of two cells; maximum size of 1.6 mi ² ; landfill construction in accordance with RCRA; capped at completion.			
Revision Title	Type	Date	Revised Decision
<i>USDOE Environmental Restoration Disposal Facility, Hanford Site, Benton County, Washington, Explanation of Significant Difference (ESD)</i> (EPA/ESD/R10-96/145)	ESD	07/1996	Allow disposal of investigation-derived waste and RCRA past-practice waste to ERDF; allow disposal of nonprocess inactive TSD waste to ERDF; allow use of ERDF leachate for dust suppression/compaction activities at ERDF.
<i>U.S. Department of Energy, Environmental Restoration Disposal Facility, Hanford Site – 200 Area, Benton County, Washington, Amended Record of Decision, Decision Summary and Responsiveness Summary, (also see proposed plan for amendment)</i> (EPA/AMD/R10-97/101)	Amended ROD	09/1997	Authorizes two additional disposal cells and the option of treating waste as needed by containerization and encapsulation at ERDF instead of at the OU.
<i>U.S. Department of Energy, Environmental Restoration Disposal Facility, Hanford Site – 200 Area, Benton County, Washington, Amended Record of Decision, Decision Summary and Responsiveness Summary, (also see proposed plan for amendment)</i> (EPA/AMD/R10-99/038)	Amended ROD	03/1999	Establishes conditional approval for delisting of the ERDF leachate.

Table B-1. CERCLA Records of Decision and Associated Changes. (9 Pages)

<i>U.S. Department of Energy, Environmental Restoration Disposal Facility, Hanford Site – 200 Area, Benton County, Washington, Amended Record of Decision, Decision Summary and Responsiveness Summary, (also see proposed plan for amendment) (EPA/AMD/R10-02/030)</i>	Amended ROD	01/2002	Authorizes four additional disposal cells and the option of staging waste at ERDF pending treatment and/or disposal.
<i>U.S. Department of Energy, Environmental Restoration Disposal Facility, Hanford Site-200 Area, Benton County, Washington, Amended Record of Decision, Decision Summary and Responsiveness Summary</i>	Amended ROD	05/2007	Allows specific waste (e.g., waste associated with surveillance and maintenance of Hanford facilities, environmental research/development activities, sample analyses, liquid effluent waste treatment, infrastructure support, and environmental monitoring programs) to be disposed of at ERDF; identifies a plug-in approach for ERDF disposal of additional similar Hanford cleanup waste generated in support of RCRA/CERCLA cleanup actions.
<i>Declaration: U.S. Department of Energy, Environmental Restoration Disposal Facility, Hanford Site - 200 Area, Benton County, Washington</i>	Amended ROD and ESD	08/2009	Allows for ERDF expansion of an area equal to 4 cells or 2 super cells; updates cell design to allow super cell concept and allows for ERDF expansion via EPA approval and fact sheets rather than ROD amendments.
<i>Explanation of Significant Differences for the U.S. Department of Energy Environmental Restoration Disposal Facility Hanford Site – 200 Area, Benton County, Washington</i>	ESD	10/2015	Allows ERDF leachate to be transferred to either the ETF located in the 200 East Area or the 200 West Area pump-and-treat for treatment. Previously, excess leachate from ERDF operations was collected and transferred by pipeline to the ETF.
<i>Declaration of the Amendment to Record of Decision for the USDOE Hanford Environmental Restoration Disposal Facility</i>	Amended ROD	12/2015	Waives the 40 CFR 268.45(a) and WAC 173-303-140(2)(a) prohibition on placing hazardous waste in a land disposal unit before completing required land disposal restriction treatment.
Record of Decision			
Title: Declaration of the Interim Record of Decision for the 200-ZP-1 Operable Unit (EPA/ROD/R10-95/114) ROD Type: CERCLA Interim Action ROD Area: 200 West; 200-ZP-1 OU Date Approved: May 1995 Initial Decision: Pump-and-treat to address carbon tetrachloride, chloroform, and trichloroethylene; treatment with air stripping and vapor-phase activated carbon; interim action to continue until final action instituted; reinjection of treated water.			
Record of Decision			
Title: Declaration of the Record of Decision for the 100-BC-1, 100-DR-1, and 100-HR-1 Operable Units, Hanford Site, Benton County, Washington (EPA/ROD/R10-95/126) ROD Type: CERCLA Interim Action ROD Area: 100; 100-BC-1, 100-DR-1, and 100-HR-1 OUs Date Approved: September 1995 Initial Decision: Remove contaminated soil, structures and debris using observational approach; treatment by thermal desorption to remove organics and/or soil washing to reduce volume, or as needed to meet waste disposal criteria; disposal of contaminated materials at ERDF; backfill of excavated areas followed by revegetation.			

Table B-1. CERCLA Records of Decision and Associated Changes. (9 Pages)

