APPENDIX D.2

300-FF (RC-GW-1, RIVER CORRIDOR)
EVALUATION UNIT SUMMARY TEMPLATE

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Table of Contents

List of Tables

List of Figures

PART I. EXECUTIVE SUMMARY

EU LOCATION

300 Industrial Area

RELATED EUS

RC-GW-2 (100-N Plume), RC-GW-3 (100-B/C/D/H/F/K Plumes), CP-GW-1 (200-East Plumes), and CP-GW-2 (200-West Plumes)

PRIMARY CONTAMINANTS, CONTAMINATED MEDIA AND WASTES:

The primary contaminants of concern in the 300 Industrial Area include uranium (primarily U^{238}), nitrate, tritium, *cis*-1,2-Dichloroethene (DCE), and trichloroethene (TCE). Contaminated media include a vadose zone comprised of sand and gravel of the Hanford formation portion of the Ringold Formation units B, C, and/or E. An unconfined aquifer also possesses contaminants within the sand and gravel from the Ringold and Hanford formations. This unconfined aquifer is highly transmissive due to the open framework gravelly sediment, resulting in high flow velocities. The base of the aquifer consists of one of a number of fine-grained layers of the Ringold Formation. In addition, numerous distinct layers of sand and gravel that typically contain water and act as local confined aquifers. Basalt confined aquifers are also present. (DOE/RL-2016-09, Rev. 0)

BRIEF NARRATIVE DESCRIPTION:

The 300 FF Area is composed of a 0.52-square mile 300 Area Industrial Complex and 1 square mile of surrounding areas used for solid and liquid waste disposal (618-10 Burial Ground/316-4 Crib, and 618-11 Burial Ground). Former operations included fabrication of nuclear fuel assemblies from 1943–1987, and research in irradiated fuel processing during the 1950s and 1960s. Groundwater contamination originated primarily from historical routine disposal of liquid effluent associated with fabrication of nuclear fuel assemblies and research involving the processing of irradiated fuel. Disposal areas and plumes of contaminated groundwater cover approximately 1.6 square miles. Principal liquid waste disposal facilities (trenches) have been out of service for decades and most have been remediated by removing contaminated soil. Contamination remaining in the underlying vadose zone and aquifer is residual. The final record of decision was signed in 2013 and remedial action of groundwater includes enhanced attenuation of uranium using sequestration by phosphate application. Monitored natural attenuation (MNA) is the remedy of choice for other contaminants of concern. (DOE/RL-2016-09, Rev. 0)

SUMMARY TABLES OF RISKS AND POTENTIAL IMPACTS TO RECEPTORS

Table D.2-1 provides a summary of nuclear and industrial safety related risks to humans and impacts to important physical Hanford site resources.

Human Health

A Facility Worker is deemed to be an individual located anywhere within the physical boundaries of the 300 FF area; a Co-located Person (CP) is an individual located 100 meters from the physical boundaries of the 300 FF areas; and Public is an individual located at the closest point on the Hanford Site boundary not subject to DOE access control. The nuclear-related risks to humans are based on unmitigated (unprotected or controlled conditions) dose exposures expressed in a range of from Not Discernible (ND) to High. The estimated mitigated exposure that takes engineered and administrative controls and protections into consideration, is shown in parentheses.

Groundwater and Columbia River

Direct impacts to groundwater resources and the Columbia River have been rated based on available information for the current status and estimates for future time periods. These impacts are also expressed in a range of from Not Discernible (ND) to Medium.

Ecological Resources

The risk ratings are based on the degree of physical disruption (and potential additional exposure to contaminants) in the current status and as a potential result of remediation options.

Cultural Resources[1]

No risk ratings are provided for Cultural Resources. Table D.2-1 identifies the three overlapping Cultural Resource landscapes that have been evaluated: Native American (approximately 10,000 years ago to the present); Pre-Hanford Era (1805 to 1943) and Manhattan/Cold War Era (1943 to 1990); and provides initial information on whether an impact (both direct and indirect) is KNOWN (presence of cultural resources established), UNKNOWN (uncertainty about presence of cultural resources), or NONE (no cultural resources present) based on written or oral documentation gathered on the entire EU and buffer area. Direct impacts include but are not limited to physical destruction (all or part) or alteration such as diminished integrity. Indirect impacts include but are not limited to the introduction of visual, atmospheric, or audible elements that diminish the cultural resource's significant historic features. Impacts to Cultural Resources as a result of proposed future cleanup activities will be evaluated in depth under Section 106 of the National Historic Preservation Act (16 USC 470, et. seq.) during the planning for remedial action.

[1] References throughout this Evaluation Unit Summary Template supporting analyses related to Ecological Resources and/or Cultural Resources may be found in Appendices J and K, respectively. Refer to the specific EU when searching for the reference.

Table D.2-1. Risk Rating Summary (for Human Health, unmitigated nuclear safety basis indicated, mitigated basis indicated in parentheses (e.g., "Low" (Low)).

Population or Resource		Evaluation Time Period Active Cleanup (to 2064) Current Condition:	 From Cleanup Actions:
Human Health	Facility Worker	Low (Low)	Low (Low)
	Co-located Person	Low (Low)	Low (Low)
	Public	Not Discernible (Not Discernible)	Not Discernible (Not Discernible)
Environmental	Groundwater (No vadose zone)	All: ND to Medium (H-3, NO3)[b] A&B Only: Low (U(tot))[b]	ND[c]
	Columbia River (No vadose zone)	All: ND to High (U(tot))[b] A&B Only: ND to High (U(tot))[b]	ND[c]
	Ecological Resources[a]	Low to Moderate	Low to Moderate
Social	Cultural Resources[a]	**Native American:** Direct: Known Indirect: Known **Historic Pre-Hanford:** Direct: Known Indirect: Known **Manhattan/Cold War:** Direct: Known Indirect: Known	**Native American:** Direct: Known Indirect: Known **Historic Pre-Hanford:** Direct: Known Indirect: Known **Manhattan/Cold War:** Direct: Known Indirect: Known

a. For both Ecological and Cultural Resources see Appendices J and K, respectively, for a complete description of Ecological Field Assessments and literature review for Cultural Resources. Ecological ratings are described in Table 4-11 of the Final Report.

b. Organics (including trichloroethene (TCE) and *cis*-1,2-dichloroethene (DCE)) are locally present in deeper sediments; however, plume extents and shoreline impacts cannot be determined from current data (DOE/RL-2016-09, Rev. 0). These omissions represent data gaps for the analysis of potential groundwater and Columbia River impacts related to 300-FF.

c. Modeling indicates that the uranium will fall below the drinking water standard (DWS) by ca. 2040 assuming no remedial actions and that tritium would decline below the DWS by ca. 2031 assuming no additional tritium to the groundwater (EPA et al., 2013). Nitrate above the DWS is due to off-site sources and was not evaluated ROD, and thus further potential impact is not related to the GW EU.

SUPPORT FOR RISK AND IMPACT RATINGS FOR EACH POPULATION OR RESOURCE

Human Health

Current

Human health risk from exposure to groundwater was evaluated through risk calculations and comparison to federal and state drinking water or cleanup standards. The approach assumes that the groundwater is used as a tap water source for a 30-year period. Potential routes of exposure include ingestion, dermal contact, and inhalation of volatiles during household activities. Groundwater concentrations were also compared to existing federal and state drinking water or cleanup standards. Current remediation activities for the 300-FF groundwater IA involve sampling and monitoring for tritium, TCE, DCE, and enhanced attenuation with monitoring for uranium. Institutional controls (ICs) are also being used to control access to residual contaminants in soil and groundwater. As such, impacts from potential remediation approaches will vary slightly, depending on the activity. (EPA et al., 2013)

Risks and Potential Impacts from Selected or Potential Cleanup Approaches

The selected cleanup alternative for 300-FF-5 groundwater OU is Alternative 3a, which uses a combination of monitored natural attenuation (MNA) for nitrate, tritium, TCE, and DCE in groundwater, and enhanced attenuation with monitoring for uranium and monitoring for gross alpha in groundwater. Institutional controls (ICs) are also being used to control access to residual contaminants in soil and groundwater as long as they exceed the cleanup levels (CULs). As such, impacts from potential remediation approaches will vary slightly, depending on the activity: MNA, IC, or enhanced attenuation with monitoring. The Facility Worker is thus described as low to medium risk (Low for MNA and IC; Medium for enhanced attenuation with monitoring).

Unmitigated Risk: Facility Worker – Low to Medium; CP – Low to Medium; Public – Low to ND.

Mitigation: The Department of Energy and contractor site-specific safety and health planning that includes work control, fire protection, training, occupational safety and industrial hygiene, emergency preparedness and response, and management and organization—which are fully integrated with nuclear safety and radiological protection—have proven to be effective in reducing industrial accidents at the Hanford site to well below that in private industry. Further, the safety and health program must effectively ensure that ongoing task-specific hazard analyses are conducted so that the selection of appropriate PPE can be made and modified as conditions warrant. Task-specific hazard analyses must lead to the development of written work planning documents and standard operating procedures (SOPs) [DOE uses the term work planning documents in addition to procedures] that specify the controls necessary to safely perform each task, to include continuous employee exposure monitoring. Last, ICs will be used to control access to residual contaminants in soil and groundwater as long as they exceed the cleanup levels (CULs).

Mitigated Risk: Facility Worker – Low; CP – Low; Public – ND.

ENVIRONMENTAL – GROUNDWATER

Evaluation of the threats to groundwater as a protected resource from saturated zone contamination utilized the groundwater evaluation framework procedure outlined in Chapter 6 of the Methodology Report (CRESP 2015). The results of this analysis are described briefly below and in additional detail in Part VI and Table D.2-3.

Note that a uranium concentration of 12.9 µg/L was selected for total uranium to identify those areas contaminated by the Hanford Site (PNNL-17034, p. 6.9). Values below this were considered to have No Effect. Also note that there is a large uncertainty relative to the No Effects level for total uranium as utilized in the Methodology Report. As stated in the CRCRA, "Effect levels span nearly three orders of magnitude (3 µg/L to 900 µg/L), reflecting considerable uncertainty in selection of a no-effect concentration. The value selected is a probable no effect concentration and is the 5th percentile of the toxicity data set" (DOE/RL-2010-117 Rev. 0, p. 6.2).

Current

The groundwater plumes (uranium, tritium, nitrate, TCE, and DCE) associated with 300-FF are described in Part V. As shown in Table D.2-3 in Part VI, the saturated zone (SZ) groundwater threat metric (GTM) values for the Group A and B primary contaminants translate to *Low* (uranium) to *Medium* (tritium and nitrate) ratings for the RC-GW-1 EU. Thus the overall rating for groundwater impacts from current plumes is *Medium*. The only Group A or B contaminant evaluated is total uranium (*Low* rating) because a plume extent cannot be determined for TCE from current data (DOE/RL-2016-09, Rev. 0).

Risks and Potential Impacts from Selected or Potential Cleanup Approaches

Selected remediation Alternative 3a uses a MNA and monitoring for nitrate, tritium, TCE, and DCE in groundwater, and enhanced attenuation with monitoring for uranium and monitoring for gross alpha in groundwater. ICs are also being used to control access to residual contaminants in soil and groundwater as long as they exceed the CULs. As such, impacts from the selected remediation approach will vary little from current conditions (i.e., during active remediation until cleanup levels are reduced below WQSs. Once below WQS (the dissolved uranium concentration is predicted to take approximately 28 years (starting in 2012) to drop below the WQS of 30 µg/L, while the tritium concentrations would decline to below the WQS by 2031 under all remediation alternatives (EPA et al., 2013))[2], the overall rating for groundwater impacts will be assessed *Not Discernible (ND)*.

