APPENDIX D.5

Interest Areas 200-BP and 200-PO in 200-East (CP-GW-1, Central Plateau) Evaluation Unit Summary Template

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PART I. EXECUTIVE SUMMARY

EU LOCATION

200-East

RELATED EUS

RC-GW-1 (300-F Plumes), RC-GW-2 (100-N Plume), RC-GW-3 (100-B/C/D/H/F/K Plumes), and CP-GW-2 (200-West Plumes), CP-LS-1 (BC Cribs and Trenches), CP-LS-8 (B Plant Cribs and Trenches), CP-LS-9 (PUREX Cribs and Trenches (inside 200-East)), CP-LS-11 (B Pond), CP-TF-5 (WMA A-AX), CP-TF-6 (WMA B-BX-BY), and CP-TF-7 (WMA C).

PRIMARY CONTAMINANTS, CONTAMINATED MEDIA AND WASTES

The CP-GW-1 Evaluation Unit (EU) is related to two Hanford groundwater interest areas (IA): 200-BP (including the 200-BP-5 CERCLA [Groundwater] Operable Unit (OU)[1]) and 200-PO (including the 200-PO-1 CERCLA GW OU). The focus in this Appendix is on the 200-East groundwater IAs because available data has been arranged based on the IAs.

The primary contaminants (i.e., those with areas of concentration exceeding drinking water standards) for the 200-BP IA are nitrate, I-129, Tc-99, uranium, Sr-90, cyanide (CN), and tritium (H-3) (DOE/RL-2016-09, Rev. 0, p. 9-4). There are unconfined, semi-confined, and confined aquifers in the 200-BP interest area where the unconfined aquifer within the 200-East area is that primarily impacted by past waste disposal operations[2]; this aquifer is associated with the suprabasalt sediment of the Ringold Formation, Cold Creek unit, and Hanford formation (DOE/RL-2016-09, Rev. 0, p. 9-5).

The primary contaminants for the 200-PO IA are tritium (H-3), I-129, nitrate, Sr-90, Tc-99, and uranium (DOE/RL-2016-09, Rev. 0, p. 10-3)[3]. Groundwater primarily occurs in an unconfined aquifer consisting of Hanford and Ringold Formations; however, due to the large extent and overall thickness of the aquifer (up to 215 meters), it also includes semiconfined and confined intervals within deeper portions of the aquifer (DOE/RL-2016-09, Rev. 0, p. 10-1).

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[1] An operable unit (OU) is a "discrete portion of the Hanford Site, [including] a group of land disposal sites placed together [based on geographic proximity, similarity of waste characteristics and site type, and the possibility for economies of scale] for the purposes of doing a Remedial Investigation/Feasibility Study (RI/FS) and subsequent cleanup actions" (from http://www.hanford.gov/files.cfm/ap-App-A.pdf). Because the Hanford groundwater OUs do not cover the entire Site, the staff informally defined "groundwater interest areas" including the GW OUs and intervening regions for scheduling, data review, and interpretation for the entire site (DOE/RL-2008-66, Rev. 0).

[2] The greatest concentrations of nitrate, Tc-99, and uranium in 200-BP are within the northwest portion of the 200 East Area near the "B Complex" (B-BX-BY Tank Farms) described in Appendix E.7 for CP-TF-6.

[3] The remedial investigation for 200-PO-1 (DOE/RL-2009-85, Rev. 1) identified tritium, I-129, nitrate, Sr-90, Tc-99, PCE, TCE, and uranium as final contaminants of potential concern. However, PCE and TCE were only detected at very low concentrations (below drinking water standards) in far field region wells (DOE/RL-2009-85, Rev. 0, p. 10-8). Thus these are not considered primary contaminants for the 200-PO IA.

BRIEF NARRATIVE DESCRIPTION

The CP-GW-1 EU is related to two Hanford interest areas: 200-BP and 200-PO, which are inclusive of two corresponding CERCLA groundwater Operable Units (OUs), 200-BP-5 and 200-PO-1, respectively.

The 200-BP interest area, including the 200-BP-5 groundwater OU and six RCRA sites including Waste Management Area (WMA) B-BX-BY (CP-TF-6 in Appendix E.7) and WMA C (CP-TF-7 in Appendix E.8), concerns groundwater and associated contaminant plumes beneath the northern half of the 200 East Area and adjacent portions of the surrounding 600 Area (DOE/RL-2016-09, Rev. 0, p. 9-1). The primary separation facilities overlying the 200-BP IA were B Plant and Hot Semi-Works; however, liquid waste from the other separation facilities were stored or released at sites overlying the IA including cribs, ditches, ponds, injection wells, and leaks from underground storage tanks in WMA B-BX-BY and WMA C. The 200-BP-5 OU, which is included in the 200-BP IA, has neither an interim nor final Record of Decision (ROD) and is being monitored under requirements of the Atomic Energy Act of 1954 (AEA), Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), and Resource Conservation and Recovery Act of 1976 (RCRA). In the 200-BP Interest Area, the following actions are being conducted:

- Ongoing perched water treatability test (200-DV-1) at WMA B-BX-BY to remove uranium. By 2015, approximately 1,240,000 L of perched water containing approximately 592 Kg of nitrate, 0.037 Ci of Tc-99, and 69.9 kg of uranium was extracted (DOE/RL-2011-118, Rev. 0, page 3.4-29; DOE/RL-2013-22, Rev. 0, Page BP-1; DOE/RL-2014-32, Rev. 0, page BP-8; DOE/RL-2015-07, Rev 0, page 9-2; DOE/RL-2016-09, Rev. 0, p. 9-4). In 2015, the “control of the extraction system was then transferred to 200 West P&T operations.” (DOE/RL-2016-09, Rev. 0, p. 9-10)
- Waste Management Area (WMA) C Tank Waste Retrieval. Tank wastes are currently being retrieved from WMA C. Waste retrieval has been completed in ten of the 16 tanks, has been completed to various limits of technology in five tanks, and retrievals are in progress in the remaining tank (Templeton, AM 2016, p. 9).
- Retrieval is also ongoing to remove the contamination from the annulus of the double shell tank 241-AY-102 (Templeton, AM 2016 (p. 9).
- “The Draft A RI (Remedial Investigation] report (DOE/RL-2009-127) was submitted to Ecology in August 2015. The RI report describes the nature and extent of contamination and identifies the COPCs for the OU.” (DOE/RL-2016-09, Rev. 0, p. 9-7).

The 200-PO interest area includes the CERCLA 200-PO-1 GW OU, seven RCRA units including the Integrated Disposal Facility and WMA A-AX (CP-TF-5 in Appendix E.6) (DOE/RL-2016-09, Rev. 0, p. 10-1). Groundwater within the 200-PO IA was contaminated by releases from cribs, pipelines, ponds, A-AX single shell tanks, and trenches associated with Plutonium-Uranium Extraction (PUREX) and B Plant operations. A remedial investigation was completed for the 200-PO-1 OU in 2008 (DOE/RL-2009-85, Rev. 1) that recommended proceeding to a feasibility study to develop remedial alternatives. The 200-PO-1 OU is being monitored under requirements of the AEA, CERCLA, and RCRA to determine the impact to groundwater prior to determining the path forward for remedial action.

SUMMARY TABLES OF RISKS AND POTENTIAL IMPACTS TO RECEPTORS

Table D.5-1 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 200-PO and 200-BP interest areas; a Co-located Person (CP) is an individual located 100 meters from the physical boundaries of the 200-PO and 200-BP interest 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 *Very High*.

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[4]

No risk ratings are provided for Cultural Resources. Table D.5-1 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.

[4] 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.5-1. Risk Rating Summary (for Human Health, unmitigated nuclear safety basis indicated, mitigated basis indicated in parentheses (e.g., "Very High" (Low))

Population or Resource		Evaluation Time Period Active Cleanup (to 2064) **Current Condition:** Monitoring	 **From Cleanup Actions:** To be determined
Human Health	Facility Worker	***Low to Medium*** (Low)	***Proposed Alternatives (range of actions)*: *Low to Medium*** (Low)
	Co-located Person	***Low to Medium*** (Low)	***Proposed Alternatives (range of actions)*: *Low to Medium*** (Low)
	Public	***Not Discernible (ND) to Low*** (ND to Low)	***Proposed Alternatives (range of actions)*: *ND to Low*** (ND)
Environmental	Groundwater (Only existing plumes – Vadose zone threats evaluated in corresponding EUs)	200-BP IA: Medium to High (Sr-90) 200-PO IA: Low to Very High (I-129) Overall: Very High (I-129)	200-BP IA: Low to High (CN) 200-PO IA: Low to Very High (I-129) Overall: Very High (I-129)
	Columbia River	Benthic: Not Discernible Riparian: Not Discernible Free-flowing: Not Discernible **Overall**: Not Discernible	Benthic: Not Discernible Riparian: Not Discernible Free-flowing: Not Discernible **Overall**: Not Discernible
	Ecological Resources[(a)]	Low	Very High
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.

SUPPORT FOR RISK AND IMPACT RATINGS FOR EACH POPULATION OR RESOURCE

Human Health

Current

Facility workers are at risk when working in or around areas with contaminated soil. Exposure to such contaminants is limited because groundwater and contaminated soils are located below grade. However, during certain operations (e.g., drilling and sampling), there may be the potential for exposure to hazardous and radioactive contaminants; however, the potential exposure would be very small.

Unmitigated Consequences: Facility Worker – Low to Medium, CP – Low to Medium; Public – ND to Low

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 Consequences: Facility Worker – Low, CP – Low; Public – ND

Risks and Potential Impacts from Selected or Potential Cleanup Approaches

Cleanup alternatives have not been selected for the 200-East Groundwater OUs (200-BP-5 and 200-PO-1, in the 200-BP and 200-PO IAs, respectively); however, the range of alternatives includes pump-and-treat (P&T) and monitored natural attenuation (MNA), and Institutional controls (ICs) 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: P&T, MNA, and IC. Worker risks are thus rated as *Low*.

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

Mitigation: Refer to Current.

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

Environmental

Current

Groundwater: As illustrated in Table D.5-2 (Part V), the saturated zone (SZ) GTM values for the 200-BP Group A and B primary contaminants range from *Medium* for I-129, Tc-99, uranium, and cyanide to *High* for Sr-90. The tritium and nitrate plume areas (Group C) translate to *Low* and *Medium*, respectively. For 200-PO, the saturated zone (SZ) GTM values Group A and B primary contaminants range from *Low* for Sr-90, Tc-99, and uranium to *Very High* for I-129. The nitrate and tritium plume areas (Group C) translate to *Medium*. Thus the overall rating for the CP-GW-1 EU is *Very High* related to the I-129 in 200-PO.

Columbia River: For 200-BP, no plume currently intersects the Columbia River at concentrations exceeding the appropriate water quality standard (WQS) as described in Part V. Thus current impacts from the 200-BP IA to the Columbia River benthic and riparian ecology are rated as *Not Discernible*. For

200-PO, only the tritium plume currently intersects the Columbia River at concentrations exceeding the corresponding water quality standard (WQS). Using the analysis in Appendix E.6 for CP-TF-5 (WMA A-AX), a rating of *Not Discernible* is obtained for the current impact of H-3 on the Columbia River, which is true for the other contaminants with plumes from this IA. The large dilution effect of the Columbia River on the contamination from the seeps and groundwater upwellings results in *Not Discernible* ratings. Thus the overall rating for the Columbia River during the Current period is *Not Discernible*.