Revision Title	Type	Date	Revised Decision
<i>Amendment to the Interim Action Record of Decision for the 100-BC-1, 100-DR-1, and 100-HR-1 Operable Units, Hanford Site, Benton County, Washington (see Draft B ESD and Proposed Amendment documents preceding this ROD amendment) (EPA/AMD/R10-97/044)</i>	Amended ROD	04/1997	Incorporates 34 additional waste sites into the ROD; refines remedial cost estimate for original 37 sites and additional 34 sites based on actual data, streamlining, and lessons learned; and eliminates the soil washing treatment option before disposal. The additional waste sites included in this ROD Amendment were from 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-KR-1 and 100-KR-2 source OUs.
Record of Decision			
Title: Declaration of the Record of Decision for the 100-IU-1, 100-IU-3, 100-IU-4, and 100-IU-5 Operable Units, Hanford Site, Benton County, Washington (EPA/ROD/R10-96/151) FINAL ROD Type: CERCLA Final ROD Area: 100; 100-IU-1, 100-IU-3, 100-IU-4, and 100-IU-5 OUs Date Approved: February 1996 Initial Decision: No action.			
Record of Decision			
Title: Declaration of the Record of Decision for the 100-HR-3 and 100-KR-4 Operable Units, Hanford Site, Benton County, Washington (EPA/ROD/R10-96/134) ROD Type: CERCLA Interim Action ROD Area: 100; 100-H, 100-K Date Approved: March 1996 Initial Decision: Interim action to remove hexavalent chromium from groundwater; 30 extraction wells; ion exchange treatment; reinject treated effluent; monitor; institute ICs.			
Revision Title	Type	Date	Revised Decision
<i>U.S. Department of Energy Hanford Site – 100 Area, Benton County, Washington, Amended Record of Decision, Decision Summary and Responsiveness Summary (EPA/AMD/R10-00/122)</i>	Amended ROD	Oct-99	Implements In Situ Redox Manipulation barrier for second chromium plume in 100-HR-3 OU; existing pump-and-treat remain in operation.
<i>Explanation of Significant Difference for the 100-HR-3 Operable Unit Record of Decision (EPA/ESD/R10-03/606)</i>	ESD	Mar-03	Provides justification for increased schedule/cost from the 1999 Amendment associated with a greater number of wells and aquifer thickness that affected implementation of the ISRM barrier.
<i>Explanation of Significant Differences for the 100-HR-3 and 100-KR-4 Operable Units Interim Action Record of Decision, Hanford Site, Benton County, Washington</i>	ESD	Aug-09	Provides justification for increased cost and location of reinjection wells from the 1999 Amendment associated with operation beyond initial 5-year estimate and need to control plume migration.
<i>Explanation of Significant Differences for the 100-HR-3 and 100-KR-4 Operable Units Interim Action Record of Decision, Hanford Site, Benton County, Washington</i>	ESD	Jun-19	Allows for miscellaneous solid waste generated in support of the 100-KR-4 interim actions to be collected and stored at a Central Plateau storage facility prior to disposal.
Record of Decision			
Title: Record of Decision for the 300-FF-1 and 300-FF-5 Operable Units (EPA/ROD/R10-96/143) ROD Type: CERCLA Final / Interim ROD Area: 300; 300-FF-1, 300-FF-5 Date Approved: July 1996 Initial Decision: Final action ROD for the 300-FF-1 OU to remove contaminated soil and debris, dispose of it at ERDF, backfill and recontour the site, and implement ICs. Interim action ROD for the 300-FF-5 OU that implements monitoring and ICs.			

Table B-1. CERCLA Records of Decision and Associated Changes. (9 Pages)

Revision Title	Type	Date	Revised Decision
<i>Explanation of Significant Differences for 300-FF-1 Operable Unit Site-Specific Variance from Land Disposal Restrictions Treatment Standard for Lead</i>	ESD	1/2000	Site-specific land disposal restriction treatability variance for lead contamination found in the 628-4 waste site, also known as Landfill 1D
<i>Explanation of Significant Difference for the 300-FF-5 Record of Decision (EPA/ESD/R10 00/524)</i>	ESD	6/2000	Expands the scope of the 300-FF-5 OU ROD to include groundwater in the 300 Area, including 300-FF-2 OU sites and any sites plugged into the 300-FF-1 OU ROD.
<i>Record of Decision for 300-FF-2 and 300-FF-5, and Record of Decision Amendment for 300-FF-1 Hanford Site, Benton County, Washington</i>	Final ROD and Amended ROD	11/2013	Selects final remedies for the waste sites in the 300-FF-2 OU and the groundwater in the 300-FF-5 OU and amends the remedy for three 300-FF-1 OU waste sites. This final action remedy replaces the interim action remedies for the 300-FF-5 and 300-FF-2 OUs selected in 1996 and 2000, respectively. It amends the 1996 remedy for the 300-FF-1 OU to add remedial action for uranium from three sites.
Record of Decision			
Title: Declaration of the Record of Decision, USDOE Hanford 200 Area, Hanford Site, Benton County, Washington (EPA/ROD/R10-97/048) ROD Type: CERCLA Interim Action ROD Area: 200 West; 200-UP-1 OU Date Approved: February 1997 Initial Decision: Extract groundwater from high concentration zone of uranium and Tc-99 plumes and treat at Effluent Treatment Facility.			
Revision Title	Type	Date	Revised Decision
<i>Explanation of Significant Differences for the Interim Action Record of Decision for the 200-UP-1 Groundwater Operable Unit, Hanford Site, Benton County, Washington</i>	ESD	02/2009	Adds National MCL of 30 µg/L for uranium as ARAR for treating extracted water; replaces 190 gal/min pumping with a pumping requirement from existing and new wells consistent with approved RDR/RAWP until uranium and Tc-99 concentrations are less than 10 times the MCL for 4 consecutive quarters; adds sampling requirements and updates cost estimates and IC requirements.
<i>Record of Decision for Interim Remedial Action Hanford 200 Area Superfund Site 200-UP-1 Operable Unit</i>	Interim Action ROD	09/2012	Supersedes previous interim action ROD (Feb-97) and ESD (Feb-09). Includes groundwater extraction/treatment (with flow path control through injection of treated water) in combination with monitored natural attenuation for Tc-99, uranium, chromium (total and hexavalent), nitrate, carbon tetrachloride and tritium; hydraulic containment and further treatment technology evaluation for I-129; remedy performance monitoring and ICs.

Table B-1. CERCLA Records of Decision and Associated Changes. (9 Pages)