ENVIRONMENTAL – COLUMBIA RIVER

Current

Plumes associated with the RC-GW-1 EU currently intersect the Columbia River, which translate to *Not Discernible* to *High* ratings for all evaluation periods.

The rating threat evaluation to the benthic ecology for uranium (total) is *High* due to the high maximum groundwater concentration to BCG ratio and impacted shoreline (1430 m).

The rating threat evaluation to the riparian ecology for uranium (total) is *High* due to the high Ratio and the moderate riparian impact area of 2.58 hectares.

Though the process of evaluating TCE lead to a rating of *ND* it noted data and modeling constraints, *identifying a significant data need for the 300-FF groundwater IA.*

The large dilution effect of the Columbia River results in a rating of *Not Discernible* for the free-flowing ecology for all evaluation periods.

Risks and Potential Impacts from Selected or Potential Cleanup Approaches

Use of MNA and monitoring for nitrate, tritium, TCE, and DCE in groundwater, and enhanced attenuation with monitoring for uranium and monitoring for gross alpha in groundwater suggests that the selected remediation approach will vary little from the current conditions until cleanup levels are reduced below WQSs (i.e., before the Active Cleanup period). Once below WQS, the overall rating for groundwater impacts to the Columbia River will be assessed *Not Discernible (ND)*.

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[2] Groundwater below the 300 Area Industrial Complex contains nitrate below the DWS due to 300 Area activities; however, nitrate measured above the DWS is from off-site sources and is not part of 300-FF-5 and the ROD (EPA et al., 2013). Thus any potential future impact to groundwater or the Columbia River is not related to this EU.

Environmental – Ecological Resources:

Current

There are areas where groundwater plumes intersect the riparian zone. Monitoring shows concentrations of uranium exceeding aquatic water criteria in groundwater near shoreline. Potential for contaminant uptake by terrestrial vegetation. Sensitive animals and bird species use region and may be at risk.

Risks and Potential Impacts from Selected or Potential Cleanup Approaches

Remediation activities in the shoreline will need to be monitored to evaluate resources and seasonal use of shoreline.

NEAR-TERM POST-CLEANUP

Rating is Low. Contamination remaining in areas for monitored natural attenuation may still result in uptake in biota, but is not likely to cause an effect to the biota. Continued long-term monitoring activities may disrupt riparian and terrestrial habitats. Re-vegetation in EU will result in additional level 3 resources, and potentially creation of level 4 resources potentially at risk because of disturbance, especially from invasive species.

Social – Cultural Resources

Current

The entire shoreline area is extremely culturally sensitive based on prehistoric, ethno-historic, and historic land use in the area. Upland areas where characterization and monitoring activities take place may be culturally sensitive regions as well. Traditional cultural places are known to be located in the vicinity as well as National Register eligible archaeological sites associated with all 3 landscapes.

Risks and Potential Impacts from Selected or Potential Cleanup Approaches

The entire shoreline area is extremely culturally sensitive based on prehistoric, ethno-historic, and historic land use in the area. Upland areas where characterization and monitoring activities take place may be culturally sensitive regions as well. Traditional cultural places are known to be located in the vicinity as well as National Register eligible archaeological sites associated with all 3 landscapes.

Considerations for timing of the cleanup actions

A record of decision for the 300-FF-5 groundwater OU was signed in November 2013 (EPA et al., 2013). The selected remediation alternative, Alternative 3a, provides for enhanced attenuation of uranium, and monitored natural attenuation, groundwater modeling, and institutional controls.

Near-Term, Post-Cleanup Risks and Potential Impacts

Assuming no long-term monitoring of groundwater wells, then no further impact to known cultural resources. Residual contamination in groundwater will likely be of concern for the Native American landscape. Permanent direct and indirect effects are possible due to the high sensitivity of the area.

PART II. ADMINISTRATIVE INFORMATION

OU and/or TSDF Designation(s)

300-FF-5

Common name(s) for EU

RC-GW-1 in 300-FF

Key Words

300 Area, RC-GW-1, 300-FF-5, Soils, Sediments, River Corridor

Regulatory Status

Regulatory basis: The U.S. Department of Energy (DOE) completed a Remedial Investigation/Feasibility Study to satisfy requirements under the Comprehensive Environmental Response, and Liability Act of 1980 (CERCLA) (DOE-RL 2010-49, 2011, Draft A, p. iv). Cleanup of the Hanford Site is also subject to the Resource Conservation and Recovery Act of 1976 (RCRA) (DOE-RL 2010-49, 2011, Draft A, p. iv). The Washington State Hazardous Waste Management Act of 1976 and the corresponding regulations in WAC 173-303, "Dangerous Waste Regulations," implement the State of Washington's federally authorized program under RCRA (DOE-RL 2010-49, 2011, Draft A, p. iv).

Applicable regulatory documentation: RI/FS (DOE/RL-2010-99, DOE/RL-2010-99-ADD1) and proposed plan (DOE/RL-2011-47) for the 300-FF-5 OU were issued in July 2013. The Record of Decision (ROD) (EPA et al., 2013) was signed on 25 November 2013.

Applicable Consent Decree or TPA milestones:

There two TPA milestones for the 300-FF-5 Groundwater OU:

M-016-85 by 09/30/2021

Lead Agency: EPA

Milestone: Complete remedial actions for the 300-296 waste site in accordance with RD/RA Work Plan for 300-FF-2 Soils (DOE/RL-2014-13-ADD1) and disposition for the 324 Building and Ancillary Buildings in accordance with the Removal Action Work Plan (DOE/RL-2004-77). Completion of facility disposition is defined as the completion of deactivation, decontamination, decommissioning, and demolition in accordance with the removal action work plan.

M-016-86 by 09/30/2021

Lead Agency: EPA

Complete remedial actions for 618-11 Burial Ground in accordance with RD/RA Work Plan for 300-FF-2 Soils (DOE/RL-2014-13-ADD1).

Risk Review Evaluation Information

Completed: Revised 20 February 2017

Evaluated by: E. LeBoeuf, K. G. Brown, H. Turner

Ratings/Impacts Reviewed by: D. Kosson, M. Gochfeld, J. Salisbury, A. Bunn

PART III. SUMMARY DESCRIPTION

CURRENT LAND USE

DOE Hanford industrial site area

DESIGNATED FUTURE LAND USE

Industrial (300 Area Final ROD)

PRIMARY EU SOURCE COMPONENTS

Legacy Source Sites

Not Applicable

High-Level Waste Tanks and Ancillary Equipment

Not Applicable.

Groundwater Plumes

Three geographic regions comprise 300-FF: the 300 Area Industrial Complex, and the 618-11 Burial Ground. The contaminants of concern include uranium, TCE, and DCE in the 300 Area Industrial Complex, and tritium and nitrate in the 618-11 Burial Ground. From the Hanford Site Groundwater Monitoring Report for 2015 (DOE/RL-2016-09, Rev. 0):

- Uranium (total) concentrations remain above the cleanup level (30 µg/L) in groundwater in the 300 Area Industrial Complex, with varying concentrations depending on changes in water table elevation as influenced by stages of the Columbia River. Large volumes of liquid waste containing uranium were discharged to the former South Process Pond (316-1) (1943 to 1975), North Process Pond (316-2) (1948 to 1975), and 300-Area Process Trenches (316-5) (1975 to 1987). Contaminated soil was removed from the 300 Area Process Trenches in 1991; additional excavation of contaminated soil occurred at this site and at other major liquid waste disposal sites in the 300-Area Industrial Complex from 1997 through 2000. A second area of uranium contamination appears downgradient from the 618-7 Burial Ground, and is apparently resulting from infiltration of dust control water and soil fixatives used during remediation activities. The contamination is migrating toward the Columbia River where it is merging with the uranium plume in the 300 Area Industrial Complex.
    - Maximum concentrations: 165 µg/L (399-3-10) versus a Cleanup Level of 30 µg/L.
    - Areal extent of the plume: 0.34 km^2.
    - Shoreline impact: 1480 m.
- The SAP for implementation of the 2013 remedy (DOE/RL-2014-42) identified nine wells in the 300 Area Industrial Complex for long-term monitoring of TCE. Calculations completed in 2015 (using data through 2014) demonstrated that eight of the nine wells had reached the cleanup level (4 µg/L) for TCE (ECF-300FF5-15-0017). These eight wells were removed from the long-term TCE monitoring network (DOE/RL-2014-42). The concentration of TCE in well 399-4-14, which had not reached the cleanup level, was 1.36 µg/L (flagged as "J," indicating an estimated concentration) in 2015. Calculations in 2016 (using data through 2015) will re-evaluate whether this well has reached the TCE cleanup level. TCE was used in degreasing operations associated with the fuels fabrication process and was discharged to the South Process Pond (316-1) and North Process Pond (316-2).
    - Maximum concentrations: 1.36 µg/L (399-4-14) versus a Cleanup Level of 4 µg/L.

    - Areal extent of the plume: Undefined[3].
    - Shoreline impact: Undefined[3].
- *cis*-1,2-dichloroethene, which is a degradation product of TCE and tetrachloroethene (PCE), also continues to exceed the cleanup level in 2015.
    - Maximum concentrations: 211 µg/L (399-1-16B) versus a Cleanup Level of 16 µg/L.
    - Areal extent of the plume: Undefined[3].
    - Shoreline impact: Undefined[3].
- A high concentration tritium plume originates from irradiated material associated with the 618-11 Burial Ground (i.e., tritium gas released from buried radiological solid wastes in a series of caissons located along the north side of the burial ground). Concentrations at a well adjacent to the burial ground have decreased from a peak value of 8,140,000 pCi/L in January 2000 to a level concentration of ~900,000 from 2007 to 2015, and the plume has maintained its basic shape since its discovery in 1999.
    - Maximum concentrations: 877,000 pCi/L (699-13-3A) versus a Cleanup Level of $2x10^4$ pCi/L.
    - Areal extent of the plume: 0.12 km^2. [4]
    - Shoreline impact: None[4]
- Nitrate concentrations near the 618-11 Burial Ground continue to exceed the cleanup level of 45 mg/L. Concentrations of nitrate above 45 mg/L are also are present in groundwater beneath part of the 300 Area Industrial Complex, from agricultural and industrial activities not associated with the Hanford Site.
    - Maximum concentrations: 57.5 µg/L[5] (399-12-2C) versus a Cleanup Level of 45,000 µg/L.
    - Areal extent of the plume: 0.18 km^2. [4]
    - Shoreline impact: None[4]

Operating Facilities

Not Applicable

LOCATION AND LAYOUT MAPS

A series of maps are used to illustrate the location of the components within the RC-GW-1 EU relative to the Hanford Site. Figure D.2-1 shows the relationship among the various Evaluation Units studied in the Interim Report and the Hanford Site. Figure D.2-2 illustrates the extent of groundwater contamination in the River Corridor. Figure D.2-3 shows a detailed view of the groundwater plumes in and near the 300-FF Interest Area (IA) and RC-GW-1 EU.