Ecological Resources: There are areas where groundwater plumes intersect the riparian vegetation. Monitoring does not show concentrations of plume contaminants 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

Groundwater: During the Active Cleanup period and during the Near-term, Post-Cleanup period (as described in Part V), only Sr-90 from the 200-BP IA and nitrate from the 200-PO IA have different (i.e., lower) ratings from those for Current conditions. These changes in ratings have to do with potential impacts from changes in recharge rate and radioactive decay.

Columbia River: The TC&WM EIS Alternatives analysis described in Part V indicates that nitrate (i.e., the only contaminant with a current plume in 200-E that also has a higher than *Not Discernible* rating) is not predicted to have concentrations exceeding the screening value in 10,000 years. Thus the rating will not be modified and all ratings are *Not Discernible*. The overall rating for the Columbia River during the Current period is *Not Discernible*.

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

Social – Cultural Resources

Current

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

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

Because remedial actions have not been defined for the 200-East Groundwater Operable Units in the 200-BP and 200-PO Interest Areas, the ratings (*High* for 200-BP and *Very High* for 200-PO) indicate the need for monitoring and treatment of groundwater in these areas. Without treatment existing contamination is likely to spread to contaminate additional groundwater resources.

Near-Term, Post-Cleanup Risks and Potential Impacts

Groundwater: During the Near-term, Post-Cleanup period, the three contaminants mentioned above have lower ratings. These changes in ratings have to do with potential impacts from changes in recharge rate and radioactive decay.

Columbia River: The TC&WM EIS Alternatives analysis indicates that all contaminants have *Not Discernible* ratings. Thus ratings will not be modified. Thus the overall rating for the Columbia River during the Current period is *Not Discernible*.

Ecological Resources: 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 Native American landscape. Permanent direct and indirect effects are possible due to high sensitivity of area.

PART II. ADMINISTRATIVE INFORMATION

OU AND/OR TSDF DESIGNATION(S)

200-BP-5 and 200-PO-1

COMMON NAME(S) FOR EU

200-BP and 200-PO Interest Areas

KEY WORDS

200 Area, CP-GW-1, 200-BP-5, 200-PO-1, Soils, Sediments, Central Plateau

REGULATORY STATUS

Regulatory basis: Neither the 200-BP-5 nor the 200-PO-1 Operable Units (OUs), which are included in the 200-BP and 200-PO Interest Areas, respectively, have either interim or final Records of Decision.

A draft decisional remedial investigation report (RIR) (DOE/RL-2009-127) was submitted for the 200-BP-5 OU describing the nature and extent of contamination and identifying contaminants of potential concern (COPCs) to support a future feasibility study (DOE/RL-2016-09, Rev. 0, p. 9-7). Other ongoing CERCLA activities related to the 200-BP IA included groundwater monitoring requirements of the Atomic Energy Act of 1954 (AEA), Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), and Resource Conservation and Recovery Act of 1976 (RCRA); expansion of the low-gradient monitoring network across the 200 East Area; completion of perched water planning documents and continued removal of contaminated perched water near WMA B-BX-BY (Appendix E.7); and locating three additional deep aquifer wells.

A remedial investigation was completed for the 200-PO-1 OU in 2008 (DOE/RL-2009-85, Rev. 1) that recommended proceeding to a feasibility study (i.e., the next step in the CERCLA process) to develop remedial alternatives. A remedial investigation addendum was completed (DOE/RL-2009-85-ADD1) to update the risk assessment for the 200-PO-1 OU based on additional groundwater data collected since 2008. The 200-PO-1 OU is being monitored under requirements of the AEA, CERCLA, and RCRA to determine the impact to groundwater prior to determining the path forward for remedial action.

Applicable regulatory documentation

200-BP: A draft decisional remedial investigation report (RIR) (DOE/RL-2009-127) indicated as completed and submitted to Ecology in DOE/RL-2016-09, Rev. 0. Sampling and Analysis Plan (DOE/RL-2001-49, Rev. 1) issued in 2005.

200-PO: Remedial Investigation (DOE/RL-2009-85, Rev. 1) issued in July 2008. Sampling and Analysis Plan (DOE/RL-2003-04, Rev. 1) issued in 2006 and amended by TPA-CN-205, and DOE/RL-2007-31 Rev. 0, as amended by TPA-CN-2-253.

Applicable Consent Decree or TPA milestones

M-015-21A by 06/30/2015 (deadline extended to 06/30/2018)

Lead Agency: Ecology

Milestone: Submit a 200-BP-5 and 200-PO-1 OU Feasibility Study Report and Proposed Plan(s) to Ecology.

RISK REVIEW EVALUATION INFORMATION

Completed: Revised 20 February 2017

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

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

PART III. SUMMARY DESCRIPTION

CURRENT LAND USE

DOE Hanford Site for industrial use. All current land-use activities in the 200-East Area are *industrial* in nature (EPA 2012).

DESIGNATED FUTURE LAND USE

Industrial-Exclusive. All four land-use scenarios listed in the Comprehensive Land Use Plan (CLUP) indicate that the 200-East Area is denoted *Industrial-Exclusive* (DOE/EIS-0222-F). An industrial-exclusive area is "suitable and desirable for treatment, storage, and disposal of hazardous, dangerous, radioactive, and nonradioactive wastes" (DOE/EIS-0222-F).

PRIMARY EU SOURCE COMPONENTS

Legacy Source Sites

Not Applicable

High-Level Waste Tanks and Ancillary Equipment

Not Applicable

Groundwater Plumes

There are current plumes exceeding water quality standards (WQS)[5] in the 200-PO and 200-BP IAs in the 200-East Area.

[5] In some interest areas, thresholds are the drinking water standards (DWS) and for others they are denoted cleanup levels, which are typically DWS or risk-based standards for cleanup. These thresholds are collectively denoted water quality standards (WQS) for the purpose of this Review.

In the 200-BP interest area, nitrate, I-129, Tc-99, and uranium form the most extensive groundwater plumes and primarily result from local sources, except for I-129 which migrated from 200-PO. Other contaminants, namely cyanide, Sr-90, tritium (H-3), Cs-137, and Pu-239/240 form smaller plumes in the 200-BP interest area. To summarize (DOE/RL-2016-09, Rev. 0):

- Nitrate continues to represent the most extensive plume in 200-BP with sources including BY Cribs, 216-B-7A&B Cribs, 216-B-8 Crib, 241-BX-102 unplanned release, releases with B tank farm (part of WMA B-BX-BY), 216-B-12 Crib, 216-B-5 Injection Well, 216-B-2-2 Ditch, WMA C, Gable Mountain Pond, and Gable Gap. The nitrate plume size has been generally increasing in size since 2008 (Figure D.5-1).
    - Maximum concentration: 168,000 µg/L (299-E33-47) versus a DWS of 45,000 µg/L
    - Areal extent of the plume: 8.2 km^2
    - Shoreline impact: 0 m
    - Riparian zone intersected: 0 ha
- Iodine-129 also represents a significant plume in 200-BP with sources in the southeastern part of 200 East Area (216-A-10 Crib vicinity, 216-A-29 Ditch, and B Pond) and potentially others including BY Cribs, 241-BX-102 unplanned release, and the 216-B-8 Crib. The plume size was reasonably stable until 2012 when it began decreased in areal extent and then began slowly increasing again (Figure D.5-1).
    - Maximum concentration: 6.1 pCi/L (299-E27-13) versus a DWS of 1 pCi/L
    - Areal extent of the plume: 5.5 km^2
    - Shoreline impact: 0 m
    - Riparian zone intersected: 0 ha
- Technetium-99 is a somewhat large plume with sources at BY Cribs, 216-B-7A&B Cribs, 216-B-8 Crib, 241-BX-102 unplanned release, releases with B tank farm (WMA B-BX-BY), WMA C, and the 216-B-5 injection well. Three general plumes are present: one area north of 200-East, one near WMA B-BX-BY (Appendix E.7 for CP-TF-6), and one near WMA-C (Appendix E.8 for CP-TF-7). The largest of the three plumes is near WMA B-BX-BY with sources including the BY Cribs, 216-B-7A&B Cribs, 216-B-8 Crib, 241-BX-102 unplanned release, and releases associated with the B tank farm. The Tc-99 plume has remained fairly stable over the past decade (Figure D.5-1).
    - Maximum concentration: 35,600 pCi/L (299-E33-345) versus a DWS of 900 pCi/L
    - Areal extent of the plume: 2.1 km^2
    - Shoreline impact: 0 m
    - Riparian zone intersected: 0 ha
- Uranium contamination in 200-BP primarily came from large-scale disposals (> 10,000 kg) to the 216-B-12 Crib and the 241-BX-102 unplanned release, which is at least an order of magnitude larger than other waste sites within 200-BP. The plume area has decreased in size from 2011 to 2014, then increased in 2015, but is still higher than that in 2010 (Figure D.5-1).
    - Maximum concentration: 5,600 µg/L (299-E33-345) versus a DWS of 30 µg/L
    - Areal extent of the plume: 0.6 km^2
    - Shoreline impact: 0 m
    - Riparian zone intersected: 0 ha
- Strontium-90, which is found at two locations, the former Gable Mountain Pond and the 216-B-5 Injection Well, tends to bind to vadose zone sediments so it has reached groundwater at those locations where the vadose zone is relatively thin (i.e., Gable Mountain Pond where the vadose zone thickness is less than 12 meters) or where waste was injected into the aquifer (i.e., 216-B-5 Injection Well). The Sr-90 plume area has increased in 2011 and has been relatively stable since then (Figure D.5-1).