Record of Decision			
Title: <i>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</i> (EPA/ROD/R10-99/039) ROD Type: CERCLA Interim Action ROD Area: 100, 200 North Date Approved: July 1999 Initial Decision: Requires RTD for 46 sites; adds the plug-in approach for the RTD remedy for both remaining 100 Area and 200 North sites and for newly identified 100 Area sites added by ESD; disposal of debris from B, D, H, and K reactors to ERDF; provides decision framework for leaving waste in place, generally below 15-ft depth.			
Revision Title	Type	Date	Revised Decision
<i>Explanation of Significant Difference for the 100 Area Remaining Sites ROD, USDOE Hanford 100 Area, 100-IU-6 Operable Unit, Hanford Site, Benton County, Washington</i> (EPA/ESD/R10-00/045)	ESD	06/2000	Plugs in 600-23 and JA Jones #1 waste sites to the Remaining Sites ROD.
<i>Explanation of Significant Differences for the 100 Area Remaining Sites Interim Remedial Action Record of Decision</i>	ESD	02/2004	Adds 28 sites to ROD; adds 10 CFR 1022 and 40 CFR 6, Appendix A as ARARs to ROD; revises annual ICs report date to be coincident with the due date for the Sitewide IC Plan (DOE/RL-2001-41) for Hanford CERCLA Response Actions.
<i>Explanation of Significant Differences for the 100 Area Remaining Sites Interim Remedial Action Record of Decision, Hanford Site, Benton County, Washington</i>	ESD	08/2009	Authorizes adding 200-CW-3 OU wastes sites, 99 newly discovered waste sites, and 87 candidate sites using the plug-in approach in the ROD and any newly discovered waste sites that will be documented in the Administrative Record and in an annual fact sheet.
Record of Decision			
Title: <i>Declaration of the Record of Decision for the 100-KR-2 Operable Unit, Hanford Site, Benton County, Washington</i> (EPA/ROD/R10-99/059) ROD Type: CERCLA Interim Action ROD Area: 100-K Date Approved: September 1999 Initial Decision: Remove spent nuclear fuel from basins; remove sludge from basins; treat and remove water from the basins; remove debris from the basins; deactivate the basins; and institute ICs.			
Revision Title	Type	Date	Revised Decision
<i>Interim Remedial Action Record of Decision Amendment, U.S. Department of Energy; 100 K Area K Basins, Hanford Site - 100 Area, Benton County, Washington</i>	Amended ROD	Jun-05	Modifies remedy for sludge by including sludge treatment prior to interim storage and shipment to a national repository; modifies remedy for debris by including grouting in place some of the basin debris followed by removal along with the removal of the basins.
<i>Explanation of Significant Differences for the Hanford Site 100 K Area K Basins Interim Remedial Action Record of Decision</i>	ESD	Jun-16	Allows for longer-term interim storage of untreated K Basin sludge at T-Plant prior to treatment.

Table B-1. CERCLA Records of Decision and Associated Changes. (9 Pages)

Record of Decision			
Title: <i>Interim Remedial Action Record of Decision for the 100-NR-1 and 100-NR-2 Operable Units, Hanford Site, Benton County, Washington</i> (EPA/ROD/R10-99/112) ROD Type: CERCLA Interim Action ROD Area: 100-N Date Approved: September 1999 Initial Decision: ICs for shoreline site; in situ and RTD with ex situ bioremediation for petroleum sites; RTD for remainder of sites in 100-NR-1; maintain ERA pump-and-treat for 100-NR-2.			
Revision Title	Type	Date	Revised Decision
<i>Explanation of Significant Difference for the 100-NR-1 Operable Unit Treatment, Storage, and Disposal Interim Action Record of Decision and 100-NR-1/100-NR-2 Operable Unit Interim Action Record of Decision</i> (EPA/ESD/R10-03/605)	ESD	05/2003	Removes July 31 annual ICs reporting requirements, consolidates reporting with the site-wide IC annual report; eliminates requirement to evaluate applying 30 in. of irrigation water to determine if remaining contaminants will impact groundwater; identifies need for additional ICs to preclude access to contaminated groundwater which will be incorporated into site-wide IC document.
<i>U.S. Department of Energy, 100-NR-1 and NR-2 Operable Units, Hanford Site - 100 Area, Benton County, Washington, Amended Record of Decision, Decision Summary and Responsiveness Summary</i>	Amended ROD	09/2010	Deploys the apatite sequestration technology for remediating Sr-90 in the 100-NR-2 OU by extending existing apatite permeable reactive barrier to ~2,500 ft, allows for deployment of the apatite sequestration technology elsewhere in the 100-NR-2 OU in accordance with an Ecology approved work plan, and includes decommissioning the treatment components of the existing pump-and-treat system.
<i>Explanation of Significant Differences for the 100-NR-1 and 100-NR-2 Operable Units Interim Remedial Action Record of Decision, Hanford Site, Benton County, Washington</i>	ESD	03/2011	Adds 45 additional waste sites in the 100-NR-1 OU for remediation by RTD (characterized per the 100-N Area sampling and analysis plan) and increases the total cost 38% to \$67,510,386.
<i>Explanation of Significant Difference for the 100-NR-1 and 100-NR-2 Operable Units Interim Remedial Action Record of Decision, Hanford Site, Benton County, Washington</i>	ESD	08/2013	Adds 2 additional waste sites in the 100-NR-1 OU for remediation by RTD and increases the total cost by \$401,500.
<i>Explanation of Significant Differences for the 100-NR-1 and 100-NR-2 Operable Unit Interim Action Record of Decision, Hanford Site, Benton County, Washington</i>	ESD	07/2019	Allows for miscellaneous solid waste to be collected when generated from the 100-NR-2 groundwater OU, transported, and stored at a central location in the Central Plateau.
Record of Decision			
Title: <i>Interim Remedial Action Record of Decision Declaration, U.S. Department of Energy 100 Area, 100-NR-1 Operable Unit, Hanford Site, Benton County, Washington</i> (EPA/ROD/R10-00/120) ROD Type: CERCLA Interim Action ROD for 2 RCRA TSDs and an associated site Area: 100-N Date Approved: January 2000 Initial Decision: RTD of 116-N-1 and 116-N-3 Cribbs with ERDF disposal; backfill and revegetate; any pipelines will be removed or sampled and left in place based on sample results.			

Table B-1. CERCLA Records of Decision and Associated Changes. (9 Pages)