[3] Organics are locally present in deeper sediments, and the plume extent cannot be determined from current data (DOE/RL-2016-09, Rev. 0). This lack of plume definition for TCE and *cis*-1,2-dichloroethene represents a data gap for the analysis of potential groundwater impacts related to 300-FF.
[4] Excludes plume associated with 200-PO Operable Unit and off-site sources of nitrate (DOE/RL-2016-09, Rev. 0).
[5] Based on wells sampled as part of the long-term monitoring network for nitrate (DOE/RL-2016-09, Rev. 0).

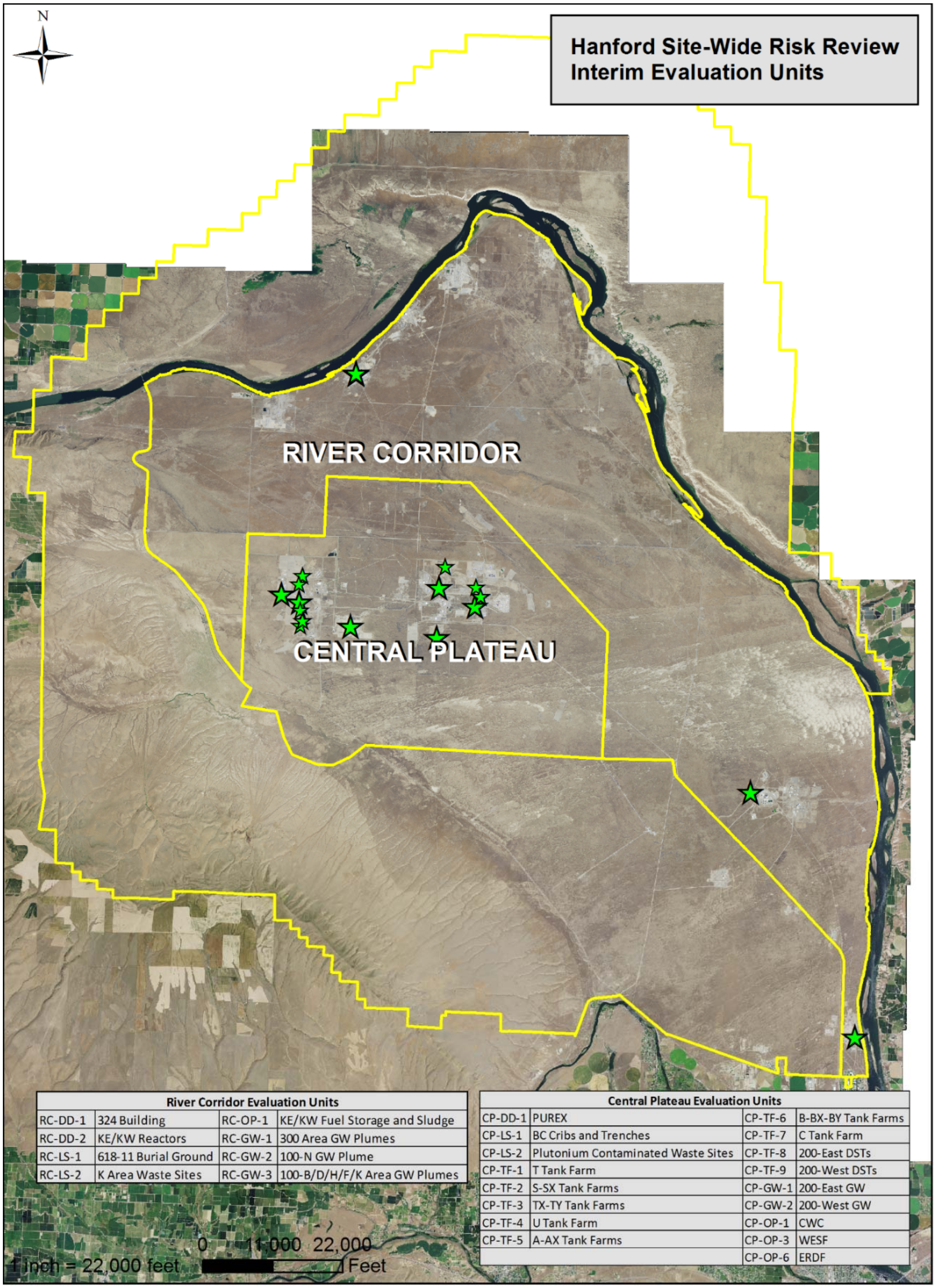

Figure D.2-1. Location of the Evaluation Units in Relation to the Hanford Site.

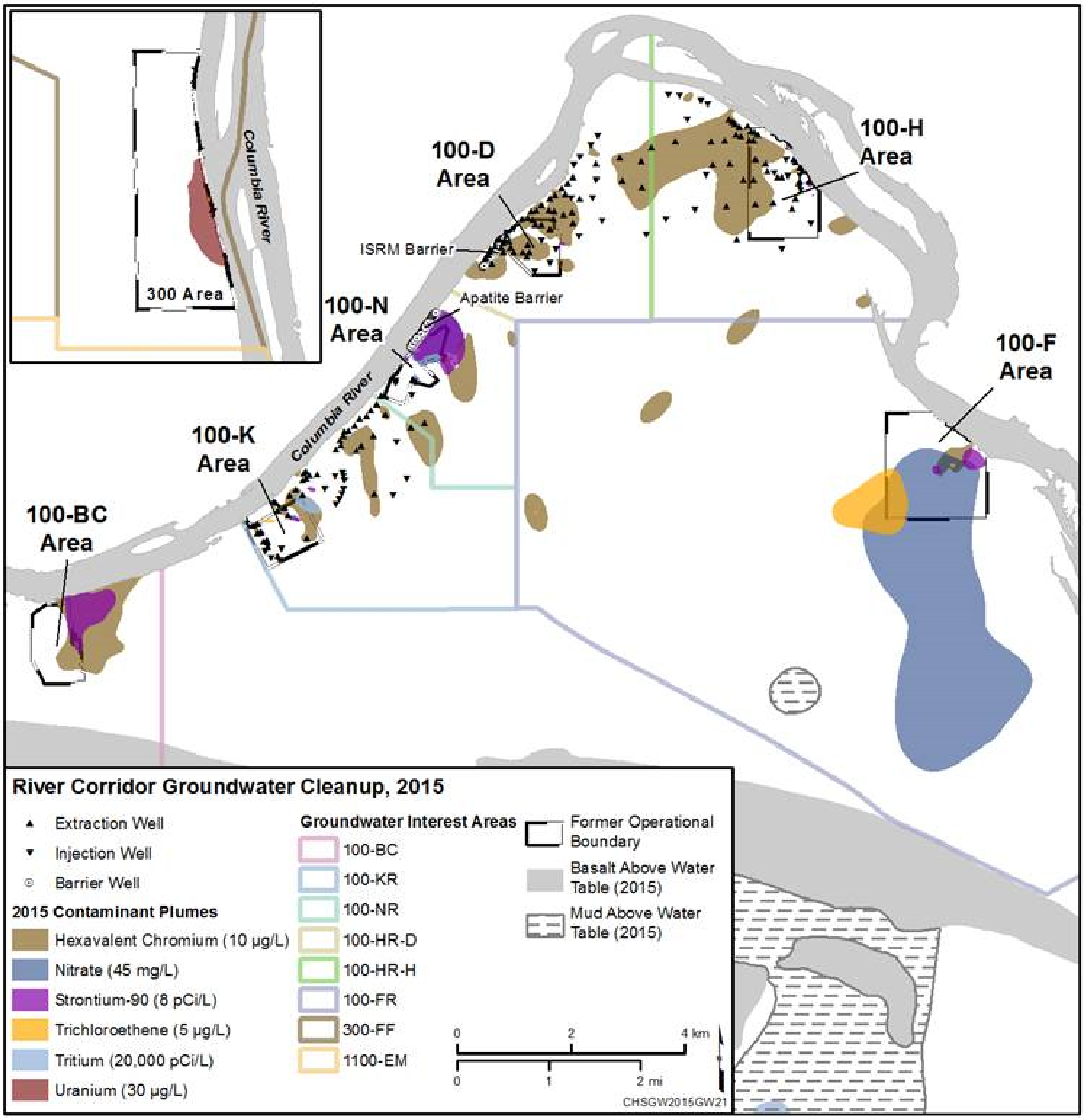

Figure D.2-2. Groundwater Contamination in the River Corridor in 2015 (DOE/RL-2016-09, Rev. 0)

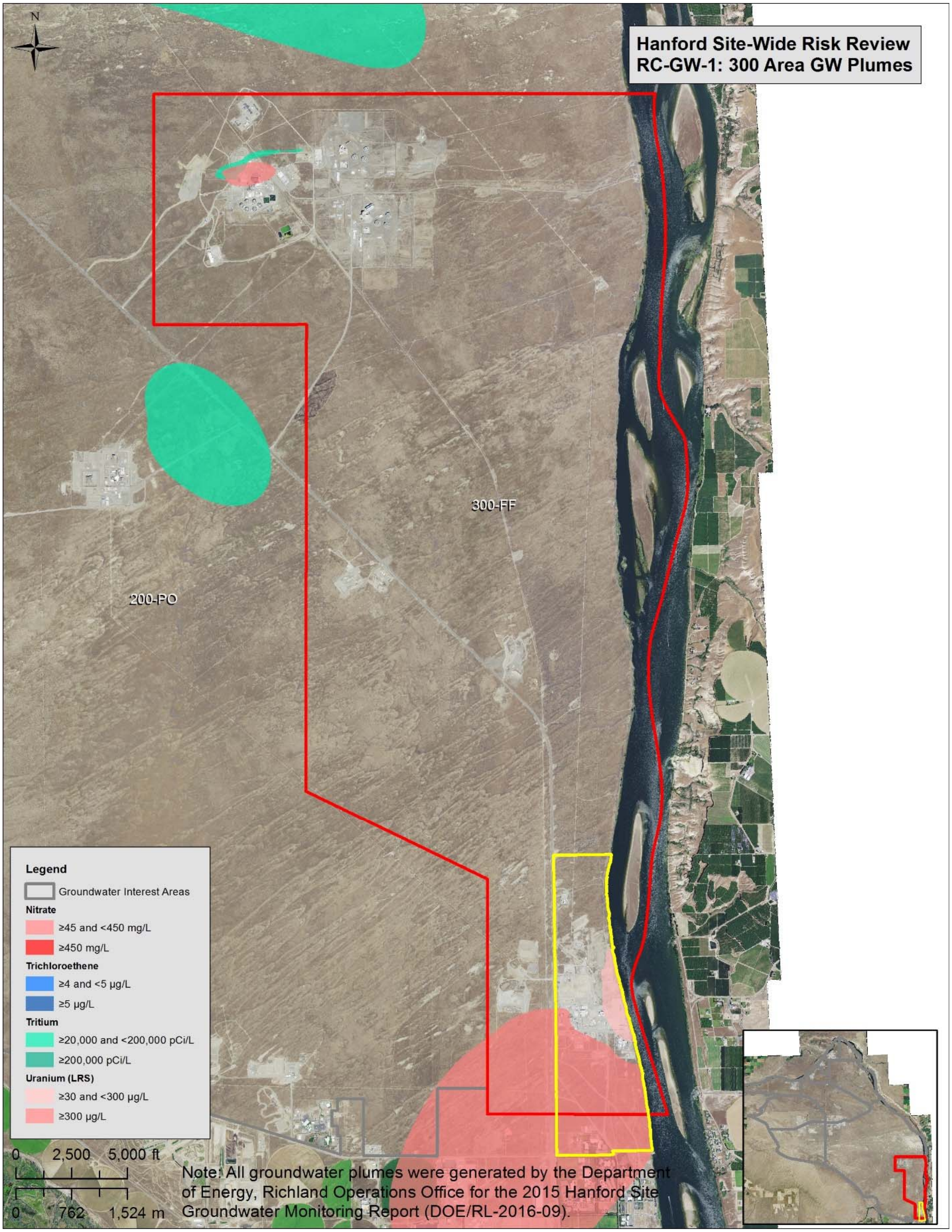

Figure D.2-3. Groundwater Plumes near the 300-FF Operable Unit in 2015

PART IV. UNIT DESCRIPTION AND HISTORY

EU Former/Current Use(s)

The groundwater contamination in 300-FF largely originated from the past routine disposal of liquid effluent from the fabrication of nuclear fuel assemblies and research involving the processing of irradiated fuel (DOE/RL-2016-09, Rev. 0). Primary liquid waste disposal facilities have been out of service for decades, and most have been remediated by removing contaminated soil leaving residual contamination in the underlying vadose zone and aquifer.