- Maximum concentration: 1,100 pCi/L (299-E28-25) versus a DWS of 8 pCi/L
- Areal extent of the plume: 0.6 km^2
- Shoreline impact: 0 m
- Riparian zone intersected: 0 ha

- Cyanide (CN) in the groundwater originated from disposal of tributyl phosphate wastes scavenged for Cs-137 where tank supernatant was discharged to the BY Cribs (after scavenging was complete). Cyanide, nitrate, and Tc-99 concentrations began to increase in the groundwater beneath the BY Cribs in the late 1990s. Low concentrations of cyanide were also detected near WMA C (CP-TF-7 in Appendix E.8) are attributed to historical releases of ferrocyanide-containing waste at that facility. In addition to the plume area to the northeast of the B/BX/BY tank farms, a plume also exists in the Gable Gap area. Both are associated with the BY cribs and, thus, with EU CP-TF-6 (B-BX-BY Tank Farms). The cyanide plume area has significantly increased over the past decade (Figure D.5-1).
  - Maximum concentration: 1,680 µg/L (299-E33-47) versus a DWS of 200 µg/L
  - Areal extent of the plume: 0.7 km^2
  - Shoreline impact: 0 m
  - Riparian zone intersected: 0 ha
- The tritium plume in the upper part of the unconfined aquifer within 200-BP has decreased since 2003 (Figure D.5-1) from radioactive decay, dispersion, and possibly diminishing levels of drainage from the vadose zone at certain locations. In 2015, tritium results exceeding DWS were detected in several regions of 200-BP. New wells have been planned in this area to depict the extent of the tritium at depth in this area.
  - Maximum concentrations: 91,600 pCi/L (299-E28-32) versus a DWS of 20,000 pCi/L
  - Areal extent of the plume: 0.1 km^2
  - Shoreline impact: 0 m
  - Riparian zone intersected: 0 ha

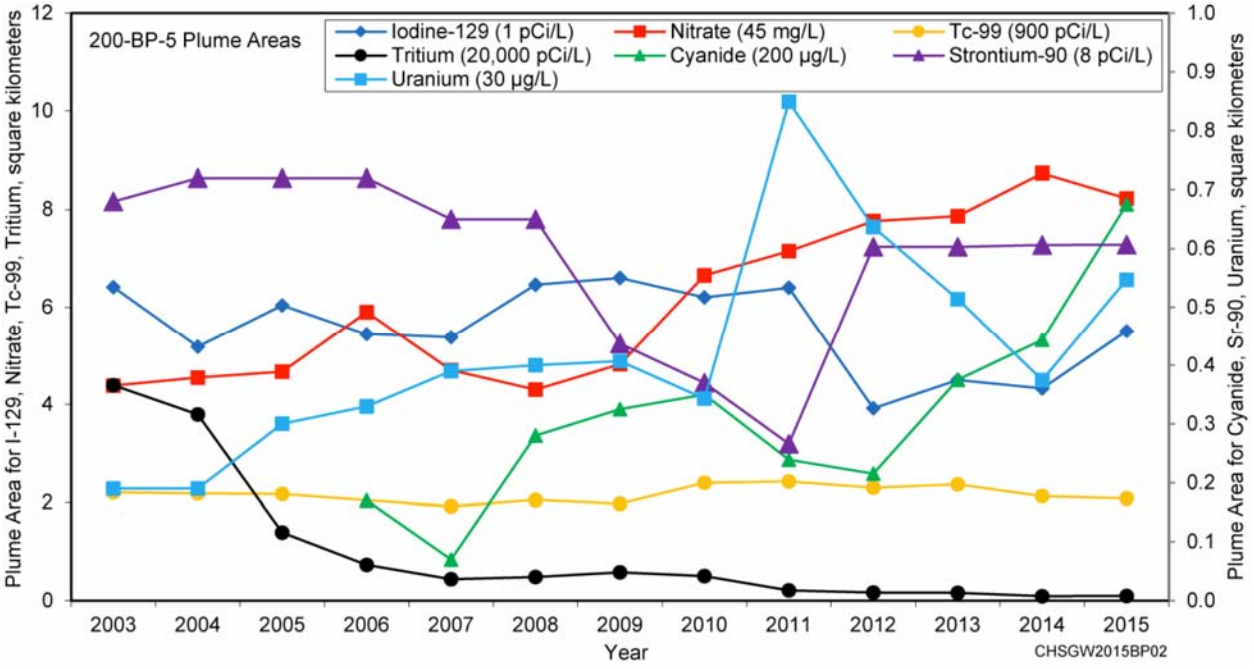

Figure D.5-1. 200-BP 2015 Plume Areas (DOE/RL-2016-09, Rev. 0, p. 9-5)

In the 200-PO interest area, tritium, I-129, and nitrate form extensive groundwater plumes, where smaller plumes are associated with Sr-90, Tc-99, and uranium. These contaminants, except Tc-99, are primarily associated with PUREX operations that discharged liquid effluents to the cribs and ditches in the southern part of the 200 East Area from 1956-72, and 1983-88. Tc-99 within 200-PO has primarily been detected above the DWS near WMA A-AX. To summarize (DOE/RL-2016-09, Rev. 0):

- Tritium contamination in groundwater is found at a concentrations greater than the DWS (20,000 pCi/L) in a large plume within 200-PO from 200 East to the Columbia River. The highest concentrations have been detected near the PUREX cribs and trenches, the major sources of this contaminant in the area. The plume continues to migrate and discharge into the Columbia River to the east although the plume is attenuating due to dispersion and radioactive decay (Figure D.5-2). However, concentrations near the PUREX cribs and trenches remain up to 25 times the DWS.
    - Maximum concentrations: 525,000 pCi/L (299-E17-19) versus a DWS of 20,000 pCi/L.
    - Areal extent of the plume: 69.5 km^2.
    - Shoreline impact: ~1800 m (i.e., no shoreline impact provided in 2015 Groundwater Report (DOE/RL-2016-09, Rev. 0); this distance estimated using PHOENIX (http://phoenix.pnnl.gov/)
    - Riparian zone intersected: 7.40 ha (18.28 acres)
- Iodine-129 is found in a relatively dispersed plume covering a large area within 200-PO and approaching the Columbia River along the same general path as the tritium plume. The highest concentrations have been detected near the PUREX cribs and trenches, which are likely major sources for this contaminant. The plume size appears to have been slowly decreasing over time (Figure D.5-2).
    - Maximum concentration: 10.1 pCi/L (699-43-45) versus a DWS of 1 pCi/L.
    - Areal extent of the plume: 54.8 km^2.
    - Shoreline impact: 0 m
    - Riparian zone intersected: 0 ha
- The extent of nitrate at concentrations greater than the DWS (45 mg/L equivalent) is small within the 200-PO interest area relative to that of tritium or I-129, where far-field nitrate concentrations have generally decreased below the DWS. However, the nitrate plume area has been generally increased from 2007 to 2012 and has been generally decreasing since 2012, though it remains above the 2007 areal extent (Figure D.5-2). The highest concentrations of nitrate have been detected near the PUREX cribs and trenches.
    - Maximum concentration: 139,000 µg/L (299-E17-19) versus a DWS of 45,000 µg/L.
    - Areal extent of the plume: 2.1 km^2.
    - Shoreline impact: 0 m
    - Riparian zone intersected: 0 ha
- Strontium-90 has historically been detected in relatively small areas near the 216-A-5, 216-A-10, and 216-A-36B cribs at concentrations greater than the DWS (8 pCi/L). In 2015, a small plume occurred near the 216-A-10 Crib and 216-A-36B Crib; Sr-90 was detected above the DWS in only two wells in 2015.
    - Maximum concentration: 14.1 pCi/L (299-E17-19) versus a DWS of 8 pCi/L.
    - Areal extent of the plume: <0.01 km^2 (assumed 0.01 km^2 for this analysis).
    - Shoreline impact: 0 m
    - Riparian zone intersected: 0 ha

- Technetium-99 has been detected in a relatively small area in the 200-PO near WMA A-AX starting in 2003. This plume appears to have sources both in WMA C (200-BP) and in WMA A-AX (200-PO), where WMA A-AX is hydraulically downgradient of WMA C. The Tc-99 plume has remained fairly stable over the past decade (Figure D.5-2).
    - Maximum concentration: 3,020 pCi/L (299-E24-22) versus a DWS of 900 pCi/L.
    - Areal extent of the plume: 0.06 km^2.
    - Shoreline impact: 0 m
    - Riparian zone intersected: 0 ha
- Uranium has been detected in a relatively small area near the PUREX Cribs and trenches and adjacent to the 618-10 burial ground (part of 300-FF). Uranium was detected in two wells in 2015 in 200-PO above the DWS of 30 µg/L. Uranium remains mobile in groundwater at 200-PO and appears to be slowly migrating away from source areas albeit with a relatively stable plume area over the past decade (Figure D.5-2).
    - Maximum concentration: 43.1 µg/L (299-E25-36) versus a DWS of 30 µg/L.
    - Areal extent of the plume: 0.04 km^2.
    - Shoreline impact: 0 m
    - Riparian zone intersected: 0 ha

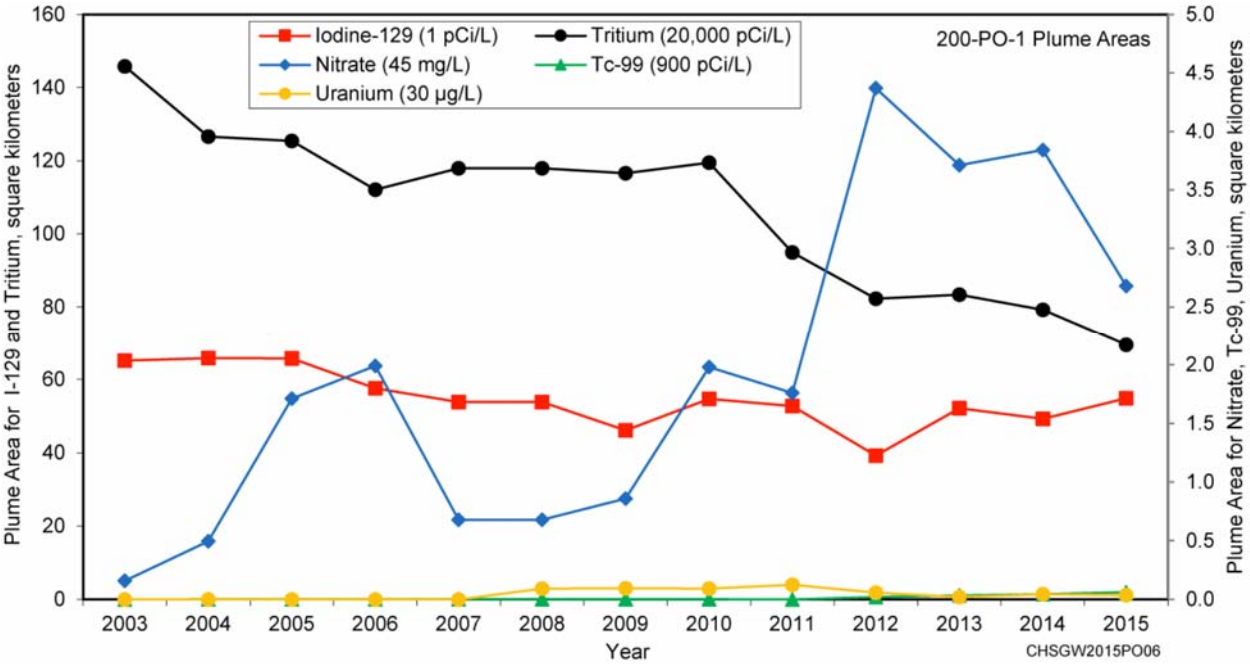

Figure D.5-2. 200-PO 2015 Plume Areas (DOE/RL-2016-09-32, Rev. 0, p. 10-10)

Operating Facilities

Not Applicable

LOCATION AND LAYOUT MAPS

A series of maps are used to illustrate the location of the components within the CP-GW-1 EU relative to the Hanford Site. Figure D.5-3 shows the relationship among the various Evaluation Units studied in the

Interim Report and the Hanford Site. Figure D.5-4 illustrates the extent of groundwater contamination in the Central Plateau. Figure D.5-5 shows a detailed view of the groundwater plumes in and near the 200-BP-5 and 200-PO-1 OUs.