Revision Title	Type	Date	Revised Decision
<i>Explanation of Significant Difference for the 100-NR-1 Operable Unit Treatment, Storage, and Disposal Interim Action Record of Decision and 100-NR-1/100-NR-2 Operable Unit Interim Action Record of Decision (EPA/ESD/R10-03/605)</i>	ESD	05/2003	Removes July 31 annual ICs requirement and consolidates reporting with the Sitewide IC annual report; eliminates requirement to evaluate applying 30 in. of irrigation water to determine if remaining contaminants will impact groundwater; identifies need for additional ICs to preclude access to contaminated groundwater for 116-N-1 which will be incorporated into Sitewide IC document.
Record of Decision			
Title: <i>Declaration of the Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-2, 100-HR-2 and the 100-KR-2 Operable Units (EPA/ROD/R10-00/121)</i> ROD Type: CERCLA Interim Action ROD Area: 100 Date Approved: September 2000 Initial Decision: Remove contaminated soil, structures, and debris; treat as needed; dispose at ERDF; backfill and revegetate. Applies to 45 burial grounds in 100 Area.			
Revision Title	Type	Date	Revised Decision
<i>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)</i>	ESD	11/2007	Established limit of RTD excavation at the 118-B-1 Burial Ground considering the balancing factors in the ROD and required additional ICs for protection of groundwater and the Columbia River.
Record of Decision			
Title: <i>Record of Decision 221-U Facility (Canyon Disposition Initiative), Hanford Site, Washington FINAL</i> ROD Type: CERCLA Final ROD Area: 200 West Date Approved: October 2005 Initial Decision: Remove waste from vessels and equipment in the facility with levels of transuranic isotopes greater than 100 nCi/g and eventual disposal at WIPP; removal of liquids from the facility or treatment to remove liquids; partial removal of contaminated equipment and piping from the gallery side of the facility and dispose at ERDF; demolition and subsequent stabilization of the railroad tunnel, 271-U, 276-U, 291-U, and 292-U structures and 291-U-1 and 296-U-10 stacks and dispose of at ERDF; construct an engineered barrier; planting semiarid-adapted vegetation on the barrier; ICs; post-closure care; and ongoing barrier performance and groundwater monitoring.			
Record of Decision			
Title: <i>Record of Decision, Hanford 200 Area, 200-ZP-1 Operable Unit Superfund Site, Benton County, Washington</i> https://pdw.hanford.gov/document/00098825 FINAL ROD Type: CERCLA Final ROD Area: 200 West; 200-ZP-1 OU Date Approved: September 2008 Initial Decision: Pump-and-treat to address carbon tetrachloride, nitrate, chromium, trichloroethylene, I-129, Tc-99, and tritium; monitored natural attenuation; flow-path control through injection of treated water; and ICs.			

Table B-1. CERCLA Records of Decision and Associated Changes. (9 Pages)

Record of Decision			
Title: <i>Record of Decision, Hanford 200 Area, Superfund Site 200-CW-5 and 200-PW-1, 200-PW-3 and 200-PW-6 Operable Units Hanford Site, Benton County, Washington</i> FINAL ROD Type: CERCLA Final ROD Area: 200 East and 200 West Date Approved: September 2011 Initial Decision: RTD of soil and debris to specified depths cleanup levels for plutonium-contaminated soils and subsurface structures/debris. Soil vapor extraction at three 200-PW-1 waste sites will continue until vadose zone cleanup levels are met. Soil covers will be used to a depth of at least 15 ft over cesium-contaminated soils. Removal of sludge followed by tank stabilization for two tanks. No action for two waste sites. ICs and long-term monitoring for waste sites where contamination is left in place and an unrestricted land use is precluded.			
Record of Decision			
Title: <i>Record of Decision for 300-FF-2 and 300-FF-5, and Record of Decision Amendment for 300-FF-1 Hanford Site, Benton County, Washington</i> FINAL ROD Type: CERCLA Final ROD Area: 300; 300-FF-1, 300-FF-2 and 300-FF-5 Date Approved: November 2013 Initial Decision: This ROD selects a remedy for the waste sites in 300-FF-2, a remedy for the groundwater in 300-FF-5 and amends the remedy for three 300-FF-1 waste sites. The interim action remedy for 300-FF-5, selected in 1996 and the interim action remedy for 300-FF-2 selected in 2001 are replaced with this final action remedy. The remedy for 300-FF-1 selected in 1996 is amended for additional remedial action of uranium from three sites. Contaminated buildings are being removed in accordance with CERCLA Action Memoranda and are not part of the OUs addressed by this ROD. The major components of the selected remedy for the 300-FF-2 OU are: • Removal, treatment (as required), and disposal (RTD) at waste sites • Temporary surface barriers and pipeline void filling • Enhanced attenuation of uranium using sequestration in the vadose zone, PRZ and top of the aquifer • ICs, including the requirement that DOE prevent the development and use of property that does not meet residential cleanup levels at the 300 Area Industrial Complex and 618-11 Burial Ground for other than industrial uses, including use of property for residential housing, elementary and secondary schools, childcare facilities and playgrounds. The major components of the selected remedy for the 300-FF-5 OU are: • Monitored Natural Attenuation • Groundwater monitoring • Enhanced attenuation of uranium at the top of aquifer • ICs. The major component of the amended remedy for 300-FF-1 is Enhanced attenuation of uranium using sequestration in the vadose zone, periodically rewetted zone and top of the aquifer.			
Revision Title	Type	Date	Revised Decision
<i>Explanation of Significant Differences for the Hanford Site 300 Area Record of Decision for 300-FF-2 and 300-FF-5, and Record of Decision Amendment for 300-FF-1</i>	ESD	09/2015	Adds two waste sites to the 300 Area ROD, Table 1. Waste site 600-386 requires no additional action to meet the selected remedy requirement of the 300-FF-2 OU and waste site 600-393 was added for RTD to residential cleanup levels.
<i>Explanation of Significant Differences #2, for the Hanford Site 300 Area Record of Decision for 300-FF-2 and 300-FF-5, and Record of Decision Amendment for 300-FF-1</i>	ESD	04/2016	Adds one waste site (600-403) to the Final Action ROD, Table 1 as well as providing a modified technology/approach for another waste site (300-288:2, or 300-288 subsite #2) as RTD to residential cleanup levels without backfilling.

Table B-1. CERCLA Records of Decision and Associated Changes. (9 Pages)

<i>Explanation of Significant Differences for the 300-FF-5 Operable Unit Record of Decision, Hanford Site, Benton County, Washington</i>	ESD	07/2019	Allows for miscellaneous solid waste generated in support of the 300-FF-5 final action to be collected and stored at a Central Plateau storage facility prior to disposal.
Record of Decision			
Title: <i>Record of Decision Hanford 100 Area Superfund Site 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and 100-IU-6 Operable Units</i> FINAL ROD Type: CERCLA Final ROD Area: 100 Area Date Approved: September 2014 Initial Decision: RTD at 91 waste sites, ICs at 15 waste sites, no additional action due to interim remedial actions completed at 198 waste sites, monitored natural attenuation to address nitrate, hexavalent chromium, trichloroethene, and strontium-90 in 100-FR-3 groundwater and ICs.			
Revision Title	Type	Date	Revised Decision
<i>Explanation of Significant Differences for the 100-FR-3 Operable Unit Record of Decision, Hanford Site, Benton County, Washington</i>	ESD	07/2019	Allows for miscellaneous solid waste generated in support of the 100-FR-3 final action to be collected and stored at a Central Plateau storage facility prior to disposal.
Record of Decision			
Title: <i>Record of Decision for Hanford 100 Area, 100-DR-1, 100-DR-2, 100-HR-1, 100-HR-2, and 100-HR-3 Operable Units, Hanford Superfund Site</i> FINAL ROD Type: CERCLA Final ROD Area: 100 Area Date Approved: July 2018 Initial Decision: RTD at 45 waste sites, pipeline capping and ICs at one waste site, ICs at 43 other waste sites, no additional action at 150 waste sites as a result of interim remedial actions completed, pump and treat operations to remove hexavalent chromium and total chromium from 100-HR-3 OU groundwater, monitored natural attenuation to address nitrate and strontium-90 in 100-HR-3 OU groundwater, and groundwater ICs.			