Groundwater in 300-FF is monitored under CERCLA, AEA, and RCRA.

Legacy Source Sites

Not Applicable

High-Level Waste Tanks

Not Applicable

Groundwater Plumes

Please see groundwater plume description in Part III above.

D&D of Inactive Facilities

Not Applicable

Operating Facilities

Not Applicable

Ecological Resources Setting

The potential for terrestrial ecological receptors to interact directly with any of the groundwater plumes is expected to be limited to those areas where the depth to groundwater is very shallow (<15 ft from the soil surface). On the Hanford Site, this condition is unlikely except where groundwater approaches the surface near the Columbia River. Where groundwater plumes intercept and enter the river, there may be mixing of river and groundwater at shallower depths (river bank storage), and plant roots and burrowing animals in the riparian zone could potentially access portions of the groundwater plume.

For purposes of this assessment, areas were delineated where the mapped riparian zone along the river shoreline intersects the estimated contours for the groundwater plumes. Riparian areas along the river shoreline are considered priority habitats that are classified as level 4 biological resources. The delineated area and acreage for the intersection of the riparian zone for separate contaminant plumes within each groundwater evaluation unit are provided in

Table D.2-2 and indicate the extent of biological resources that could potentially be affected by the groundwater plumes. For the groundwater evaluation units, there are approximately 70.64 acres of riparian habitat along the river shoreline that where contaminated groundwater could affect the ecological resources.

Table D.2-2. Areal Extent (Acres) of Riparian Zone Intersected by 2015 Groundwater Plumes Within Each Groundwater Interest Area.

Evaluation Unit Groundwater Interest Area COPC	Reference Value	RC-GW-3 100-BC	RC-GW-3 100-KR	RC-GW-2 100-NR	RC-GW-3 100-HR-D	RC-GW-3 100-HR-H	CP-GW-1 200-PO	RC-GW-1 300-FF	Total Area
Carbon-14	2,000 pCi/L[a]	-	-	-	-	-		-	-
Cyanide	200 µg/L[a]	-	-	-	-	-	-	-	-
Chromium	10 µg/L[b]	8.62	1.57	-	2.80	30.30	-	-	43.29
Carbon Tetrachloride	5 µg/L[a]	-	-	-	-	-	-	-	-
Iodine-129	1 pCi/L[a]	-	-	-	-	-	-	-	-
Nitrate	45 mg/L[a]	-	-	0.20	-	-	-	0.79	1.00
Strontium-90	8 pCi/L[a]	2.34	-	1.46	-	-	-	-	3.80
Technetium-99	900 pCi/L[a]	-	-	-	-	-	-	-	-
Trichloroethylene	5 µg/L[c]	-	-	-	-	-	-	-	-
TPH-D	500 µg/L[c]	-	-	0.10	-	-	-	-	0.10
Tritium	20,000 pCi/L[a]	-	-	0.14	-	-	18.28	-	18.42
Uranium	30 µg/L[a]	-	-	-	-	-	-	6.38	6.38
Total Extent of Plumes[d]	-	8.82	1.57	1.70	2.80	30.30	18.28	7.17	70.64
Total Riparian Area[e]	-	491.51	78.06	11.39	329.74	463.00	357.48	212.30	2664.66

a. EPA Drinking Water Standard

b. Criteria for chronic exposure in fresh water, WAC 173-201A-240. "Water Quality Standards for Surface Waters of the State of Washington," "Toxic Substances," Table 240(3)

c. Washington State Department of Ecology, "Method A Cleanup Levels for Groundwater," from "Model Toxics Control Act Cleanup Regulation Chapter 173-340 WAC", Table 720-1

d. The Total Extent of Plumes for a given Interest Area is not equal the sum of individual COPC plume areas because some plumes overlap; i.e., the total represents the combined 2-dimensional extent of individual COPC plumes.

e. The Total Riparian Area is the based on the areal extent of mapped riparian vegetation along the Benton County shoreline of the Hanford Site. The total riparian area listed (2664.66 ac) includes riparian area within 100-FR (721.2 ac), which is part of the Hanford Reach but is not listed in other parts of the table because there is no plume intersection with the riparian zone.

Cultural Resources Setting

The potential for cultural resources in the area of the groundwater plumes is high and likely to affect the Native American, Historic Pre-Hanford, and Manhattan Project/Cold War landscapes. As discussed in RC-LS-2, K Area Waste Sites EU, there are documented cultural resources along the shoreline for all the landscapes. A literature review of the setting for the groundwater EUs has not been completed.

Current remedial actions for groundwater plumes have included evaluation of Section 106 of the National Historic Preservation Act. Future activities will also include Section 106 evaluations.

Consultation with Hanford Tribes (Confederated Bands of the Yakama Nation, Wanapum, Confederated Tribes of the Umatilla Indian Reservation, and the Nez Perce) and other groups who may have an interest in the areas (e.g. East Benton Historical Society, Prosser Cemetery Association, Franklin County Historical Society, the Reach, and the B-Reactor Museum Association) will be completed. Consultation with Hanford Tribes will be necessary to provide input on indirect effects to both recorded and potential unrecorded TCPs in the area and other cultural resource issues of concern.

PART V. WASTE AND CONTAMINATION INVENTORY

The method described in Chapter 6 of the Methodology Report (CRESP 2015) was used to approximate saturated zone inventories for the 300-FF primary contaminants.

CONTAMINATION WITHIN PRIMARY EU SOURCE COMPONENTS

Legacy Source Sites

Not Applicable

High Level Waste Tanks and Ancillary Equipment

Not Applicable

Vadose Zone Contamination

Please see 618-11 and other related EUs for specific details on the vadose zone contamination

Groundwater Plumes

The estimated inventory for the saturated zone contamination is provided in Table D.2-3 where the process is outlined in Chapter 6 of the Methodology Report (CRESP 2015). For the groundwater plumes described in the 300-FF IA (DOE/RL-2016-09, Rev. 0), inventories are estimated as follows:[6]

- Uranium – The maximum measured concentration in 2015 was 165 µg/L, the upper 95% confidence limit (UCL) on the log-transformed groundwater and aquifer tube (AT) data from HEIS (http://ehs.hanford.gov/eda/) was 142 µg/L. The areal extent of the plume is 0.34 km^2. The plume pore volume is estimated to be 0.918E+06 m^3.
- Tritium – The maximum measured concentration in 2015 was 8.77E+05 pCi/L, the upper 95% confidence limit (UCL) on the log-transformed groundwater and aquifer tube (AT) data from HEIS (http://ehs.hanford.gov/eda/) was 2.62E+05 pCi/L. The plume inventory (pore water) is estimated to be 142 kg.

[6] As indicated in Table D.2-3, plume depths are not known for the 300-FF primary contaminants. As indicated in the Methodology Report (CRESP 2015), in this case, the minimum of the value from the Hanford 200-UP-1 OU Interim ROD (EPA 2012) or the unconfined aquifer thickness is used. The unconfined aquifer thickness used (~25 m) is the combination of Hanford Unit (~5 m) (DOE/RL-2016-09, Rev. 0) and Ringold Unit E (~20 m) (Last 2006, pp. 4.5-4.6). However, TCE and DCE do not have plume areas and thus no volumes of threats are computed for these contaminants; these omissions represent data gaps in the analysis of threats to groundwater. Furthermore, use of the depths from the Hanford 200-UP-1 OU Interim ROD (EPA 2012) likely results in very large uncertainties in the pore volume and related estimates.

- Nitrate – The maximum measured concentration in 2015 was 57.5 mg/L. Due to issues with identifying appropriate well data in HEIS (http://ehs.hanford.gov/eda/), a 95th % GW UCL was not calculated for NO3. This does not impact the review because, for NO3 (Group C), it is not needed for the evaluation.
- TCE and DCE – No plume inventories were estimated since no plume areal extent was provided due to fate and transport modeling limitations.

As illustrated in Table D.2-3, the maximum of the saturated zone (SZ) GTM values for the Group A and B primary contaminants (where uranium is evaluated and TCE could not be due to data limitations) are 4.36 Mm^3 for the RC-GW-1 EU translating to *Low* rating. The plume areas for the Group C contaminants (tritium and nitrate) translate to *Medium* ratings.

It is unlikely that additional PCs might contaminant the groundwater in the 300-FF IA in the future. Remediation activities including MNA, monitoring, enhanced attenuation, and ICs should not increase contaminant migration into groundwater. Scenarios where this is possible, albeit unlikely, include increased infiltration of water into the subsurface due to a broken water pipe or other significant water addition event such as could occur for dust suppression. Neither of which is associated with any planned remediation activities or ICs.

Columbia River

Contaminant plumes of uranium, tritium, nitrate and TCE are in contact or close proximity of the Columbia River, and thus have already or are expected to migrate to the Columbia River within 10 years or less. As such, Chapter 6 evaluation methodologies of the Methodology Report (CRESP 2015) based on *current impacts* to benthic and riparian ecology will be used as a function of the ratio (*Ratio*) of the maximum groundwater concentration to the biota concentration guide (BCG) or ambient water quality criterion (AWQC). For radionuclides, the BCG consistent with DOE Technical Standard DOE-STD-1153-2002[7] is used. For chemical PCs, the AWQC from the Columbia River Component Risk Assessment (CRCRA) (DOE/RL-2010-117, Rev. 0) Volume I: Screening Level Ecological Risk Assessment are used (where the Tier II Screening Risk Values are used when the AWQC is unavailable, which is also consistent with the CRCRA). The only exception is (total) uranium where the AWQC (5 µg/L) from the CRCRA is less than the background uranium concentration (~0.5-12.8 µg/L) (PNNL-17034, p. 6.9). As described in Chapter 6 of the Methodology Report (CRESP 2015) and noted above, a value (12.9 µg/L) was selected for total uranium to identify those areas contaminated by the Hanford Site.[8]

As illustrated in Table D.2-4, the overall evaluation of groundwater as a pathway to the Columbia River is assessed as *High* for uranium (total), *Low* for nitrate, and *Not Discernible* for tritium and TCE.