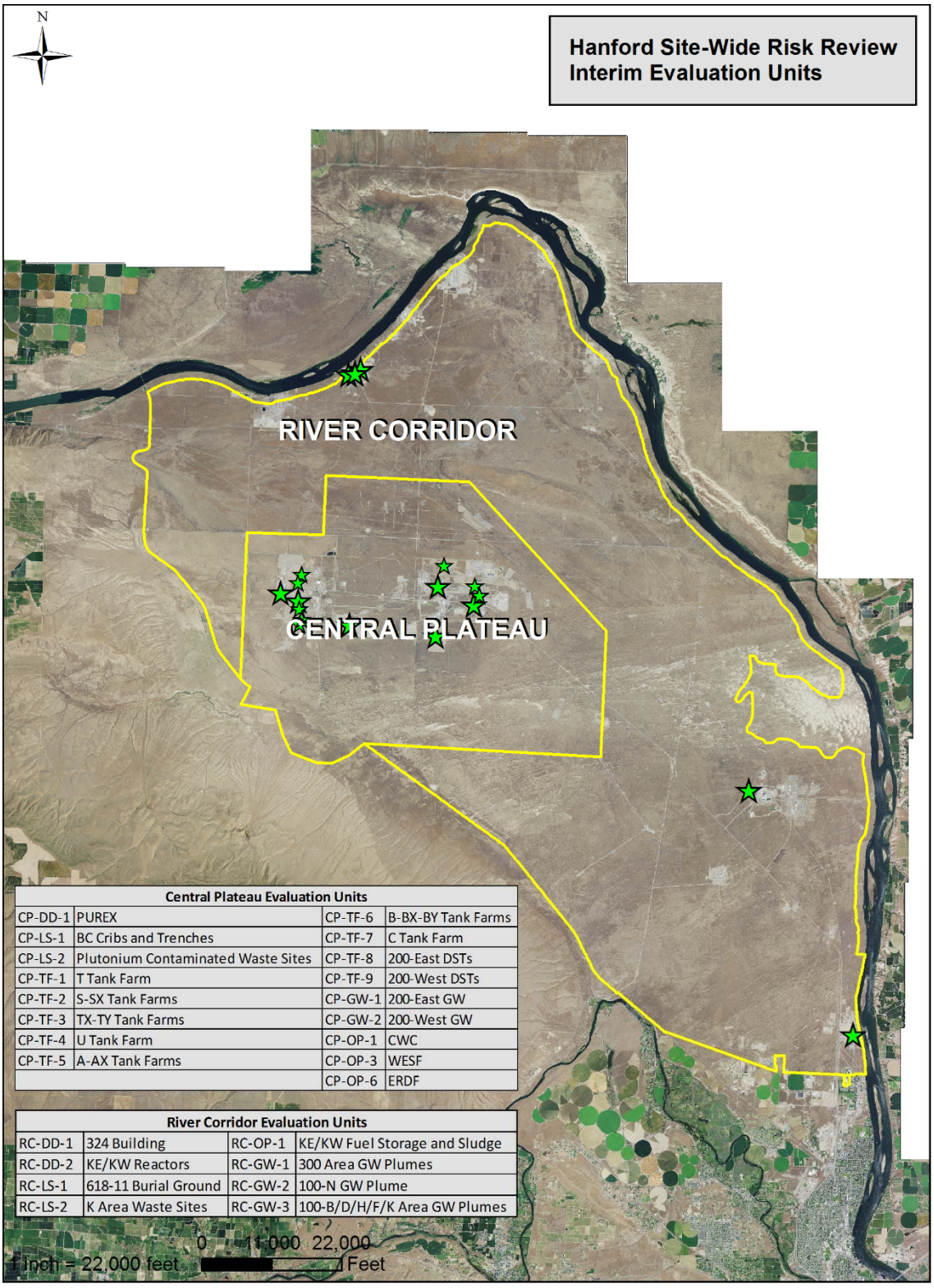

Figure D.5-3. Location of the Evaluation Units in Relation to the Hanford Site.

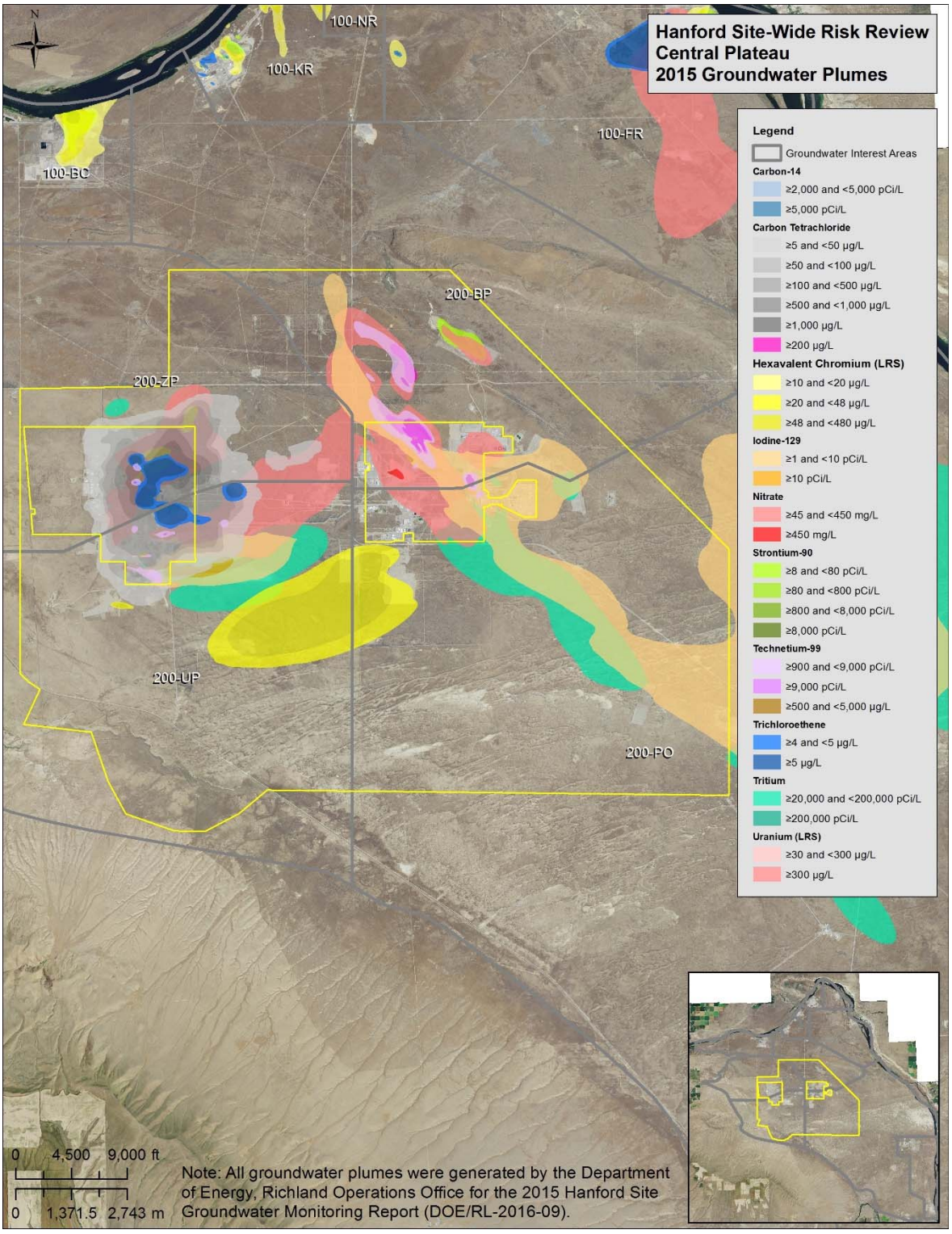

Figure D.5-4. Groundwater Contamination in the Hanford Central Plateau in 2015

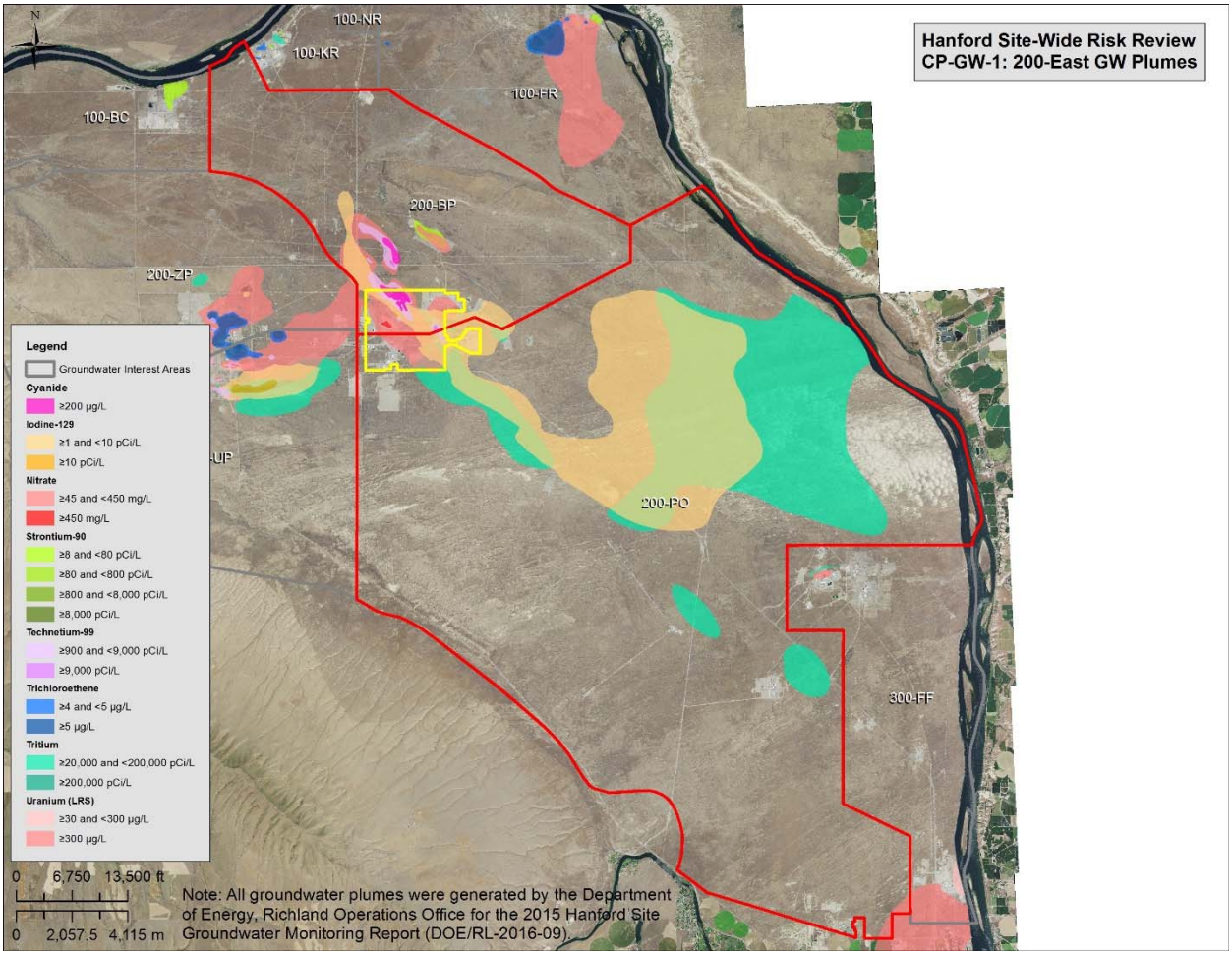

Figure D.5-5. Groundwater Plumes near the 200-BP and 200-PO Interest Areas in 2015

PART IV. UNIT DESCRIPTION AND HISTORY

EU FORMER/CURRENT USE(S)

The CP-GW-1 EU is related to two Hanford interest areas: 200-BP and 200-PO containing two CERCLA groundwater Operable Units (OUs), 200-BP-5 and 200-PO-1, respectively.