ARAR	= applicable or relevant and appropriate requirement
CERCLA	= <i>Comprehensive Environmental Response, Compensation, and Liability Act of 1980</i>
EPA	= U.S. Environmental Protection Agency
ERA	= expedited response action
ERDF	= Environmental Restoration Disposal Facility
ESD	= explanation of significant difference
IC	= institutional controls
ISRM	= in situ redox manipulation
MCL	= maximum contaminant limit
OU	= operable unit
PCB	= polychlorinated biphenyl
RCRA	= <i>Resource Conservation and Recovery Act of 1976</i>
RDR/RAWP	= remedial design report/remedial action work plan
ROD	= record of decision
RTD	= removal, treatment (as required), and disposal
TSD	= treatment, storage, and disposal
WIPP	= Waste Isolation Pilot Plant

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APPENDIX C

SOIL AND GROUNDWATER CLEANUP LEVELS FOR SELECTED 100 AREA AND 300 AREA OPERABLE UNITS WITH FINAL ACTION RECORDS OF DECISION

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APPENDIX C

SOIL AND GROUNDWATER CLEANUP LEVELS FOR SELECTED 100 AREA AND 300 AREA OPERABLE UNITS WITH FINAL ACTION RECORDS OF DECISION

In support of narrative presented in the main body of this report, this appendix includes soil and groundwater cleanup levels for selected OUs, as presented in final action RODs. A listing for the series of cleanup level tables is provided below:

- Tables C-1 through C-3, are Tables 5 through 7, respectively, from *Record of Decision Hanford 100 Area Superfund Site 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-1 and 100-IU-6 Operable Units* ([EPA 2014](#))
- Tables C-4 through C-6, are Tables 4 through 6, respectively from *Record of Decision Hanford 100 Area Superfund Site 100-DR-1, 100-DR-2, 100-HR-1, 100-HR-2 and 100-HR-3 Operable Units* ([EPA 2018](#))
- Tables C-7 and C-8, are Tables 4 and 5, respectively from *Record of Decision Hanford 300 Area Superfund Site 300-FF-2 and 300-FF-5 Operable Units and ROD Amendment for the 300-FF-1 Operable Unit* ([EPA and DOE 2013](#)).

C1.0 REFERENCES

- EPA, 2014, *Record of Decision, Hanford 100 Area Superfund Site 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and 100-IU-6 Operable Units*, U.S. Environmental Protection Agency, Washington, D.C. Available on line at <http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0082927H>.
- EPA, 2018, *Record of Decision Hanford 100 Area Superfund Site 100-DR-1, 100-DR-2, 100-HR-1, 100-HR-2, 100-HR-3 Operable Units*, U.S. Environmental Protection Agency, Washington, D.C. Available online at <https://pdw.hanford.gov/document/0065047H>.
- EPA and DOE, 2013, *Hanford Site 300 Area Record of Decision for 300-FF-2 and 300-FF-5, and Record of Decision Amendment for 300-FF-1*, U.S. Environmental Protection Agency, Region 10, and U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available online at <http://pdw.hanford.gov/arpir/pdf.cfm?accession=0087180>.

C2.0 CLEANUP LEVEL TABLES

Tables C-1 through C-3 are Tables 5 through 7, respectively, from *Record of Decision Hanford 100 Area Superfund Site 100-FR-1, 100-FR-2 100-FR-3, 100-IU-2, and 100-IU-6 Operable Units* ([EPA 2014](#)).

Table C-1. Soil Cleanup Levels for Protection of Human Health.¹

Media: Soil and Debris Site Area: 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 OUs			
Contaminant of Concern	Units	Cleanup Level (≤4.6 m [15 ft] bgs)	Basis for Cleanup Level
Radionuclides			
Cesium-137	pCi/g	4.4	Direct contact residential scenario
Cobalt-60	pCi/g	1.4	Residential interim remedial action cleanup level
Europium-152	pCi/g	3.3	Residential interim remedial action cleanup level
Europium-154	pCi/g	3.0	Residential interim remedial action cleanup level
Nickel-63	pCi/g	608	Direct contact residential scenario
Strontium-90	pCi/g	2.3	Direct contact residential scenario
Chemicals			
Arsenic	mg/kg	20	MTCA Method A
Hexavalent Chromium	mg/kg	240	MTCA Method B
Lead	mg/kg	250	MTCA Method A
Mercury	mg/kg	24	MTCA Method B
Nitrate	mg/kg	568,000	MTCA Method B
Aroclor 1254	mg/kg	0.50	MTCA Method B
Aroclor 1260	mg/kg	0.50	MTCA Method B
Benzo(a)pyrene	mg/kg	0.14	MTCA Method B
TPH–Diesel Range	mg/kg	2,000	MTCA Method A
TPH–Motor Oil (High Boiling)	mg/kg	2,000	MTCA Method A

¹Source: EPA, 2014, *Record of Decision Hanford 100 Area Superfund Site 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and 100-IU-6 Operable Units*, Table 5, U.S. Environmental Protection Agency, Washington, D.C.