Results of the Threat Evaluation to the Benthic Ecology

The rating threat evaluation to the benthic ecology is summarized in Table D.2-4. Here, the rating *Ratio* (R1) for uranium (total) is 12.8, and a shoreline impact of 1480 m, garnering a threat evaluation rating of *High*. Though the process of evaluating TCE lead to a rating of *ND* it noted data and modeling constraints, *identifying a significant data need for the 300-FF groundwater IA.*

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[7] The values used are taken from RESRAD BIOTA (https://web.evs.anl.gov/resrad/home2/biota.cfm), which is consistent with DOE Technical Standard DOE-STD-1153-2002 and the Columbia River Component Risk Assessment (DOE/RL-2010-117, Rev. 0) Volume I: Screening Level Ecological Risk Assessment.

[8] Note that there is a large uncertainty relative to the No Effects level for total uranium. As stated in the CRCRA, "Effect levels span nearly three orders of magnitude (3 µg/L to 900 µg/L), reflecting considerable uncertainty in selection of a no-effect concentration. The value selected is a probable no effect concentration and is the 5th percentile of the toxicity data set" (DOE/RL-2010-117 Rev. 0, p. 6.2).

Results of the Threat Evaluation to the Riparian Zone Ecology

The rating threat evaluation to the riparian ecology is also summarized in Table D.2-4. Here, the rating *Ratio* (R1) for uranium (total) is again 12.8, and a riparian impact area of 2.58 hectares, garnering a rating of *High*. Riparian ratings were not able to be determined for TCE due to data and modeling constraints, *identifying a significant data need for the 300-FF groundwater OU.* The rating *Ratio* for nitrate is greater and one and for tritium is less than one, garnering ratings of Low and *Not Discernible*, respectively.

Threats to the Columbia River Free-flowing Ecology

The threat determination process for the free-flowing River ecology was evaluated in a manner similar to that described above for benthic receptors (Chapter 6, Methodology Report (CRESP 2015)). However, because of the large dilution effect of the Columbia River on the contamination from the seeps and groundwater upwellings[9], the differences from EU to EU were not found distinguishing and the potential for groundwater contaminant discharges from Hanford to achieve concentrations above relevant thresholds is very remote.

Facilities for D&D

Not Applicable

Operating Facilities

Not Applicable

[9] "Groundwater is a potential pathway for contaminants to enter the Columbia River. Groundwater flows into the river from springs located above the water line and through areas of upwelling in the river bed. Hydrologists estimate that groundwater currently flows from the Hanford unconfined aquifer to the Columbia River at a rate of ~ 0.000012 cubic meters per second (Section 4.1 of PNNL-13674). For comparison, the average flow of the Columbia River is ~3,400 cubic meters per second (DOE/RL-2016-09, Rev. 0)." This represents a dilution effect of more than eight orders of magnitude (a dilution factor of greater than 100 million).

Table D.2-3. Summary of the Evaluation of Current Threats to Groundwater as a Protected Resource from Saturated Zone (SZ) Contamination associated with RC-GW-1 (300-FF).

IA	PC	Grp	WQS[a]	Area (km²)[b]	Thick-ness (m)[c]	Pore Vol. (Mm³)	Max GW Conc	95th % GW UCL	Porosity[d]	K_d (mL/g)[d]	ρ (kg/L)[d]	R	SZ Total M^{SZ} (kg or Ci)	SZ GTM (Mm³)	SZ Rating[e]
300-FF	U	B	30 µg/L	0.34	15	0.918	165 µg/L	63.1 µg/L	0.18	0.8	1.84	9.18	5.79E+01	1.93E+00	Low
	H-3	C	20000 pCi/L	0.12	25	0.54	877000 pCi/L	262000 pCi/L	0.18	0	1.84	1	1.42E+02	---	Medium
	NO3	C	45 mg/L	0.18[f]	24	0.778	57.5	---[g]	0.18	0	1.84	1	---	---	Medium
	TCE	B	4 µg/L	Undefined	25	---	370 µg/L[h]	---[g]	0.18	0	1.84	1	---	---	---
	DCE	---	16 µg/L	Undefined	25	---	211 µg/L	208 µg/L	0.18	0	1.84	1	---	---	---

a. The Water Quality Standard (WQS) is typically the drinking water standard (DWS). The exception is trichloroethene (TCE) where the risk-based cleanup value (4 µg/L) is used instead of the DWS of 5 µg/L (although the DWS is used to estimate the GTM for TCE).

b. Plume area (DOE/RL-2016-09, Rev. 0). Organics (TCE and DCE) are locally present in deeper sediments, and the plume extent cannot be determined from current data (DOE/RL-2016-09, Rev. 0). This lack of plume definition for TCE and *cis*-1,2-dichloroethene (DCE) represents a data gap for the analysis of potential groundwater impacts related to 300-FF.

c. As described in Chapter 6 of the Methodology Report (CRESP 2015), for those areas outside of the 200-UP IA, the minimum of the value from the Hanford 200-UP-1 OU Interim ROD (EPA 2012) or the unconfined aquifer thickness is used. The unconfined aquifer thickness used (~25 m) is the combination of Hanford Unit (~5 m) (DOE/RL-2016-09, Rev. 0) and Ringold Unit E (~20 m) (Last 2006, pp. 4.5-4.6). However, the TCE and DCE do not have plume areas and thus no volumes of threats are computed for these contaminants; these omissions represent data gaps in the analysis of threats to groundwater.

d. Parameters obtained from the analysis provided in Attachment 6-1 to Methodology Report (CRESP 2015).

e. Groundwater Threat Metric (GTM) rating based on Table 6-3, Methodology Report (CRESP 2015).

f. The nitrate plume area is for the plume in the north section of 300-FF near 618-11 only. It excludes nitrate in the plume associated with 200-PO and nitrate from offsite (DOE/RL-2016-09) that is in the south section of 300-FF. Including this additional plume area would not change the rating of *Medium*.

g. Due to issues with identifying appropriate well data in HEIS (http://ehs.hanford.gov/eda/), a 95th % GW UCL was not calculated for NO3 or TCE. This does not impact the review because, for NO3 (Group C), it is not needed for the evaluation and, for TCE (Group B), no plume area defined means it is already not possible to evaluate further.

h. The maximum groundwater concentration provided by the 2015 Hanford Site Groundwater Monitoring Report (DOE/RL-2016-09) is a “laboratory estimated value.”

Table D.2-4. Summary of the Evaluation of Groundwater as Pathway to the Columbia River associated with RC-GW-1 (300-FF).

IA	PC	Grp	WQS[a]	BCG or AWQC[b]	Max GW Conc	95th % GW UCL	$R1, \frac{\text{Max GW Conc}}{\text{BCG or AWQC}}$	$R2, \frac{\text{95th \% GW UCL}}{\text{BCG or AWQC}}$	Shoreline Impact (m)[c]	Riparian Area (ha)[d]	Benthic rating[e]	Riparian rating[e]	Overall rating[e]
300-FF	U	B	30 µg/L	12.9 µg/L	165 µg/L	63.1 µg/L	1.28E+01	4.89E+00	1.48E+03	2.58E+00	High	High	High
	H-3	C	20000 pCi/L	2.65E+08 pCi/L	877000 pCi/L	262000 pCi/L	3.31E-03	9.89E-04	None	---	---	---	ND
	NO3	C	45 mg/L	7.1 mg/L	57.5	---[(g)]	1.83E+00	---	None	3.20E-01	---	---	Low
	TCE	B	4 µg/L	47 µg/L	370 µg/L[(h)]	---[(g)]	7.87E+00	---	Undefined	---	---	---	ND
	DCE	---	16 µg/L	590 µg/L	211 µg/L	208 µg/L	3.58E-01	3.53E-01	Undefined	---	---	---	---

a. The Water Quality Standard (WQS) is typically the drinking water standard (DWS). The exception is trichloroethene (TCE) where the risk-based cleanup value (4 µg/L) is used instead of the DWS of 5 µg/L.

b. Biota Concentration Guide (BCG) from RESRAD-BIOTA v1.8 (consistent with DOE Technical Standard DOE-STD-1153-2002) for radionuclides. For chemicals, either the Ambient Water Quality Criterion (AWQC) (Table 6-1 in DOE/RL-2010-117, Rev. 0) or Tier II Screening Concentration Value (SVC) (http://rais.ornl.gov/documents/tm96r2.pdf) is used when AQWC not available. The exception is (total) uranium where a value (12.9 µg/L) was selected for total uranium to identify those areas contaminated by the Hanford Site.

c. Shoreline impact from 2015 Hanford Site Groundwater Monitoring Report (DOE/RL-2016-09, Rev. 0). Excludes tritium and nitrate in plumes associated with the 200-PO groundwater interest area (Appendix G.1). The shoreline rating for TCE and DCE are undefined because these organics are locally present in deeper sediments.

d. The intersection area between the groundwater plume and the riparian zone was provided by PNNL based on the 2015 Hanford Site Groundwater Monitoring Report (DOE/RL-2016-09, Rev. 0).

e. Benthic and riparian zone ratings based on Figure 6-11 in the Methodology Report (CRESP 2015). The free-flowing ratings are all ND. The overall rating is the maximum rating.

PART VI. POTENTIAL RISK/IMPACT PATHWAYS AND EVENTS

CURRENT CONCEPTUAL MODEL (ADAPTED AFTER EPA ET AL., 2013)

The ground surface in the 300 Area Industrial Complex is flat except for a steep slope on the eastern edge down to the Columbia River which is the only surface water feature in the area. For the rest of the 300 Area, surface elevations change from approximately 137 m (449 ft) above mean sea level at the inland 618-11 Burial Ground to approximately 115 m (377 ft) at the 300 Area Industrial Complex.

The vadose zone is comprised of backfill materials and unconsolidated gravels and sand of the Hanford formation. In the 300 Area Industrial Complex, the average thickness of the vadose zone in the area of the waste sites is 10 m (33 ft); the thickness of the vadose zone at the 618-10 Burial Ground, the 618-11 Burial Ground and the 400 Area is 21 m (68 ft), 19 m (63 ft) and 31 m (125 ft), respectively.

As the river water height goes up and down on a seasonal cycle, so too does the groundwater level throughout the 300 Area Industrial Complex that abuts the river. Rising groundwater saturates what usually is the deep layer of the vadose zone. In some years, the river water height is much higher and remains high for much longer than in most years, and resulting elevated groundwater saturates deep vadose zone layers that may not have been wet for years. This fluctuating groundwater elevation creates the PRZ (Figure D.2-4).