The primary separation facilities overlying the 200-BP IA were B Plant and Hot Semi-Works; however, liquid waste from the other separation facilities were stored or released at sites overlying the IA including cribs, ditches, ponds, injection wells, and leaks from underground storage tanks in WMA B-BX-BY (CP-TF-6 in Appendix E.7) and WMA C (CP-TF-7 in Appendix E.8). The 200-BP-5 OU has neither an interim nor final Record of Decision (ROD) and is being monitored under requirements of the Atomic Energy Act of 1954 (AEA), Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), and Resource Conservation and Recovery Act of 1976 (RCRA).

Groundwater within the 200-PO IA was contaminated by releases from cribs, pipelines, ponds, A-AX single shell tanks, and trenches associated with Plutonium-Uranium Extraction (PUREX) and B Plant operations. A remedial investigation was completed for the 200-PO-1 OU in 2008 (DOE/RL-2009-85, Rev. 1) that recommended proceeding to a feasibility study to develop remedial alternatives. The 200-PO-1

OU is being monitored under requirements of the AEA, CERCLA, and RCRA to determine the impact to groundwater prior to determining the path forward for remedial action.

Thus the 200-BP-5 and 200-PO-1 OUs have neither interim nor final RODs with groundwater being monitored under requirements of the Atomic Energy Act of 1954, CERCLA, and RCRA. The 200-PO-1 OU is being monitored to determine impact to groundwater prior to determining the path forward for remedial action. For 200-BP IA, the following actions are being conducted:

- Ongoing perched water treatability test (200-DV-1) at WMA B-BX-BY to remove uranium. By 2015, approximately 1,240,000 L of perched water containing approximately 592 Kg of nitrate, 0.037 Ci of Tc-99, and 69.9 kg of uranium was extracted (DOE/RL-2011-118, Rev. 0, page 3.4-29; DOE/RL-2013-22, Rev. 0, Page BP-1; DOE/RL-2014-32, Rev. 0, page BP-8; DOE/RL-2015-07, Rev 0, page 9-2; DOE/RL-2016-09, Rev. 0, p. 9-4). In 2015, the "control of the extraction system was then transferred to 200 West P&T operations." (DOE/RL-2016-09, Rev. 0, p. 9-10)
- Waste Management Area (WMA) C Tank Waste Retrieval. Tank wastes are currently being retrieved from WMA C. Waste retrieval has been completed in ten of the 16 tanks, has been completed to various limits of technology in five tanks, and retrievals are in progress in the remaining tank (Templeton, AM 2016, p. 9).
- Retrieval is also ongoing to remove the contamination from the annulus of the double shell tank 241-AY-102 (Templeton, AM 2016 (p. 9).
- "The Draft A RI (Remedial Investigation] report (DOE/RL-2009-127) was submitted to Ecology in August 2015. The RI report describes the nature and extent of contamination and identifies the COPCs for the OU." (DOE/RL-2016-09, Rev. 0, p. 9-7).

LEGACY SOURCE SITES

Not Applicable

HIGH-LEVEL WASTE TANKS

Not Applicable

GROUNDWATER PLUMES

Please see groundwater plumes 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 1 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.

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 primary contaminants in the 200-BP and 200-PO Interest Areas. Because estimated plume depths in the 200 East IAs were not available, either the depth from the corresponding contaminant in the 200-UP IA or the unconfined aquifer depth was used to estimate the saturated zone inventory. Thus these estimates likely have very large associated uncertainties.

CONTAMINATION WITHIN PRIMARY EU SOURCE COMPONENTS

Legacy Source Sites

Not Applicable

High Level Waste Tanks and Ancillary Equipment

Not Applicable

Vadose Zone Contamination

The potential impacts of remaining vadose zone inventory on groundwater is evaluated in the corresponding legacy source and tank waste and farms EUs. There are numerous sources for the groundwater plumes in the 200-PO and 200-BP IAs as described in Part III, Primary EU Source

Components. The vadose zone threats to the area groundwater are described in the corresponding Appendix.

Groundwater Plumes

The estimated inventory for the saturated zone contamination is provided in Table D.5-2 where the process outlined in Chapter 6 of the Methodology Report (CRESP 2015). For the 200-BP and 200-PO groundwater plumes (DOE/RL-2016-09, Rev. 0), the following information is provided:

- Maximum measured groundwater concentration in 2015 (DOE/RL-2016-09, Rev. 0);
- Upper 95% confidence limit (UCL) on the log-transformed 2015 groundwater and aquifer tube (AT) data from HEIS (http://ehs.hanford.gov/eda/) exceeding the WQS where the AT can also be used if the plume is in contact with the Columbia River;
- Plume area in 2015 (exceeding the water quality standard (WQS), often the DWS or risk-based cleanup level) (DOE/RL-2016-09, Rev. 0);
- Assumed plume thickness, which as described in Chapter 6 of the Methodology Report (CRESP 2015) is the minimum of the thickness from Table 3 from the Hanford 200-UP-1 Operable Unit Interim Record of Decision (EPA 2012) for the corresponding contaminant or the unconfined aquifer thickness;
- Estimated plume pore volume and mass or activity in water (M^{SZ}) using the process described in Chapter 6 of the Methodology Report (CRESP 2015);
- The Groundwater Threat Metric (GTM) for the plume and corresponding rating (CRESP 2015).

As illustrated in Table D.5-2, the saturated zone (SZ) GTM values for the 200-BP IA Group A and B primary contaminants range from *Medium* for I-129, Tc-99, uranium, and cyanide to *High* for Sr-90. A perched water treatability test is being conducted in the 200-DV-1 OU under the B Complex to remove uranium. The tritium and nitrate plume areas (Group C) translate to *Low* and *Medium*, respectively.

The saturated zone (SZ) GTM values (Table D.5-2) for the 200-PO Group A and B primary contaminants range from *Low* for Sr-90, Tc-99, and uranium to *Very High* for I-129. The nitrate and tritium (Group C) plume areas translate to *Medium* ratings. Thus the overall rating for the CP-GW-1 EU would be *Very High* related to the I-129 in 200-PO.

Impact of Recharge Rate and Radioactive Decay on Groundwater Ratings

For this analysis, predicted results from the TC&WM EIS groundwater screening analysis (DOE/EIS-0391 2012, Appendix O) for a given plume at the nearest "barrier" are used to gauge potential impacts of recharge rate, transport, and radioactive decay on groundwater ratings (CRESP 2015)[6]. A "barrier" represents the edge of the infiltration barrier to be constructed over disposal areas that are within 100 meters [110 yards] of facility fence lines (DOE/EIS-0391 2012). In general, the B Barrier and A Barrier results were used as indications of contaminant transport for the 200-BP and 200-PO IAs, respectively. Despite potentially including sources other than those directly related to the 200-PO and 200-BP IAs, the groundwater screening analysis was considered reasonable to assess rate of movement of contaminants

[6] The Core Zone Boundary was also considered for large plumes; however, values at the B Barrier and Core Zone Boundary were essentially the same for the purposes of this Review so B Barrier values are used to simplify the analysis. The Core Zone Boundary is a rectangular region encompassing the entire area that would be directly affected by project facilities and thus represents the "fence line" of projected tank closure operational facilities for each of the alternatives (DOE/EIS-0391 2012, p. 2-209).

through the Hanford subsurface for this Review. The groundwater transport analysis (DOE/EIS-0391 2012, Appendix O) indicates that there may be large impacts resulting from radioactive decay and transport including that from emplacing the engineered surface barrier (and resulting reduction of infiltrating water) on the predicted peak groundwater concentrations at various Barriers. To summarize, the results for all Central Plateau sources (Appendix O, DOE/EIS-0391 2012) include:

- Nitrate (Group C) – There are current plumes in both 200-BP (8.2 km^2) near the B Barrier and 200-PO (2.1 km^2) near the A Barrier. Peak concentrations at the B Barrier and A Barrier are 187 mg/L (CY 2066) and 46.9 mg/L (CY 2136), respectively, for the No Action Alternative and 171 mg/L (CY 2055) and 17.9 mg/L (CY 2172), respectively, for Landfill Closure where the DWS (equivalent) is 45 mg/L. Since the B Barrier peak concentration exceeds the DWS during the Active Cleanup period (and would likely also do so into the Near-term, Post-Cleanup period) with a plume area likely still exceeding 0.1 km^2, the groundwater rating for the 200-BP IA nitrate remains *Medium* for these evaluation periods. Since the predicted peak concentration for 200-PO (Landfill Scenario) would be less than the DWS and the resulting plume area would be insignificant during the Active Cleanup and Near-term, Post-Cleanup periods, the groundwater ratings for these periods would be *Low* to allow for uncertainty.
- I-129 (Group A) – There are current plumes in both 200-BP (5.5 km^2) near the B Barrier and 200-PO (54.8 km^2) where the 200-PO plume extends out beyond the A Barrier and Core Zone Boundary approaching the Columbia River in concentrations exceeding the DWS (1 pCi/L). Peak concentrations at the A Barrier, B Barrier, and Core Zone Boundary are 38.5 pCi/L (CY 2123), 58.8 pCi/L (CY 3577), and 58.8 pCi/L (CY 3577), respectively, for the No Action Alternative and 1.5 pCi/L (CY 2104), 4.5 pCi/L (CY 2056), and 4.5 pCi/L (CY 2056), respectively, for Landfill Closure. For 200-BP and 200-PO, the same plume areas and peak concentrations for the Landfill Scenario (for lack of better information) would translate to *Medium* and *Very High* ratings, respectively, or no change from the ratings for Current conditions. Even with the significantly lower peak concentration at the A Barrier of 1.5 pCi/L, the 200-PO plume area would have to decrease by more than a factor of six over the Cleanup and Near-term, Post-Cleanup periods to change the ratings from *Very High* to *High*, which seems implausible (within the limits of uncertainty) without treatment. Thus without treatment in the 200-BP and 200-PO IAs, the ratings remain *Medium* and *Very High*, respectively, during the Active and Near-term, Post-Cleanup periods, indicating the need for monitoring and treatment.
- Tc-99 (Group A) – There are current plumes in both 200-BP (2.1 km^2) near the B Barrier and 200-PO (0.06 km^2) near the A Barrier. Peak concentrations at the B Barrier and A Barrier are 26,500 pCi/L (CY 3957) and 41,700 pCi/L (CY 2121), respectively, for the No Action Alternative and 3,570 pCi/L (CY 2056) and 774 pCi/L (CY 2101) for Landfill Closure where the DWS is 900 pCi/L. For 200-BP, the predicted peak concentration (for the B Barrier assuming a constant plume area) would translate to a *Medium* rating. Thus the Active Cleanup rating is maintained as *Medium* and the Near-term, Post-Cleanup rating is *Medium* (accounting for uncertainty) indicating a need for monitoring and treatment. For the 200-PO IA, the peak concentration could fall below the DWS during the Near-term, Post-Cleanup period. Thus the Active Cleanup rating would remain *Low* and the Near-term, Post-Cleanup rating would also be *Low* to account for uncertainties.
- Uranium (Group B) – Because uranium already has a plume in 200-PO, the rating will remain *Low* for the Active and Near-term, Post-Cleanup periods (to account for uncertainty) even though the predicted peak concentrations do not exceed the DWS. However, for 200-BP, the predicted peak concentration for uranium is 41 µg/L (CY 11,778) at the B Barrier (i.e., exceeds

the 30 µg/L standard); thus the *Medium* rating would apply for both the Active Cleanup and Near-term Post-Cleanup periods (without treatment).