MTCA = Washington State's Model Toxics Control Act

MTCA Method A and B = Soil Cleanup Levels for Unrestricted Land Use

bgs = below ground surface

Table C-2. Soil Cleanup Levels for Protection of Groundwater and Surface Water.¹

Media: Soil and Debris			
Site Area: 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 OUs			
Contaminant of Concern	Soil Cleanup Levels for Protection of Groundwater and Surface Water (Ground Surface to Water Table)		
	100-FR-1 and 100-FR-2	100-IU-2	100-IU-6
Radionuclides (pCi/g)			
Cesium-137	—	—	—
Cobalt-60	—	—	—
Europium-152	—	—	—
Europium-154	—	—	—
Nickel-63	—	—	—
Strontium-90	24,600	64,200	104,000
Chemicals (mg/kg)			
Arsenic	—	—	—
Hexavalent Chromium	2.0	2.0	2.0
Lead	—	—	—
Mercury	—	—	—
Nitrate	1,790	6,360	11,300
Aroclor 1254	—	—	—
Aroclor 1260	—	—	—
Benzo(a)pyrene	—	—	—
TPH–Diesel Range	2,000	2,000	2,000
TPH–Motor Oil (High Boiling)	2,000	2,000	2,000

¹Source: EPA, 2014, *Record of Decision Hanford 100 Area Superfund Site 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and 100-IU-6 Operable Units*, Table 6, U.S. Environmental Protection Agency, Washington, D.C.

TPH = total petroleum hydrocarbon

Note: Basis for soil cleanup level for groundwater and surface water protection is the soil leach model in the 100-F/IU RI/FS.

Table C-3. Cleanup Levels for 100-FR-3 COCs – Groundwater.¹

Media: Groundwater Site Area: 100-FR-3 OU Available Use: Drinking water and all other uses			
Contaminant of Concern	Units	Cleanup Level	Basis for Cleanup Level
Strontium-90	pCi/L	8	DWS
Hexavalent chromium	µg/L	10/48 ²	WAC 173-201A/WAC 173-340-720
Trichloroethene	µg/L	4	Risk-based MTCA cleanup level for drinking water
Nitrate	mg/L	45	DWS

¹Source: EPA, 2014, *Record of Decision Hanford 100 Area Superfund Site 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and 100-IU-6 Operable Units*, Table 7, U.S. Environmental Protection Agency, Washington, D.C.

²Cleanup levels for hexavalent chromium are 48 µg/L in the upland groundwater and 10 µg/L where groundwater discharges to surface water.

DWS = drinking water standard (Maximum Contaminant Levels [MCLs] and non-zero Maximum Contaminant Level Goals [MCLGs])

WAC = Washington Administrative Code

WAC 173-201A = “Water Quality Standards for Surface Waters of the State of Washington.”

WAC 173-340-720 = “Model Toxics Control Act—Cleanup,” “Groundwater Cleanup Standards

Tables C-4 through C-6, are Tables 4 through 6, respectively from *Record of Decision Hanford 100 Area Superfund Site 100-DR-1, 100-DR-2, 100-HR-1, 100-HR-2 and 100-HR-3 Operable Units* ([EPA 2018](#))

Table C-4. Soil Cleanup Levels for Protection of Human Health.

Media: Soil and Debris Site Area: 100-DR-1, 100-DR-2, 100-HR-1, and 100-HR-2 OUs			
Contaminant	Units	Cleanup Level (<4.6 m [15 ft]) bgs)	Basis for Cleanup Level
Radionuclides			
Cesium-137	pCi/g	4.4	Direct contact residential scenario
Cobalt-60	pCi/g	1.4	Residential remedial action cleanup level•
Europium-152	pCi/g	3.3	Residential remedial action cleanup level•
Europium-154	pCi/g	3.0	Residential remedial action cleanup level•
Nickel-63	pCi/g	608	Direct contact residential scenario
Strontium-90	pCi/g	2.3	Direct contact residential scenario
Chemicals			
Antimony	mg/kg	32	Direct contact, MTCA Method B
Arsenic	mg/kg	20	WAC 173-340-900, Table 740-1, MTCA Method A
Barium	mg/kg	16,000	Direct contact, MTCA Method B
Cadmium	mg/kg	80	Direct contact, MTCA Method B
Total chromium	mg/kg	120,000	Direct contact, MTCA Method B

Hexavalent chromium	mg/kg	240	Direct contact, MTCA Method B
Copper	mg/kg	3,200	Direct contact, MTCA Method B
Lead	mg/kg	250	WAC 173-340-900, Table 740-1, MTCA Method A
Mercury	mg/kg	24	Direct contact, MTCA Method B
Nickel	mg/kg	1,600	Direct contact, MTCA Method B
Silver	mg/kg	400	Direct contact, MTCA Method B
Zinc	mg/kg	24,000	Direct contact, MTCA Method B
Aroclor 1016	mg/kg	5.6	Direct contact, MTCA Method B
Aroclor 1221	mg/kg	0.19	Inhalation, MTCA Method B
Aroclor 1232	mg/kg	0.19	Inhalation, MTCA Method B
Aroclor 1242	mg/kg	0.50	Direct contact, MTCA Method B
Aroclor 1248	mg/kg	0.50	Direct contact, MTCA Method B
Aroclor 1254	mg/kg	0.50	Direct contact, MTCA Method B
Aroclor 1260	mg/kg	0.50	Direct contact, MTCA Method B
Benzo(a)pyrene	mg/kg	0.14	Direct contact, MTCA Method B
Benzo(b)fluoranthene	mg/kg	1.4	Direct contact, MTCA Method B
Benzo(k)fluoranthene	mg/kg	1.4	Direct contact, MTCA Method B
Chrysene	mg/kg	14	Direct contact, MTCA Method B
Dibenz(a,h)anthracene	mg/kg	1.4	Direct contact, MTCA Method B
Indeno(1,2,3-cd)pyrene	mg/kg	1.4	Direct contact, MTCA Method B
Pyrene	mg/kg	1.4	Direct contact, MTCA Method B

Based on 15 mrem / year cleanup level used in the Interim Records of Decision that are more stringent / protective than the 1×10^{-4} levels

MTCA = "Model Toxics Control Act-Cleanup" (WAC 173-340), Methods A and B (Soil Cleanup Levels for Unrestricted Land Use)

bgs = below ground surface

Waste sites that contain multiple contaminants will meet cumulative risk limits of 10^{-4} for radionuclides, 10^{-5} for chemicals, and a hazard index of 1.

Table C-5. Soil Cleanup of Groundwater and Surface Water.