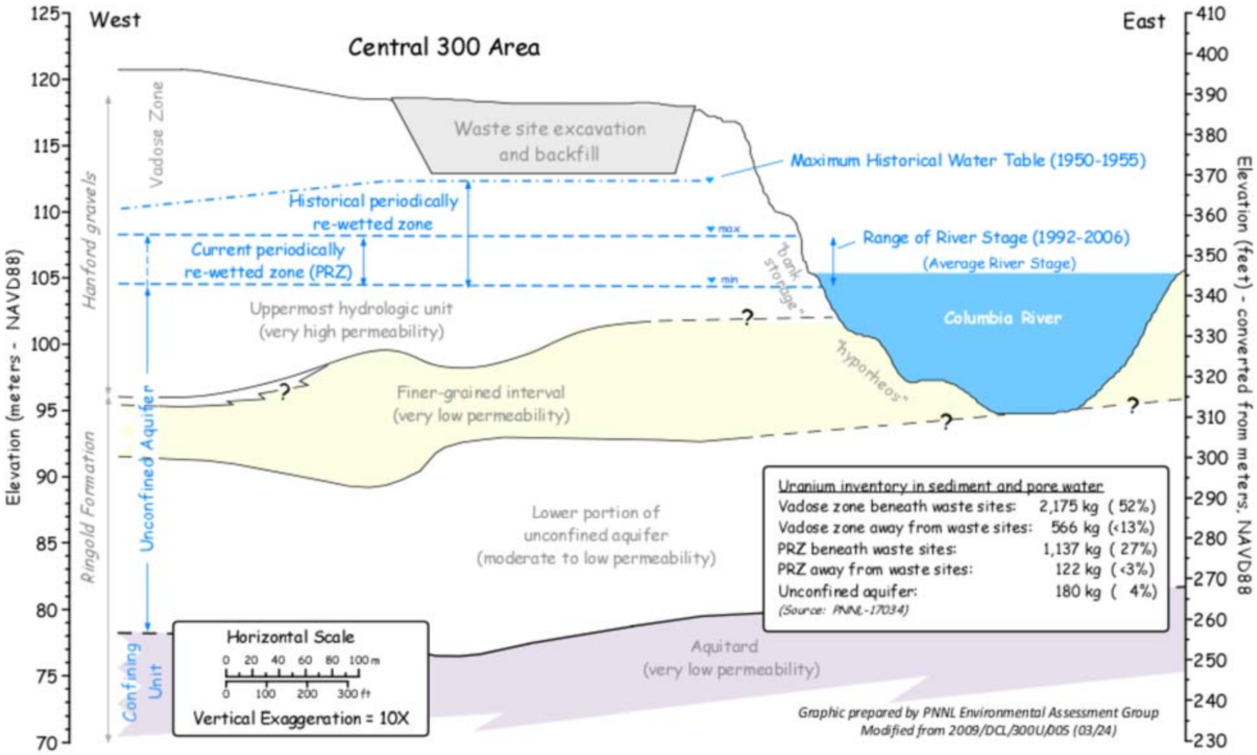

Figure D.2-4. Principal Subsurface Features with PRZ and Uranium Inventory Estimates (after EPA et al., 2013).

The unconfined aquifer occurs in the highly permeable gravel-dominated Hanford formation and in the underlying, less permeable sands and gravels of the Ringold Formation (Figure D.2-5). The Ringold Formation lower mud unit is a confining layer, the aquitard at the base of the unconfined aquifer, and is characterized by very low permeability fine-grained sediment. This hydrologic unit prevents further downward movement of groundwater contamination to the deeper aquifers. The thickness of the unconfined aquifer along the Columbia River shoreline is about 25 m (80 ft). Groundwater in the unconfined aquifer discharges to the Columbia River via upwelling through the riverbed and riverbank springs and seeps. The flux from the Hanford Site aquifer is very low, compared to the flow of the river. Because the river stage regularly fluctuates up and down, flow beneath the shoreline is back and forth, with river water intruding into the unconfined aquifer and mixing with groundwater at times. When the river stage drops quickly to a low elevation, riverbank seeps appear.

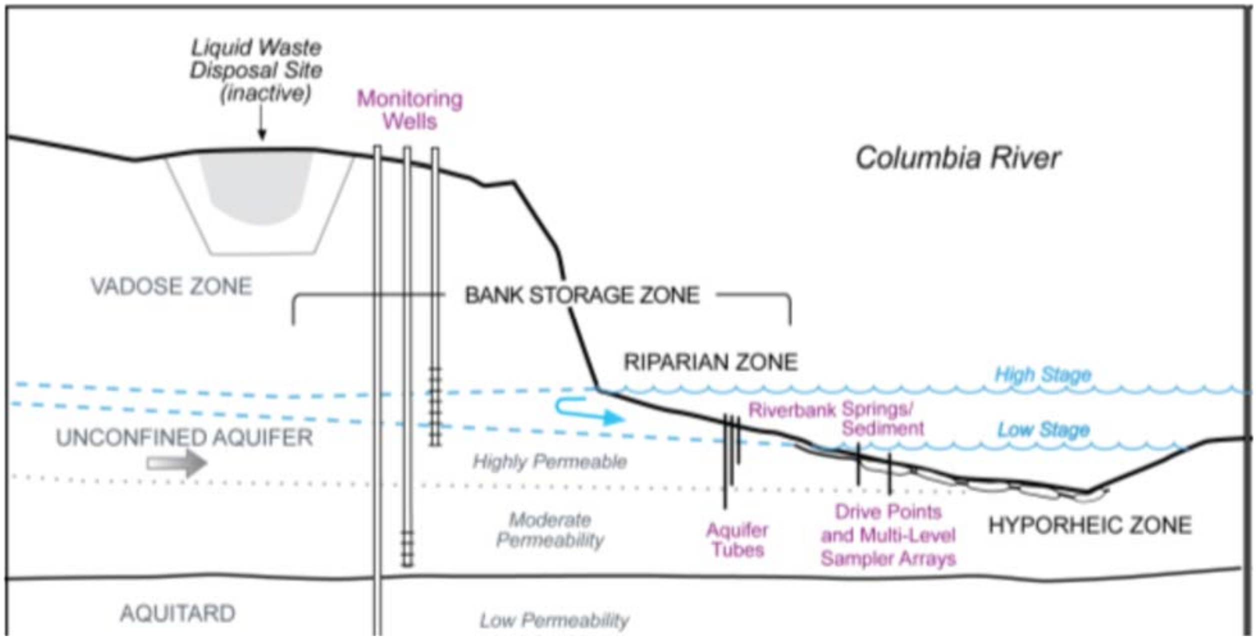

Figure D.2-5. Conceptual Site Model of River and Groundwater Mixing Zone (after EPA et al., 2013).

Groundwater flow velocities beneath the 300 Area in the Hanford formation portion of the aquifer are rapid, with rates up to 18 m/d (59 ft/d) having been observed. However, the hydraulic gradients change direction in response to river stage, which fluctuates on seasonal and multiyear cycles. Consequently, groundwater flow is not always directed toward the river.

In general, regional groundwater flow converges from the northwest, west and southwest, inducing an east-southeast flow direction in the 300 Area. During periods of extended high river stage (March through June), water flows from the river into the groundwater. The rise and fall of the river stage creates a dynamic zone of interaction between groundwater and river water (figure 4), affecting groundwater flow patterns, contaminant transport rates (e.g., uranium in groundwater), groundwater geochemistry, contaminant concentrations and attenuation rates.

Key hydrogeologic factors considered in the remedy selection for deep uranium are the interaction between the groundwater and the Columbia River, the relatively high permeability of the sands and gravels in the vadose zone and unconfined aquifer and the lateral extent of the PRZ. When groundwater rises into the PRZ, it mobilizes residual mobile uranium contamination. Some of the mobilized residual uranium moves vertically to groundwater, some moves laterally to the nearby PRZ and some is redeposited back near the original location. In addition to river water fluctuations, small amounts of precipitation periodically percolate down toward the groundwater, which can further move uranium contamination to the PRZ and groundwater. The result is the deep uranium contamination spreads vertically and laterally with each high water event. This periodic input of mobile uranium to the groundwater results in a persistent uranium plume and continued discharge of relatively low uranium concentrations to the river until the source of uranium is depleted. (EPA et al., 2013)

POPULATIONS AND RESOURCES CURRENTLY AT RISK OR POTENTIALLY IMPACTED

Facility Worker

Only workers at risk or impacted would be working on the active remediation activities, to include monitoring and sampling.

Co-Located Person (CP)

Workers are not directly exposed to contaminated groundwater because it is located below grade beneath a clean soil cover.

Public

The contamination remains underground, except where contaminated groundwater intersects the Columbia River.

Groundwater

Evaluation of the threats to groundwater as a protected resource from saturated zone contamination utilized the groundwater evaluation framework procedure outlined in Chapter 6 of the Methodology Report (CRESP 2015). The results of this analysis are described below and summarized in Table D.2-3.

Current

For uranium, tritium, nitrate, TCE, and DCE, the measured maximum groundwater concentrations currently exceed the water quality standard (WQS) in each instance. Further, contaminants are grouped based on their relative mobility and persistence, with Group A possessing both high mobility and high persistence (e.g., I-129), followed by Group B (e.g., TCE, Uranium (total)), Group C (e.g., tritium, nitrate), and Group D (e.g., Cs-137). From Table 6-1 in the Methodology Report (CRESP 2015), uranium and TCE are categorized as Group B primary contaminants (PCs), while tritium and nitrate are categorized as Group C PCs. For Group A and Group B PCs, the groundwater threat metric (GTM) is used to evaluate the groundwater threat and represents the maximum volume of water that could be contaminated by the inventory of a primary contaminant from a source if it was found in the saturated zone at the WQS and in equilibrium with the soil/sediment. Note that the GTM accounts only for (i) source inventory; (ii) partitioning with the surrounding subsurface; and (iii) the WQS. The GTM reflects a snapshot in time (assuming no loss by decay/degradation or dispersion, etc.) and does not account for differences in contaminant mobility or bulk groundwater flow. For Group C PCs, the threat is evaluated in terms of contaminant plume area.

Based on a GTM (units of 1E6 m^3 or Mm^3) of 4.36 Mm^3 for uranium, the threat rating was evaluated as *Low*. Unfortunately, no GTM rating was able to be determined for TCE or DCE due to the inability to adequately define the plumes by current data (DOE/RL-2016-09, Rev. 0), although these organics were determined to be locally present in deeper sediments. For tritium and nitrate, the contaminant plume areas were 0.12 km^2 and 0.18 km^2, respectively, reflecting a *Medium* groundwater threat.

Risks and Potential Impacts from Selected or Potential Cleanup Approaches

Contaminant fate and transport modeling was performed to simulate and predict the movement of uranium, tritium, TCE, and DCE (EPA et al., 2013). The model predictions for uranium indicate a long-term declining trend in the dissolved uranium concentrations in groundwater for uranium transported from vadose zone sediments, with seasonal increases and decreases in concentrations as the water table rises and falls with river stage fluctuations. With no remedial actions, the dissolved uranium concentration is predicted to take approximately 28 years (starting in 2012) to drop below the WQS of

30 µg/L. A fate and transport model was also constructed for the tritium in the groundwater that exceeds the federal WQS beneath the 618-11 Burial Ground. This analysis determined that the tritium concentrations would decline to below the WQS by 2031 under all remediation alternatives, assuming no additional tritium input to groundwater. Monitored natural attenuation (MNA) will be used for nitrate and tritium contaminant plumes located down gradient from the 618-11 Burial Ground, and TCE and DCE at the 300 Area Industrial Complex.

Columbia River

As described in Part V (Table D.2-4), plumes associated with the RC-GW-1 EU currently intersect the Columbia River, which translate to *Not Discernible* to *High* ratings.

The rating threat evaluation to the benthic ecology for uranium (total) is *High* due to the high maximum groundwater concentration to BCG ratio and impacted shoreline.

The rating threat evaluation to the riparian ecology for uranium (total) is *High* due to the high Ratio and the moderate riparian impact area of 2.58 hectares. The rating *Ratio* for TCE is 2.98E-02, garnering a rating of *ND*.