- Tritium (Group C) – There are current plumes in both 200-BP (0.1 km^2) near the B Barrier and 200-PO (69.5 km^2) that extend outside the A Barrier and Core Zone Boundary to the Columbia River. Peak concentrations at the B Barrier and Columbia Nearshore are 349 pCi/L (CY 2064) and 502 pCi/L (CY 2050), respectively, for the No Action Alternative and 7 pCi/L (CY 2051) and 477 pCi/L (CY 2051), respectively, for Landfill Closure where the DWS is 1 pCi/L. Since the B Barrier and Nearshore peak concentrations still exceed the DWS during the Active Cleanup period (and would likely do so into the Near-term, Post-Cleanup period) with a plume area likely still (far) exceeding 0.1 km^2 in 200-PO, the groundwater rating would remain *Medium* into these evaluation periods indicating the need for monitoring and treatment. The plume area for 200-BP has just recently dropped below 0.1 km^2, so to account for uncertainty, the rating remains Low for both periods.
- No values are reported at the B Barrier (200-BP) or A Barrier (200-PO) for Sr-90 or cyanide for either scenario, which indicates that predicted peak fluxes were less than 1×10^{-8} Ci/yr for radionuclides or less than 1×10^{-8} g/yr for chemical contaminants (Appendix O, DOE/EIS-0391 2012, p. O-2) or that relevant sources are not included in the TC&WM EIS evaluation. For Sr-90 in 200-BP (current rating is *High*), the times required for the saturated zone inventory to decay (without an additional significant secondary source) to values that would result in *Medium* and *Low* ratings are 23 and 119 years, respectively. Thus the Sr-90 ratings for the Active Cleanup and Near-term, Post-Cleanup periods would be *Medium* and *Low*, respectively, indicating the need for monitoring (especially, for impacts from secondary sources). The plume size for cyanide (current rating is *Medium*) has increased by factor of approximately 10 since 2007. The plume is not currently being treated and a similar increase would lead to a rating of *High* within the Active Cleanup period. The rating of *High* rating is maintained for the Near-term, Post-Cleanup period due to uncertainty in plume growth rate and treatment options. Because Sr-90 in 200-PO already has a plume, the rating for Sr-90 in 200-PO remains *Low* for the Active and Near-term, Post-Cleanup periods (to account for uncertainty).

The above results are summarized in Table D.5-2 and Table D.5-3. The potential Table D.5-3 impacts of remaining vadose zone inventory on groundwater is evaluated in the corresponding legacy source EU.

Columbia River

The process illustrated in Chapter 6 of the Methodology Report (CRESP 2015) is used to evaluate potential impacts to the Columbia River. Note that the evaluation of potential benthic and riparian impacts has a common thread up to the point when the shoreline impact (benthic) or riparian zone impact area is used to define ratings. Thus a common evaluation for the benthic and riparian zone is performed here. The results for threats to the Columbia River are summarized in Table D.5-4.

Benthic and Riparian Zone – Current Impacts

Based on the information in the 2015 Hanford Site Groundwater Monitoring Report (DOE/RL-2016-09, Rev. 0) and HEIS (http://ehs.hanford.gov/eda/) , no plume from the 200-BP IA currently intersects the Columbia River at concentrations exceeding the appropriate water quality standard (WQS). Thus current impacts from the 200-BP IA to the Columbia River benthic and riparian ecology would be rated as *Not Discernible*. For example, potential impacts related to the 200-BP IA are described in Appendix E.7 for CP-TF-6 (WMA B-BX-BY).

Based on the information in the 2015 Hanford Site Groundwater Monitoring Report (DOE/RL-2016-09, Rev. 0) and HEIS (http://ehs.hanford.gov/eda/), only the tritium (Group C) plume from the 200-PO IA

currently intersects the Columbia River at concentrations exceeding the appropriate water quality standard (WQS)[7]. Using the framework process (Figure 6-11, Chapter 6, Methodology Report (CRESP 2015)), the ratio, R1, of the maximum concentration to the Biota Concentration Guide (BCG) (i.e., 2.65×10^{8} pCi/L from RESRAD, Version 1.8 consistent with the DOE Technical Standard DOE-STD-1153-2002) is needed to evaluate a Group C radionuclide. The TC&WM EIS groundwater screening evaluation (DOE/EIS-0391 2012, Appendix O) is used to provide an estimate of the maximum tritium concentration in the nearshore region of the Columbia River; this concentration is predicted to be 502 pCi/L in CY 2050 (DOE/EIS-0391 2012, p. O-59). Thus the ratio, R1, is far less than one; therefore, the rating is *Not Discernible*.

Benthic and Riparian Zone – Active Cleanup and Near-term, Post Cleanup for Current Plumes

Because of the high decay rate of H-3 relative to the Active Cleanup and Near-term, Post-Cleanup evaluation periods; the *Not Discernible* rating for H-3 from the 200-PO IA would also apply to these evaluation periods. Because other 200-PO IA plumes originate from 200-East, it is possible that a current plume might reach the Columbia River in the next 150 years (considering that the tritium plume originated from the same general area). However, the TC&WM EIS screening results (as described in Appendix O and P in DOE/EIS-0391 2012 and Appendix E.6 for CP-TF-5 (WMA A-AX)) suggest that it is unlikely that any radionuclides either currently impacting groundwater (e.g., I-129, Sr-90, and Tc-99) or remaining in the vadose zone would impact the Columbia River over the next 150 years leading to *Not Discernible* ratings for the Active Cleanup and Near-term, Post-Cleanup periods.

The TC&WM EIS screening results indicate that only nitrate and chromium were *predicted* to impact the Columbia River (i.e., Hazard Quotients > 1) in the 10,000-yr EIS evaluation period[8]. However, for nitrate (Group C chemical with a current plume), the peak predicted concentration was in the past and the analysis leads to a *Not Discernible* rating for the Active Cleanup and Near-term, Post-Cleanup evaluation periods. Because other, current 200-BP IA plumes also originate from 200-East, a *Not Discernible* rating is obtained for current plumes for the Active Cleanup and Near-term, Post-Cleanup.

Benthic and Riparian Zone – Long-term

The ecological screening results in the TC&WM EIS (DOE/EIS-0391 2012, Appendix P) indicate that exposure to radioactive contaminants from peak groundwater discharge was below benchmarks (0.1-rad-per-day for wildlife receptors and 1-rad-per-day for benthic invertebrates and aquatic biota, including salmonids consistent with DOE Technical Standard DOE-STD-1153-2002) (DOE/EIS-0391 2012, Appendix P, p. P-52), indicating there should be no expected adverse effects from radionuclides during the TC&WM EIS evaluation period (10,000 years) from 200-East groundwater plumes.

The corresponding evaluation in the TC&WM EIS for potential impacts of chemical contaminants discharged with groundwater to the near-river ecology (benthic and riparian) indicate that, of the chemical contaminants with current plumes, nitrate could have expected Hazard Quotients exceeding one for aquatic and riparian receptors over the evaluation period (10,000 years). However, the results of the screening evaluation at the near-shore region under the No Action Alternative (DOE/EIS-0391 2012, Appendix O) indicate that the nitrate peak concentration (and discharge) occurred in the past and that

[7] The only Central Plateau plume currently in contact with the Columbia River is tritium that was primarily discharged to the PUREX cribs and trenches (DOE/RL-2016-09 Rev. 0). There are plumes associated with River Corridor GW OUs that are also in contact with the Columbia River.

[8] Hexavalent chromium in the vadose zone was a potential risk driver for the CP-TF-5 (WMA A-AX); however, the chromium is not a current plume. Furthermore, recent well data suggest that chromium plumes in the Central Plateau are moving much less rapidly than predicted in the TC&WM EIS (DOE/EIS-0391 2012, Appendix O).

future concentrations would appear to not exceed either the drinking water standard or ambient water quality criterion in the future, and thus nitrate from the 200-East groundwater EU would pose little additional risk to the Columbia River benthic or riparian ecology. Furthermore, the potential impact of increased nitrate levels may depend on other factors (e.g., phosphorus). These results are consistent with the statements in the TC&WM EIS[9]:

> "For groundwater discharging to the Columbia River (see Table 2–23), potential long-term impacts on aquatic and riparian receptors would be unlikely for all COPCs and receptors except for chromium and aquatic biota, including salmonids...." (DOE/EIS-0391 2012, Chapter 2, p. 2–235)
>
> "… maximum groundwater concentrations and nearshore surface-water concentrations of chromium resulting from all Tank Closure alternatives, including the No Action Alternative, could pose a toxicological risk to aquatic biota, including salmonids, exposed to surface water in the nearshore environment of the Columbia River…." (DOE/EIS-0391 2012, Chapter 2, p. 2–235 & 2–237)

Threats to the Columbia River Free-flowing Ecology

As described in Chapter 6 of the Methodology Report (CRESP 2015) and Appendix E.2, the large dilution effect of the Columbia River on the contamination from the seeps and groundwater upwellings results in *Not Discernible* ratings for the Active Cleanup and Near-term, Post Cleanup periods and insignificant long-term impacts to the free-flowing ecology for all contaminants.

Potential Impact of Recharge Rate on Threats to the Columbia River

The TC&WM EIS Alternatives analysis indicates that all radionuclides and chemicals would have *Not Discernible* ratings. Thus ratings will not be modified.