Contaminant	Soil Cleanup Levels for Protection of Groundwater and Surface Water (Ground Surface to Water Table)"	
	100-D	100-B
Radionuclides (pCi/g)		
Cesium-137	-	-
Cobalt-60	-	-
Europium-152	-	-
Europium-154	-	-
Nickel-63	-	>1,000,000
Strontium-90	29,400	157,000
Chemicals mg/kg		
Antimony	-	5,590
Arsenicb	246	20
Contaminant	Soil Cleanup Levels for Protection of Groundwater and Surface Water (Ground Surface to Water Table)•	
	100-D	100-H
Barium	389,000	389,000
Cadmium	1.3	15
Total chromium	-	-
Hexavalent chromiumb	2.0	2.0
Copper	4,030	1,920
Lead	-	-
Mercury	-	17
Nickel	-	150,000
Silver	18	191
Zinc	-	225,000
Aroclor 1016	-	260
Aroclor 1221	0.099	1.0
Aroclor 1232	0.099	1.0
Aroclor 1242	-	77
Aroclor 1248	-	72
Aroclor 1254	-	591
Aroclor 1260	-	-
Benzo(a)pyrene	-	-
Benzo(b)fluoranthene	-	-
Benzo(k)fluoranthene	-	-
Chrysene	-	-

Dibenz(a,h)anthracene	-	-
Indeno(1,2,3-cd)pyrene	-	-
Pyrene	-	389,000

^a Soil cleanup levels protective of groundwater and protective of surface water are provided on a unit-length basis. To apply these soil cleanup levels, divide the listed value by a representative length across the waste site decision unit in the general direction of groundwater flow to obtain the cleanup value for evaluation use. (Note that this scaling is not applicable to soil cleanup levels for arsenic and Cr(VI), the cleanup levels for these two analytes are in units of mg/kg.)

^b This value is not scaled by the representative waste site decision unit dimension in the general direction of groundwater flow

Table C-6. Cleanup Levels for 100-HR-3 Groundwater.

COC	Units	Cleanup Level	Basis for Cleanup Level
Hexavalent chromium ^a	µg/L	10/48	WAC 173-201A/WAC 173-340-720
Total chromium ^b	µg/L	65/100	40 CFR 131/DWS
Nitrate ^c	µg/L	45,000	DWS
Strontium-90	pCi/L	8	DWS

Note: DWSs are from 40 CFR 141. "National Primary Drinking Water Regulations."

40 CFR 131, "Water Quality Standards."

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

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

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

^b Cleanup levels for total chromium are 65 µg/L where groundwater discharges to surface water and 100 µg/L in the upland groundwater.

^c Nitrate may be expressed as nitrate-nitrogen (NO₃-N) or as nitrate (NO₃). The DWSs for NO₃-N and NO₃ are 10,000 and 45,000 µg/L, respectively.

COC = contaminant of concern

DWS = drinking water standard

Tables C-7 and C-8, are Tables 4 and 5, respectively from *Record of Decision Hanford 300 Area Superfund Site 300-FF-2 and 300-FF-5 Operable Units and ROD Amendment for the 300-FF-1 Operable Unit* ([EPA and DOE 2013](#)).

Table C-7. Cleanup Levels for 300-FF-2 COCs- Soil, Structures and Debris.

Media: Soil, Structures and Debris Site Area: 300-FF-2					
Controls to Ensure Restricted Use: Yes.					
Contaminant	Units	Residential Cleanup Areas Outside both the 300 Area Industrial Complex and 618-11		Industrial Cleanup Areas within the 300 Area Industrial Complex and 618-11	
		Shallow Zone <= 15 ft bgs Direct Exposure Human Health		Shallow Zone <= 15 ft bgs Direct Exposure Human Health	
		CUL	Basis for CUL	CUL	Basis for CUL
			Soil CUL for GW & River Prot. Surface To GW		Soil CUL for GW & River Prot. Surface To GW

Americium-241	pCi/g	32	RA	--	210	RA	--
Cesium-137	pCi/g	4.4	RA	--	18	RA	--
Cobalt-60	pCi/g	1.4	RA	--	5.2	RA	--
Europium-152	pCi/g	3.3	RA	--	12	RA	--
Europium-154	pCi/g	3.0	RA	--	11	RA	--
Europium-155	pCi/g	125	RA	--	518	RA	--
Iodine-129	pCi/g	0.076	RA	12.8	1,940	RA	37.1
Plutonium-238	pCi/g	39	RA	--	155	RA	--
Plutonium-239/240	pCi/g	35	RA	--	245	RA	--
Plutonium-241	pCi/g	854	RA	--	12,900	RA	--
Technetium-99	pCi/g	1.5	RA	272	166,000	RA	420
Total beta radiostrontium (Strontium-90)	pCi/g	2.3	RA	227,000	1,970	RA	--
Tritium	pCi/g	459	RA	9,180	1,980	RA	12,200
Uranium-233/234	pCi/g	27.2	RA	--	167	RA	--
Uranium-235	pCi/g	2.7	RA	--	16	RA	--
Uranium-238	pCi/g	26.2	RA	--	167	RA	--
Uranium isotopes total	pCi/g	56.1	RA	--	350	RA	--
Antimony	mg/kg	32	MTCA-B	252	1,400	MTCA-C	760
Arsenic	mg/kg	20	MTCA-B	20	20	MTCA-C	--
Barium	mg/kg	16,000	MTCA-B	--	700,000	MTCA-C	--
Beryllium	mg/kg	160	MTCA-B	--	7,000	MTCA-C	--
Cadmium	mg/kg	80	MTCA-B	176	3,500	MTCA-C	--
Chromium (Total)	mg/kg	120,000	MTCA-B	--	>1,000,000	MTCA-C	--
Chromium (VI)	mg/kg	2.1	CWA	2.0	10,500	CWA	2.0
Cobalt	mg/kg	24	MTCA-B	--	1,050	MTCA-C	--
Copper	mg/kg	3,200	MTCA-B	3,400	140,000	MTCA-C	--
Lead	mg/kg	250	MTCA-A	1,480	1,000	MTCA-C	--
Lithium	mg/kg	160	MTCA-B	--	7,000	MTCA-C	--
Manganese	mg/kg	11,200	MTCA-B	--	490,000	MTCA-C	--
Mercury	mg/kg	24	MTCA-B	8.5	1,050	MTCA-C	--
Nickel	mg/kg	1,600	MTCA-B	--	70,000	MTCA-C	--
Selenium	mg/kg	400	MTCA-B	302	17,500	MTCA-C	912
Silver	mg/kg	400	MTCA-B	--	17,500	MTCA-C	--
Strontium	mg/kg	48,000	MTCA-B	--	>1,000,000	MTCA-C	--
Tin	mg/kg	48,000	MTCA-B	--	>1,000,000	MTCA-C	--
Uranium	mg/kg	81	MTCA-B	102	505	MTCA-C	157
Vanadium	mg/kg	400	MTCA-B	--	17,500	MTCA-C	--
Zinc	mg/kg	24,000	MTCA-B	64,100	>1,000,000	MTCA-C	--
Cyanide	mg/kg	48	MTCA-B	636	42	MTCA-C	1,960