Though the process of evaluating TCE lead to a rating of *ND* it noted data and modeling constraints, *identifying a significant data need for the 300-FF groundwater IA.*

The rating threat evaluation for nitrate if *Low* due to a Ratio of 1.83, which is greater than 1.

The large dilution effect of the Columbia River results in a rating of *Not Discernible* for the free-flowing ecology for all evaluation periods.

Ecological Resources

For the four groundwater evaluation units with plumes that are estimated to intersect the Columbia River, there are approximately 70.64 acres of riparian habitat and resources along the river shoreline that could potentially be affected.

Remediation actions taken to reduce the contaminated groundwater plumes may have indirect effects on terrestrial ecological resources. Subsurface remediation actions such as pump and treat activities or development of subsurface chemical barriers to contaminant transport may indirectly affect ecological resources through several mechanisms:

- Injection and pumping wells might alter the hydrology in the vadose zone, and change soil water availability for plants.
- Injection of barrier constituents might alter soil chemistry and nutrient availability depending on rate or distance of migration of those constituents and whether the constituents interact with soils within the rooting zone
- Well pad and road construction may disturb the surface, degrade available habitat, and impact ecological resources/receptors
- Pedestrian and vehicle traffic during construction, maintenance, monitoring, and decommission of subsurface barrier systems may degrade habitats, disturb wildlife and affect animal behavior, and introduce exotic plant species.

Use of plants to accomplish phytoremediation would incur both direct and indirect effects to ecological receptors within the area of the EU used for treatment. Direct effects include surface disturbance and habitat removal associated with preparation and planting of the phytoremediation species to be used. As with subsurface treatment activities, pedestrian and vehicle traffic during construction, maintenance, monitoring, and decommission may degrade habitats, disturb wildlife and affect animal behavior, and introduce exotic plant species.

Cultural Resources

The potential for cultural resources in the area of the groundwater plumes is high and likely to affect the Native American, Historic Pre-Hanford, and Manhattan Project/Cold War landscapes. A literature review of the setting for the groundwater EUs has not been completed. Current remedial actions for groundwater plumes have included evaluation of Section 106 of the National Historic Preservation Act. Future activities will also include Section 106 evaluations.

Cleanup Approaches and End-State Conceptual Model

The Record of Decision (ROD) (EPA et al., 2013) for the 300-FF-5 OU was signed on 25 November 2013. Remedial action objectives were defined including the following:

- Prevent human exposure to groundwater containing concentrations of contaminants of concern (COC) above cleanup levels.
- Prevent COCs migrating and/or leaching through soil that will result in groundwater concentrations above cleanup levels for protection of groundwater, and of surface water concentrations above cleanup levels for the protection of surface water at locations where groundwater discharges to surface water.
- Restore groundwater impacted by Hanford Site releases to cleanup levels which include drinking water standards (DWSs), within a timeframe that is reasonable given the particular circumstances of the site.

These remedial action objectives provide four remedy components:

- MNA for nitrate, tritium, TCE, DCE
- Groundwater monitoring for uranium, gross alpha, nitrate, tritium, TCE, DCE
- Enhanced attenuation of uranium using sequestration by phosphate application at the top of aquifer
- Institutional controls

The selected cleanup alternative for the 300-FF-5 groundwater OU is Alternative 3a: which uses a combination of monitored natural attenuation (MNA) for nitrate, tritium, TCE, and DCE in groundwater, and enhanced attenuation with monitoring for uranium and monitoring for gross alpha in groundwater. As uranium is an alpha-emitter, uranium attenuation will result in gross alpha attenuation. ICs are also used to control access to residual contaminants in soil and groundwater as long as they exceed the CULs. This alternative is anticipated to reduce the time to restore the uranium-contaminated groundwater in the 300 Area Industrial Complex to the CUL. The estimated time to achieve cleanup levels in groundwater for uranium is 22 to 28 years and tritium is 18 years.

A brief summary of the primary remediation activities as noted in the Record of Decision for 300-FF-2 and 300-FF-5, and Record of Decision Amendment for 300-FF-1 (EPA et al., 2013) follows below:

- Groundwater monitoring would be conducted for uranium from waste sites in 300-FF-1 and 300-FF-2 with uranium contamination above CULs deeper than 4.6 m (15 ft) bgs (former liquid waste sites 316-1, 316-2, 316-3 and 316-5 and former solid waste sites 618-2 and 618-

3) and 618-1 because of the large waste disposal inventory and the proximity of 618-1 to higher uranium groundwater concentrations.

- The enhanced attenuation of residual uranium in the deep vadose zone and periodically rewetted zone (PRZ) will occur in an approximately 1 hectare (3 acre) area that is the highest contributing area to the persistent uranium groundwater contamination. This treatment area is in the vicinity of former waste sites 316-5 and 316-2, where the highest uranium contamination consistently occurs in groundwater.
- This alternative will apply phosphate to the highest uranium concentration areas of the vadose zone and PRZ using a combination of surface infiltration, PRZ injection and groundwater injection techniques. Prior to phosphate application in the vadose zone and PRZ, phosphate will be injected into the upper portion of the groundwater below and to the east and south of the vadose zone and PRZ treatment area. This is done to sequester uranium potentially mobilized by the surface infiltration and PRZ injection. During implementation, tests will be conducted on post treatment vadose zone core samples to refine the groundwater model, and groundwater monitoring will be conducted to assess changes in uranium concentrations and the lateral spread of phosphate.
- The use of sequestration as an enhancement to immobilize the deep residual uranium that is providing the highest uranium concentrations to the groundwater is expected to accelerate the natural attenuation of uranium contamination in the vadose zone, PRZ and aquifer.
- Uranium sequestration in alternative 3a is estimated to take approximately four years to complete. This time period is based on one year to complete the RD/RAWP and three years to implement the enhanced attenuation. This alternative addresses the deep uranium contamination contributing to the persistent groundwater contamination.
- Contaminant fate and transport modeling was performed to simulate and predict the movement of uranium, tritium, TCE, and DCE. The model predictions for uranium indicate a long-term declining trend in the dissolved uranium concentrations in groundwater for uranium transported from vadose zone sediments, with seasonal increases and decreases in concentrations as the water table rises and falls with river stage fluctuations. With no remedial actions, the dissolved uranium concentration is predicted to take approximately 28 years (starting in 2012) to drop below the drinking water standard (DWS) of 30 µg/L. The estimates of the time for the uranium concentration to decline below the DWS for each remedial alternative were based on the longer time of either the 90th percentile, or the 95 percent upper confidence limit on the mean of the uranium concentration in the most contaminated monitoring well. These fate and transport simulations assume that the current hydrologic and chemical conditions remain unchanged. This two-dimensional model was developed specifically for this evaluation, incorporating data collected since the original modeling was performed that supported the 1996 ROD, and includes more physically-based treatment of uranium sorption and desorption processes based on information about uranium transport in this environment learned from research at DOE's Integrated Field Research Center test site located in the former South Process Pond (316-1).
- 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.

- Groundwater monitoring, including 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 contaminants of concern (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 verses 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 that there is significant uncertainty in the estimated time to achieve the uranium CUL in slected remediation Alternative 3a due to complex interactions of the contamination in the vadose zone, PRZ, and groundwater with the dynamic groundwater levels controlled by seasonal changes in the elevation of the river water. Further, the model predictions do not include uranium mobilized from the vadose zone and PRZ during remedial activities (either through sequestration or RTD), which can influence the time necessary to achieve the CUL. This remediation alternative minimizes these impacts by providing partial treatment of the groundwater to sequester uranium mobilized through the application of phosphate to the overlying vadose zone and PRZ. The estimated time to achieve the uranium CUL is also influenced by when the phosphate application can occur. Phosphate application will be performed when groundwater velocities are slow (i.e., rising and high river stage) and the groundwater conditions are favorable, so the limited window of opportunity for these favorable conditions may delay the schedule if the favorable conditions are missed. Although Alternative 3a is estimated to achieve the uranium CUL in 22 to 28 years, this timeframe is uncertain due to the factors described above. (EPA et al., 2013)

Contaminant Inventory Remaining at the Conclusion of Planned Active Cleanup Period

Current and anticipated water use in the 300 Area Industrial Complex derives from municipal water from the city of Richland. There are no current plans to start using 300-FF groundwater as drinking water when drinking water standards (DWSs) are met. The expected timeframes to attain the WQSs in 300-FF groundwater range from 22-28 years for uranium, and 18 years for tritium. An expected timeframe for nitrate concentrations to achieve the DWS has not been determined since the nitrate originates from off-site sources and is not part of 300-FF. Similarly, the timeframe for organics TCE and DCE degradation to DWSs could not be estimated due to insufficient data on the contaminant plumes. (EPA et al., 2013)

Risks and Potential Impacts Associated with Cleanup

Ecological Resources

Personnel, cars, trucks, heavy equipment and drill rigs, as well as heavy, wide hoses, on roads through non-target areas or remediation site carry seeds or propagules on tires, injure or kill vegetation or animals, make paths, cause greater compaction of soil, displace animals and disrupt behavior/reproductive success. Also seeds and propagules can be dispersed from soil from truck or blowing from heavy equipment. Often permanent or long-term compaction can result in the destruction of soil invertebrates. Compaction can decrease plant growth in those areas, decrease abundance and diversity of soil invertebrates, and prevent fossorial snakes or mammals from using the area. Compaction of soils may permanently destroy areas of the site with intense activity. Construction of new buildings can cause permanent destruction of plants and animals, and of the on-site ecosystem larger than the footprint of the building. Effects will radiate from the building, and post-remediation effects depend on the degree of use (e.g., personnel and truck traffic, type of truck traffic and heavy equipment activity). During remediation, radionuclides or other contaminants could be released or spilled on the surface, and depending upon the type and quantity, could have adverse effects on the plants and animals on site.

Cultural Resources

Personnel, truck, heavy equipment, and drill rigs may have direct impact on cultural resources in the riparian areas and in upland areas where there is soil/ground or alteration to the landscape. Assuming heavy equipment locations, new roads and staging areas have been cleared for cultural resources, then it is assumed adverse effects would have been resolved and/or mitigated. If heavy equipment and drilling locations and staging areas have not been cleared, this could result in artifact breakage and scattering, compaction and disturbance to the soil surface and immediate subsurface, thereby compromising stratigraphic integrity of an archaeological site. TCPs may be directly affected if personnel are on roads located on TCP and if personnel are unaware of cultural resource sensitivity, appropriate behaviors and protocols. For traffic on roads located on TCP, direct effects include visual, auditory and vibrational alterations to landscape/setting. Heavy equipment and drilling may cause direct effects to TCPs including destruction of culturally important plants, physical attributes of the TCP and introduction of noise and vibrations also altering the setting. These actions may interfere with traditional uses of TCP. The use of heavy, wide hoses could have direct effects to archaeological resources including artifact scattering or breakage as well as disturbance of surface sediments, if the areas have not been previously cleared. Construction of staging areas and other containment systems, and/or soil removal activities are assumed to have been cleared for cultural resources and any adverse effects would be resolved and/or mitigated. If staging areas and other containment system locations have not been reviewed for cultural resources this could result in compaction and disturbance to the soil surface and throughout the subsurface leading to permanent adverse effects to the surface and subsurface integrity of an archaeological site by destroying the stratigraphic relationships of the soil, archaeological artifacts and features as well as all proximal information associated with archaeological artifacts and features. Construction of staging areas and other containment systems, and/or soil removal activities can have direct effects to TCPs including destroying physical attributes of TCP, destruction of culturally important plants, alteration of the setting and introduction of noise and vibrations also altering the setting. These actions may interfere with traditional uses of TCP. In some instances, the waste site is considered an archaeological site and/or pockets of undisturbed soils and potentially intact archaeological material are present. In these instances, effects could include preservation of artifacts in-situ if any information had already been gleaned from archeological site testing prior to capping. Otherwise, containment systems could result in compaction and compression of artifacts by destroying the stratigraphic relationships of the soil, archaeological artifacts and features as well as all proximal information associated with archaeological artifacts and features. Direct effects to TCPs include permanent alteration of physical setting and design of TCP, permanent viewshed impacts and possibly permanent interference with traditional use of TCP. Revegetation activities may cause direct effects to TCPs including physical alteration to or restoration of TCP depending on how the area is recontoured and what plants are selected for revegetation. Contamination remaining in situ may have direct effects including permanent physical alteration of TCP, and lead to permanent intrusion in long-term use and access to TCP.