Facilities for D&D

Not Applicable

Operating Facilities

Not Applicable

[9] However, note that TC&WM EIS Appendix P indicates that "…Based on the conservative nature of the exposure assumptions, the estimated Hazard Indices and Hazard Quotients for the representative receptors indicated that no adverse effects of radioactive or chemical COPCs in air and groundwater releases to the Columbia River under the various alternatives evaluated are expected." (DOE/EIS-0391 2012, Appendix P, pp. P–53-54)

Table D.5-2. Summary of the Evaluation of Threats to Groundwater as a Protected Resource from Current Saturated Zone (SZ) Contamination associated with the CP-GW-1 Evaluation Unit (200-BP and 200-PO Interest Areas)

IA	PC	Grp	WQS[a]	Area (km^2)[b]	Thick-ness (m)[c]	Pore Vol. (Mm^3)	Max GW Conc.	95th % GW UCL	Poro-sity[d]	K_d (mL/g)[d]	ρ (kg/L)[d]	R	SZ Total M^{SZ}	SZ GTM (Mm^3)	SZ Rating[e]
200-BP	NO3	C	45 mg/L	8.2	24	4.92E+01	1330 mg/L	180 mg/L	0.25	0	1.82	1.00E+00	8.88E+06 kg	---	Medium*
	I-129	A	1 pCi/L	5.5	30	4.13E+01	6.09 pCi/L	2.40 pCi/L	0.25	0.2	1.82	2.46E+00	9.88E-02 Ci	9.88E+01	Medium
	Tc-99	A	900 pCi/L	2.1	20	1.05E+01	35600 pCi/L[f]	5930 pCi/L	0.25	0	1.82	1.00E+00	6.23E+01 Ci	6.92E+01	Medium*
	U	B	30 µg/L	0.6	15	2.25E+00	5600 µg/L[f]	146 µg/L	0.25	0.8	1.82	6.82E+00	3.29E+02 kg	1.10E+01	Medium*
	Sr-90	B	8 pCi/L	0.6	15	2.25E+00	1100 pCi/L	623 pCi/L	0.25	22	1.82	1.61E+02	1.40E+00 Ci	1.75E+02	High
	CN	B	200 µg/L	0.7	24	4.20E+00	1680 µg/L	711 µg/L	0.25	0	1.82	1.00E+00	2.98E+03 kg	1.49E+01	Medium
	H-3	C	20000 pCi/L	0.1	30	7.50E-01	91600 pCi/L	58700 pCi/L	0.25	0	1.82	1.00E+00	4.40E+01 Ci	---	Low
200-PO	H-3	C	20000 pCi/L	69.5	30	5.21E+02	525000 pCi/L	142000 pCi/L	0.25	0	1.82	1.00E+00	7.40E+04 Ci	---	Medium
	I-129	A	1 pCi/L	54.8	30	4.11E+02	10.1 pCi/L	3.81 pCi/L	0.25	0.2	1.82	2.46E+00	1.57E+00 Ci	1.57E+03	Very High
	NO3	C	45 mg/L	2.1	24	1.26E+01	139 mg/L	76.6 mg/L	0.25	0	1.82	1.00E+00	9.65E+05 kg	---	Medium
	Sr-90	B	8 pCi/L	0.01	15	3.75E-02	14.1 pCi/L	12.7 pCi/L[g]	0.25	22	1.82	1.61E+02	4.76E-04 Ci	5.95E-02	Low
	Tc-99	A	900 pCi/L	0.06	20	3.00E-01	3020 pCi/L	1820 pCi/L	0.25	0	1.82	1.00E+00	5.46E-01 Ci	6.07E-01	Low
	U	B	30 µg/L	0.04	15	1.50E-01	43.1 µg/L	38.8 µg/L[h]	0.25	0.8	1.82	6.82E+00	5.81E+00 kg	1.94E-01	Low

a. The Water Quality Standard (WQS) is the drinking water standard (DWS) (or equivalent for nitrate) for these OUs.

b. Plume area (DOE/RL-2016-09, Rev. 0).

c. As described in Chapter 6 of the Methodology Report (CRESP 2015), for those areas outside of the 200-UP-1 OU, the minimum of the value from the Hanford 200-UP-1 OU Interim ROD (EPA 2012) or the unconfined aquifer thickness is used. For the 200 East OUs, the corresponding values from the 200-UP-1 OU Interim ROD are used since no depth estimates were available and the unconfined aquifer thickness is larger than the depths from the 200-UP-1 Interim ROD. This use likely results in very high uncertainty estimates of saturated zone inventory.

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

e. For Group C contaminants, rating is based on plume area (CRESP 2015). Groundwater Threat Metric (GTM) rating based on Table 6-3, Methodology Report for the Group A and B primary contaminants. There is an ongoing perched water treatability test (200-DV-1) at WMA B-BX-BY to remove uranium. By 2015, approximately 1,240,000 L of perched water containing approximately 592 Kg of nitrate, 0.037 Ci of Tc-99, and 69.9 kg of uranium was extracted (DOE/RL-2011-118, Rev. 0, page 3.4-29; DOE/RL-2013-22, Rev. 0, Page BP-1; DOE/RL-2014-32, Rev. 0, page BP-8; DOE/RL-2015-07, Rev 0, page 9-2; DOE/RL-2016-09, Rev. 0, p. 9-4). The contaminants with perched water extraction amounts are indicated in the table with an asterisk (*).

f. The 200-BP summary table (DOE/RL-2016-09, Rev. 0, p. 9-4) reports the maximum concentration excluding the perched aquifer beneath the B Complex, which has maximum values of 40,900 pCi/L and 111000 µg/L from well 299-E33-344 for Tc-99 and U, respectively. The perched aquifer values from this well were also excluded when estimating the 95% confidence limit (UCL) exceeding the DWS. This is consistent with considering the perched water separate from the lower unconfined saturated zone (PNNL-22499). The analysis in this report considers the perched water inventory as part of the vadose zone.

g. For Sr-90 in 200-PO, only three measurements are available, and the 95th % GW UCL estimate on the mean of 16.1 pCi/L is higher than the maximum measured concentration of 14.1 pCi/L. Thus the average value (log-space) of the measured concentrations exceeding the limit, 12.7 pCi/L, is used as the 95% UCL to compute the saturated zone total aqueous amount and the saturated zone GTM for this constituent and GW OU.

h. For U in 200-PO, only four measurements are available, and the 95th % GW UCL estimate on the mean of 46.0 μg/L is higher than the maximum measured concentration of 43.1 μg/L. Thus the average value (log-space) of the measured concentrations exceeding the limit, 38.8 μg/L, is used as the 95% UCL to compute the saturated zone total aqueous amount and the saturated zone GTM for this constituent and GW OU.

Table D.5-3. Summary of the Evaluation of Future Threats to Groundwater as a Protected Resource from Saturated Zone (SZ) Contamination associated with the CP-GW-1 Evaluation Unit (200-BP and 200-PO Interest Areas)

OU	PC	Grp	WQS[a]	SZ Total M^{SZ} (kg or Ci)	SZ GTM (Mm^3)	Current SZ Rating[b]	Plume in 50 yrs (No Action/ Closure)?[c]	Plume being treated?[d]	Treatment completed (yrs)[e]	Active Cleanup SZ Rating	Plume in 150 yrs (No Action/ Closure)?[c]	Near-term, Post-Cleanup SZ Rating
200-BP	NO3	C	45 mg/L	8.88E+06 kg	---	Medium*	Yes/Yes	No*	Undefined	Medium	Yes/Yes	Medium
	I-129	A	1 pCi/L	9.88E-02 Ci	9.88E+01	Medium	Yes/Yes	No	Undefined	Medium	Yes/Yes	Medium
	Tc-99	A	900 pCi/L	6.23E+01 Ci	6.92E+01	Medium*	Yes/Yes	No*	Undefined	Medium	Yes/Yes	Medium
	U	B	30 µg/L	3.29E+02 kg	1.10E+01	Medium*	Yes/No	No*	Undefined	Medium	Yes/No	Medium
	Sr-90	B	8 pCi/L	1.40E+00 Ci	1.75E+02	High	No/No	No	Undefined	Medium[g]	No/No	Low[g]
	CN	B	200 µg/L	2.98E+03 kg	1.49E+01	Medium	No[f]	No	Undefined	High	No[f]	High
	H-3	C	20000 pCi/L	4.40E+01 Ci	---	Low	No/No	No	Undefined	Low	No/No	Low
200-PO	H-3	C	20000 pCi/L	7.40E+04 Ci	---	Medium	No/No	No	Undefined	Medium	No/No	Medium
	I-129	A	1 pCi/L	1.57E+00 Ci	1.57E+03	Very High	Yes/Yes	No	Undefined	Very High	Yes/Yes	Very High
	NO3	C	45 mg/L	9.65E+05 kg	---	Medium	Yes/No	No	Undefined	Low	Yes/No	Low
	Sr-90	B	8 pCi/L	4.76E-04 Ci	5.95E-02	Low	No/No	No	Undefined	Low	No/No	Low
	Tc-99	A	900 pCi/L	5.46E-01 Ci	6.07E-01	Low	Yes/No	No	Undefined	Low	Yes/No	Low
	U	B	30 µg/L	5.81E+00 kg	1.94E-01	Low	No/No	No	Undefined	Low	No/No	Low

a. The Water Quality Standard (WQS) is the drinking water standard (DWS) (or equivalent for nitrate) for these OUs.

b. Ratings provided in Table D.5-2. For Group C contaminants, rating is based on plume area (CRESP 2015). The Groundwater Threat Metric (GTM) rating based on Table 6-3, Methodology Report (CRESP 2015) for Group A and B contaminants.

c. This evaluation is based on the TC&WM EIS screening results for the No Action and Landfill Closure scenarios using the peak concentrations and times at the most proximate "barriers" (DOE/EIS-0391 2012, Appendix O).

d. There is an ongoing perched water treatability test (200-DV-1) at WMA B-BX-BY to remove uranium. By 2015, approximately 1,240,000 L of perched water containing approximately 592 Kg of nitrate, 0.037 Ci of Tc-99, and 69.9 kg of uranium was extracted (DOE/RL-2011-118, Rev. 0, page 3.4-29; DOE/RL-2013-22, Rev. 0, Page BP-1; DOE/RL-2014-32, Rev. 0, page BP-8; DOE/RL-2015-07, Rev 0, page 9-2; DOE/RL-2016-09, Rev. 0, p. 9-4). The contaminants with perched water extraction amounts are indicated in the table with an asterisk (*); however, no groundwater is being treated.

e. No interim or final RODs have been issued for the 200 East GW OUs.

f. The screening results in the TC&WM EIS (DOE/EIS-0391 2012, Appendix O) are assumed to be uninformative for cyanide.

g. Accounts for radioactive decay.