Fluoride	mg/kg	4,800	MTCA-B	--	210,000	MTCA-C	--
Nitrate	mg/kg	568,000	MTCA-B	13,600	>1,000,000	MTCA-C	21,000
Aroclor 1016	mg/kg	5.6	MTCA-B	--	245	MTCA-C	--
Aroclor 1221	mg/kg	0.50	MTCA-B	0.017	66	MTCA-C	0.026
Aroclor 1232	mg/kg	0.50	MTCA-B	0.017	66	MTCA-C	0.026
Aroclor 1242	mg/kg	0.50	MTCA-B	0.14	66	MTCA-C	--
Aroclor 1248	mg/kg	0.50	MTCA-B	0.13	66	MTCA-C	--
Aroclor 1254	mg/kg	0.50	MTCA-B	--	66	MTCA-C	--
Aroclor 1260	mg/kg	0.50	MTCA-B	--	66	MTCA-C	--
Cis-1,2-Dichloroethylene (DCE)	mg/kg	160	MTCA-B	11	7,000	MTCA-C	18
Carbon tetrachloride	mg/kg	0.61	MTCA-B	0.44	6.1	MTCA-C	0.86
Chloroform	mg/kg	0.24	MTCA-B	1.3	2.4	MTCA-C	2.1
1,1,1-Trichloroethane	mg/kg	3,660	MTCA-B	361	8,000	MTCA-C	686
1,2-Dichloroethene (total)	mg/kg	720	MTCA-B	55	31,500	MTCA-C	89
Methylethylketone (2-Butanone)	mg/kg	28,400	MTCA-B	1,670	62,200	MTCA-C	2,590
Methylisobutyl ketone (hexone) (4-Methyl-2-pentanone)	mg/kg	6,400	MTCA-B	285	28,700	MTCA-C	445
Benzene	mg/kg	0.57	MTCA-B	0.82	5.7	MTCA-C	1.4
Ethyl acetate	mg/kg	72,000	MTCA-B	--	>1,000,000	MTCA-C	--
Ethylene glycol	mg/kg	160,000	MTCA-B	5,030	>1,000,000	MTCA-C	7,770
Hexachlorobutadiene	mg/kg	13	MTCA-B	--	1,680	MTCA-C	--
Hexachloroethane	mg/kg	2.5	MTCA-B	23	25	MTCA-C	72
Tetrachloroethene	mg/kg	20	MTCA-B	2.4	82	MTCA-C	6.0
Toluene	mg/kg	4,770	MTCA-B	1,150	10,400	MTCA-C	2,190
Vinyl chloride	mg/kg	0.53	MTCA-B	0.013	5.2	MTCA-C	0.021
Xylenes (total)	mg/kg	103	MTCA-B	4,700	227	MTCA-C	11,090
Benzo(a)pyrene	mg/kg	0.14	MTCA-B	--	18	MTCA-C	--
Chrysene	mg/kg	14	MTCA-B	--	1,800	MTCA-C	--
Tributyl phosphate	mg/kg	111	MTCA-B	217	14,600	MTCA-C	658
Trichloroethene (TCE)	mg/kg	1.1	MTCA-B	1.3	3.5	MTCA-C	2.4
Normal paraffin hydrocarbon (Kerosene)	mg/kg	2,000	MTCA-A	2,000	2,000	MTCA-C	2,000
Total Petroleum Hydrocarbons - diesel	mg/kg	2,000	MTCA-A	2,000	2,000	MTCA-C	2,000
Total Petroleum Hydrocarbons - motor oil	mg/kg	2,000	MTCA-A	2,000	2,000	MTCA-C	2,000

bgs = below ground surface CUL = cleanup level
 GW = groundwater CWA = Clean Water Act Prot. = protection
 RA = risk assessment

MTCA = Washington State's Model Toxics Control Act. MTCA-B is unrestricted, MTCA-C is industrial.
 CULs basis for radionuclides is a cancer risk of 1×10^{-4} or 15 mrem/year dose whichever is more conservative. For uranium, 15 mrem/year is more conservative so that is the basis for the uranium isotopes total CUL. That total is divided among the individual uranium isotopes using the natural ratio of isotopes.
 No uranium isotopes CUL is selected for groundwater and river protection because the DWS is used which is based on uranium metal.
 CULs basis for chemicals is the more conservative of a hazard index of one or the cancer risk. The cancer risk is 1×10^{-6} for residential cleanup and 1×10^{-5} for industrial cleanup based on MTCA.
 Basis for soil CUL for groundwater and river protection is the soil leach model in the RI.

Table C-8. Cleanup Levels for 300-FF-5 COCs – Groundwater.

Media: Groundwater Site Area: 300-FF-5			
Available Use: Drinking water and all other uses			
Controls to Ensure Restricted Use: Yes			
Contaminant of Concern	CUL	Units	Basis for CUL
Uranium	30	ug/L	DWS
Tritium	20,000	pCi/L	DWS
Nitrate (as NO ₃)	45,000	ug/L	DWS
Trichloroethene (TCE)	4	ug/L	Risk assessment for drinking water
Cis-1,2-Dichloroethene (DCE)	16	ug/L	Risk assessment for drinking water
Gross Alpha	15	pCi/L	DWS

CUL for total uranium metal of 30 ug/L is also protective of the uranium isotopes U-233/234, U-235 and U-238.

Basis for these CULs are risk limits and DWS ARARs to protect drinking water uses which also are protective of the river.