Indirect effects from personnel, truck, heavy equipment, and drill rigs may lead to the introduction of invasive plant species or removal of culturally important plants that alters the landscape/setting for roads located within the viewshed and noise-scape of TCP. New roads alter the viewshed or noise-scape. Presence of vehicles may result in visual, auditory and vibrational alterations to landscape/setting. Remediation actions may lead to visual alteration of landscape/setting. Introduction of noise alters landscape/setting. Introduction of equipment and buildings may interfere with traditional uses of TCP. During remediation activities, indirect effects could result in temporary auditory, visual and vibrational effects. Revegetation could lead to indirect effects from visual alterations to setting depending on how the area is recontoured and what plants are selected for revegetation. Remaining contamination could lead to indirect effects from permanent intrusion, which could limit the use and access to TCP.

Populations and Resources at Risk or Potentially Impacted During or as a Consequence of Cleanup Actions

Workers (directly involved)

Please see above.

Co-located Person (CP)

Please see above.

Public

Please see above.

Groundwater

Please see above. As described in Part V, concentrations related to 300-FF will fall below drinking water standards before the beginning of the Active Cleanup period resulting in *Not Discernible* ratings.

Columbia River

Please see above. As described in Part V, concentrations related to 300-FF will fall below drinking water standards before the beginning of the Active Cleanup period resulting in *Not Discernible* ratings.

Ecological Resources

Personnel, car, pick-up truck, truck traffic as well as heavy equipment, drill rigs, and new facilities in the non-target and remediated areas will likely lead to permanent effects in areas of heavy equipment use, drill rigs and construction areas. Effects on the ecological resources are likely to include exotic/alien species, differences in native species structure, and soil invertebrate changes in areas of high activity (compaction). During remediation, radionuclides or other contaminants released or spilled on the surface could have long-term effects if the contamination remained, and plants did not recolonize or thrive. Such disruptions could affect the associated animal and plant communities.

Cultural Resources

Personnel, truck, heavy equipment, and drill rigs may have direct impact on cultural resources in the riparian areas and in upland areas where there is soil/ground or alteration to the landscape. Assuming heavy equipment locations, new roads and staging areas have been cleared for cultural resources, then it is assumed adverse effects would have been resolved and/or mitigated. If heavy equipment and drilling locations and staging areas have not been cleared, this could result in artifact breakage and scattering, compaction and disturbance to the soil surface and immediate subsurface, thereby compromising stratigraphic integrity of an archaeological site. TCPs may be directly affected if personnel are on roads located on TCP and if personnel are unaware of cultural resource sensitivity, appropriate behaviors and protocols. For traffic on roads located on TCP, direct effects include visual, auditory and vibrational alterations to landscape/setting. Heavy equipment and drilling may cause direct effects to TCPs including destruction of culturally important plants, physical attributes of the TCP and introduction of noise and vibrations also altering the setting. These actions may interfere with traditional uses of TCP. The use of heavy, wide hoses could have direct effects to archaeological resources including artifact scattering or breakage as well as disturbance of surface sediments, if the areas have not been previously cleared. Construction of staging areas and other containment systems, and/or soil removal activities are assumed to have been cleared for cultural resources and any adverse effects would be resolved and/or mitigated. If staging areas and other containment system locations have not been reviewed for cultural resources this could result in compaction and disturbance to the soil surface and throughout the subsurface leading to permanent adverse effects to the surface and subsurface integrity of an archaeological site by destroying the stratigraphic relationships of the soil, archaeological artifacts and features as well as all proximal information associated with archaeological artifacts and features. Construction of staging areas and other containment systems, and/or soil removal activities can have direct effects to TCPs including destroying physical attributes of TCP, destruction of culturally important plants, alteration of the setting and introduction of noise and vibrations also altering the setting. These actions may interfere with traditional uses of TCP. In some instances, the waste site is considered an archaeological site and/or pockets of undisturbed soils and potentially intact archaeological material are present. In these instances, effects could include preservation of artifacts in-situ if any information had already been gleaned from archeological site testing prior to capping. Otherwise, containment systems could result in compaction and compression of artifacts by destroying the stratigraphic relationships of the soil, archaeological artifacts and features as well as all proximal information associated with archaeological artifacts and features. Direct effects to TCPs include permanent alteration of physical setting and design of TCP, permanent viewshed impacts and possibly permanent interference with traditional use of TCP. Revegetation activities may cause direct effects to TCPs including physical alteration to or restoration of TCP depending on how the area is recontoured and what plants are selected for revegetation. Contamination remaining in situ may have direct effects including permanent physical alteration of TCP, and lead to permanent intrusion in long-term use and access to TCP.

Indirect effects from personnel, truck, heavy equipment, and drill rigs may lead to the introduction of invasive plant species or removal of culturally important plants that alters the landscape/setting for roads located within the viewshed and noise-scape of TCP. New roads alter the viewshed or noise-scape. Presence of vehicles may result in visual, auditory and vibrational alterations to landscape/setting. Remediation actions may lead to visual alteration of landscape/setting. Introduction of noise alters landscape/setting. Introduction of equipment and buildings may interfere with traditional uses of TCP. During remediation activities, indirect effects could result in temporary auditory, visual and vibrational effects. Revegetation could lead to indirect effects from visual alterations to setting depending on how the area is recontoured and what plants are selected for revegetation. Remaining contamination could lead to indirect effects from permanent intrusion, which could limit the use and access to TCP.

ADDITIONAL RISKS AND POTENTIAL IMPACTS IF CLEANUP IS DELAYED

Please see above.

NEAR-TERM, POST-CLEANUP STATUS, RISKS AND POTENTIAL IMPACTS

Please see above.

POPULATIONS AND RESOURCES AT RISK OR POTENTIALLY IMPACTED AFTER CLEANUP ACTIONS (FROM RESIDUAL CONTAMINANT INVENTORY OR LONG-TERM ACTIVITIES)

Table D.2-5. Populations and Resources at Risk or Potential Impacted After Cleanup Actions.

Population or Resource		Risk/Impact Rating	Comments
Human	Facility Worker	Low	Only workers at risk or impacted would be working on the active remediation activities, to include monitoring and sampling.
	Co-located Person	Low	Workers are not directly exposed to the contaminated groundwaters because they are located below grade beneath a clean soil cover.
	Public	Not Discernible	The contamination remains underground, except where the contaminated groundwater intersects the Columbia River.
Environmental	Groundwater	Not Discernible	Based on a GTM (units of 1E6 m^3 or Mm^3) of 4.36 Mm^3 for uranium, the original threat rating was evaluated as *Low*. No GTM rating was able to be determined for TCE or DCE due to the inability to adequately define the plumes by current data (DOE/RL-2016-09, Rev. 0), although these organics were determined to be locally present in deeper sediments (i*ndicating a significant data need for the 300-FF groundwater IA*). For tritium and nitrate, the contaminant plume areas translated to *Medium* ratings. However, modeling (EPA et al., 2013) suggests that concentrations will fall below drinking water standards before the beginning of the Active Cleanup (and thus the near-term, post-Cleanup period) resulting in *Not Discernible* ratings.
	Columbia River	Not Discernible	The current benthic ecology rating for total uranium (Group B) is *High* due to the high maximum groundwater concentration to BCG ratio and impacted shoreline. Though the process of evaluating TCE lead to a rating of *ND*, it noted data and modeling constraints, *identifying a significant data need for the 300-FF groundwater IA.*

			The current rating to the riparian ecology for total uranium (Group B) is *High* due to the high Ratio and the moderate riparian impact area of 2.58 hectares. The rating *Ratio* for TCE is 2.98E-02, garnering a rating of *ND*. However, modeling (EPA et al., 2013) suggests that concentrations will fall below drinking water standards (and thus corresponding riparian and benthic thresholds) before the beginning of the Active Cleanup (and thus the near-term, post-Cleanup period) resulting in *Not Discernible* ratings. The large dilution effect of the Columbia River results in a rating of *Not Discernible* for the free-flowing ecology for all evaluation periods.
	Ecological Resources*	Low	Contamination remaining in areas for monitored natural attenuation may still result in uptake in biota, but is not likely to cause an effect to the biota. Continued long-term monitoring activities may disrupt riparian and terrestrial habitats. Re-vegetation in EU will result in additional level 3 resources, and potentially creation of level 4 resources potentially at risk because of disturbance, especially from invasive species.
Social	Cultural Resources*	**Native American:** Direct: Known Indirect: Known **Historic Pre-Hanford:** Direct: Known Indirect: Known **Manhattan/Cold War**: Direct: Unknown Indirect: Unknown	Permanent direct and indirect effects are possible due to high sensitivity of area.

*For both Ecological and Cultural Resources see Appendices J and K, respectively, for a complete description of Ecological Field Assessments and literature review for Cultural Resources. Ecological ratings are described in Table 4-11 of the Final Report.

LONG-TERM, POST-CLEANUP STATUS – INVENTORIES AND RISKS AND POTENTIAL IMPACT PATHWAYS

The National Contingency Plan (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, potential beneficial groundwater uses include drinking water, irrigation, and industrial uses. Drinking water use includes other domestic uses such as bathing and cooking. (EPA et al., 2013)

Current and anticipated water use in the 300 Area Industrial Complex is municipal water from the city of Richland. There are no plans to start using 300-FF groundwater as drinking water when standards are met. The expected timeframes to attain the DWSs in 300-FF groundwater are 22-28 years for uranium, and 18 years for tritium. Once these standards are met, risks and potential impacts to facility workers, CPs, public, groundwater, and surface water (Columbia River) would be assessed as *Not Discernible (ND)*, but with requisite 5 year reviews as noted in the Record of Decision (EPA et al., 2013). Nitrate above the DWS is from off-site sources and is not part of 300-FF so an expected timeframe to attain the DWS has not been determined. The timeframe for organics TCE and DCE degradation to DWSs could not be estimated due to fate and transport modeling limitations. *As such, additional characterization and trend data for organics should be collected*. Characterization data and trend data is limited due to the hydraulically tight formation that impedes sample collection. (EPA et al., 2013)

PART VII. SUPPLEMENTAL INFORMATION AND CONSIDERATIONS

The 300 FF area needs to remain under DOE control to maintain institutional control for all remediation activities until all soil and groundwater contaminants reach CULs, to include areas outside 300 FF which have the potential to also contaminant groundwater in this area.

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