Table D.5-4. Summary of the Evaluation of Groundwater as Pathway to the Columbia River associated with CP-GW-1 Evaluation Unit (200-BP and 200-PO Interest Areas)

OU	PC	Group	WQS	BCG or AWQC[a]	Max GW Conc	95th % GW UCL	R1, Max GW Conc / BCG or WQS	R2, 95th % GW UCL / BCG or WQS	Shoreline Impact (m)[b]	Riparian Area (ha)[c]	Benthic rating	Riparian rating	Overall rating[d]
200-BP	NO3	C	45 mg/L	7.10 mg/L	1330 mg/L	180 mg/L	4.23E+01	5.74E+00	---	---	---	---	ND*
	I-129	A	1 pCi/L	38500 pCi/L	6.09 pCi/L	2.40 pCi/L	1.58E-04	6.22E-05	---	---	---	---	ND
	Tc-99	A	900 pCi/L	667000 pCi/L	35600 pCi/L	5930 pCi/L	5.34E-02	8.89E-03	---	---	---	---	ND*
	U	B	30 µg/L	5.00 µg/L	5600 µg/L	146 µg/L	1.12E+03	2.92E+01	---	---	---	---	ND*
	Sr-90	B	8 pCi/L	279 pCi/L	1100 pCi/L	623 pCi/L	3.94E+00	2.23E+00	---	---	---	---	ND
	CN	B	200 µg/L	5.20 µg/L	1680 µg/L	711 µg/L	3.23E+02	1.37E+02	---	---	---	---	ND
	H-3	C	20000 pCi/L	2.65E+08 pCi/L	91600 pCi/L	58700 pCi/L	3.46E-04	2.22E-04	---	---	---	---	ND
200-PO	H-3	C	20000 pCi/L	2.65E+08 pCi/L	525000 pCi/L	142000 pCi/L	1.98E-03	5.36E-04	---	7.40E+00	---	---	ND
	I-129	A	1 pCi/L	38500 pCi/L	10.1 pCi/L	3.81 pCi/L	2.62E-04	9.90E-05	---	---	---	---	ND
	NO3	C	45 mg/L	7.10 mg/L	139 mg/L	76.6 mg/L	4.42E+00	2.44E+00	---	---	---	---	ND
	Sr-90	B	8 pCi/L	279 pCi/L	14.1 pCi/L	12.7 pCi/L	5.05E-02	4.55E-02	---	---	---	---	ND
	Tc-99	A	900 pCi/L	667000 pCi/L	3020 pCi/L	1820 pCi/L	4.53E-03	2.73E-03	---	---	---	---	ND
	U	B	30 µg/L	5.00 µg/L	43.1 µg/L	38.8 µg/L	8.62E+00	7.80E+00	---	---	---	---	ND

a. Biota Concentration Guide (BCG) from RESRAD-BIOTA v1.8 (consistent with DOE Technical Standard DOE-STD-1153-2002) for radionuclides. For chemicals, 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) used when AQWC not provided.

b. Shoreline impact (m) (DOE/RL-2016-09, Rev. 0)

c. 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).

d. Only the tritium plume (Group C) from the 200-PO-1 OU is currently in contact with the Columbia River; however, the rating according to the process in Chapter 6 of the Methodology Report translates to a ND rating. The contaminants with extraction amounts are indicated in the table with an asterisk (*).

PART VI. POTENTIAL RISK/IMPACT PATHWAYS AND EVENTS

Current Conceptual Model

Large and small contaminant plumes in the 200-East Area comprising the CP-GW-1 EU pose a current and continuing risk to protected natural resources in the area including groundwater and the Columbia River. However, since there is prohibition on the use of groundwater through the Active and Near-term, Post-Cleanup periods, there is no risk to humans. Furthermore, the risks to benthic, riparian zone, and free-flowing ecology are minimal as previously described in Part V.

Briefly describe the current institutional, engineered and natural barriers that prevent release or dispersion of contamination, risk to human health and impacts to resources:

1. *What nuclear and non-nuclear safety accident scenarios dominate risk at the facility? What are the response times associated with each postulated scenario?*

There is also little remedial work being done in the 200-East Area; thus risk to workers would tend to be related to standard industrial risks ("slips, trips, and falls") and those related to monitoring activities including sampling and well drilling.

2. *What are the active safety class and safety significant systems and controls?*

Not applicable.

3. *What are the passive safety class and safety significant systems and controls?*

Not applicable.

4. *What are the current barriers to release or dispersion of contamination from the primary facility? What is the integrity of each of these barriers? Are there completed pathways to receptors or are such pathways likely to be completed during the evaluation period?*

There is a deep vadose zone beneath the 200-East Area through which contaminants must travel to reach groundwater and then to off-site areas (e.g., Columbia River) where receptors could be exposed. Restrictions on use of site groundwater also represent a barrier to exposure. Because of relatively long travel times, natural attenuation of the radionuclides with relatively short half-lives (when compared to travel times) is also a barrier. Furthermore, the large flow in the Columbia River tends to dilute the concentration of any contaminants to which receptors might be exposed via the surface water pathway.

5. *What forms of initiating events may lead to degradation or failure of each of the barriers?*

The thick vadose zone under the Central Plateau and generally arid climate result in natural infiltration rates of between less than detection to more than 100 mm/yr (RPP-13033). Present conditions (e.g., bare ground and coarse sand and gravel surfaces) in the 200-East Area are conducive to higher infiltration rates than would be expected on undisturbed ground within the 200 Areas. Thus the vadose zone is currently acting as both a barrier and, in some areas, a secondary source for tank waste contaminants. Episodic groundwater recharge may occur following periods of high precipitation, especially if combined with topographic depressions, highly permeable surface deposits such as gravel, and where the land is denuded of vegetation (RPP-13033), which would also increase infiltration

through the vadose zone[10]. The vadose zone and groundwater have been contaminated from Central Plateau sources; however, the travel times from these areas to potential receptors has been sufficiently long that no off-site receptors are known to have been exposed to these wastes other than tritium.

6. What are the primary pathways and populations or resources at risk from this source?

The primary pathway and primary impacted protected resource are both groundwater. Since there is a restriction on use of groundwater, there are no human receptors; the ecological receptors are those (benthic, riparian zone, and free-flowing) near where the groundwater enters the Columbia River. The groundwater also serves as a current pathway (tritium plume from 200-PO) and potential future pathway (e.g., I-129 and nitrate) for impact to the Columbia River (a protected natural resource) from the CP-GW-1 (namely, the 200-BP and 200-PO IAs).

There are complete pathways for the exposure of ecological receptors to vadose zone contaminants in the legacy source areas. There will also be other possible pathways (ingestion, external radiation and dermal, inhalation) from residual wastes to human and ecological receptors after institutional controls are lifted.

7. What is the time frame from each of the initiating events to human exposure or impacts to resources?

The relatively long residence times in Hanford groundwater are consistent with recharge conditions for a semi-arid site; however, there is variation in expected residence times (PNNL-6415 Rev. 18, p. 4-72). Groundwater travel time from the 200 East Area to the Columbia River is relatively fast, ~10-30 years (PNNL-6415 Rev. 18, p. 4.72) because of 1) the large recharge volume from wastewater disposed in the 200 Areas between 1944 and mid-1990s and 2) the relatively high permeability of Hanford formation sediments (that are below the water table). Travel times from the 200 Areas to the Columbia River are expected to decrease because of the reduced hydraulic gradient from the discontinued wastewater recharge in the 200 Areas.

Large and small contaminant plumes in the 200-East Area comprising the CP-GW-1 EU pose a current and continuing risk to protected natural resources in the area including groundwater and the Columbia River. However, since there is prohibition on the use of groundwater through the Active and Near-term, Post-Cleanup periods, there is no risk to humans. Furthermore, the risks to benthic, riparian zone, and free-flowing ecology are minimal as previously described in Part V.

POPULATIONS AND RESOURCES CURRENTLY AT RISK OR POTENTIALLY IMPACTED DURING OR AS A CONSEQUENCE OF CLEANUP ACTIONS

Facility workers are at risk when working in or around areas with contaminated soils. Exposure to such contaminants is limited because groundwater and contaminated soils are located below grade. However, during certain operations (e.g., drilling, sampling, removal, treatment, and disposal), there may be the potential for exposure to hazardous and radioactive contaminants; however, the potential exposure would be very small. Similarly, co-located persons would be expected to have similar to reduced exposure to facility workers, while the public would be expected to have significantly reduced exposure. As noted above, The Department of Energy and contractor site-specific safety and health planning that includes work control, fire protection, training, occupational safety and industrial hygiene,

[10] Because the waste tanks divert water, there are areas of low moisture content and regions of higher moisture denoted an ”umbrella effect” (RPP-23752). Similar effects can be seen in cribs. It is assumed that the potential impact of the variation in moisture is captured by the range of recharge rates evaluated in this Review.

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). As such, mitigation actions will generally lead to reduced risks.

Facility Worker

Risks are thus rated as *Low to Medium*, with mitigated risk reduced to *Low*.

Co-Located Person

Risks are rated as *Low*; mitigated risk is also rated as *Low*.

Public

Risks are located as *Not Discernible* to *Low*; mitigated risk is rated as *Not Discernible*.

Groundwater

As illustrated in Table D.5-2, the saturated zone (SZ) GTM values for the 200-BP Group A and B primary contaminants range from *Medium* for I-129, Tc-99, uranium, and cyanide to *High* for Sr-90. The tritium and nitrate plume areas (Group C) translate to *Low* and *Medium*, respectively. The corresponding saturated zone (SZ) GTM values (Table D.5-2) for the 200-PO Group A and B primary contaminants range from *Low* for Sr-90, Tc-99, and uranium to *Very High* for I-129. The nitrate and tritium plume areas (Group C) translate to *Medium* ratings. Thus the overall rating for the CP-GW-1 EU would be *Very High* related to the I-129 in 200-PO.

Columbia River

As described in Part V, although tritium (Group C) from the 200-PO currently intersects the Columbia River, current ratings for all contaminants for the benthic, riparian, and free-flowing ecology are *Not Discernible*.

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; and/or
- 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 200-BP IA has neither an interim nor final Record of Decision (ROD) and is being monitored under requirements of the Atomic Energy Act of 1954 (AEA), Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), and Resource Conservation and Recovery Act of 1976 (RCRA). For 200-BP, and ongoing perched water treatability test (200-DV-1) is being conducted at WMA B-BX-BY to remove uranium, the Waste Management Area (WMA) C Tank Waste is currently under retrieval (including being completed in ten of the 16 tanks), and retrieval is also ongoing to remove the contamination from the annulus of the double shell tank 241-AY-102. “The Draft A RI (Remedial Investigation] report (DOE/RL-2009-127) was submitted to Ecology in August 2015. The RI report describes the nature and extent of contamination and identifies the COPCs for the OU.” (DOE/RL-2016-09, Rev. 0, p. 9-7).

A remedial investigation was completed for the 200-PO-1 OU in 2008 (DOE/RL-2009-85, Rev. 1) that recommended proceeding to a feasibility study to develop remedial alternatives. The 200-PO-1 OU is being monitored under requirements of the AEA, CERCLA, and RCRA to determine the impact to groundwater prior to determining the path forward for remedial action.

Therefore, no cleanup decisions have been made for the CP-GW-1. The range of alternatives to restore 200-E groundwater to beneficial use include[11]:

- Install P&T system for 200-BP-5 OU; implement monitored natural attenuation for 200-PO-1 OU; perform well support and maintenance activities.
- Allow monitored natural attenuation to proceed under LTS with appropriate institutional controls.

[11] 400 Area groundwater cleanup actions are included as part of 200-PO-1 OU.

- Install P&T system for 200-BP-5 and selective P&T for 200-PO-1 hot spots.

CONTAMINANT INVENTORY REMAINING AT THE CONCLUSION OF PLANNED ACTIVE CLEANUP PERIOD

Since no remedial decisions have been made for the 200-E Area, it is not possible to predict the contaminant inventory that would remain after the Active Cleanup period is complete. However, assuming that groundwater in the area will be treated to allow for beneficial use, it is likely that concentrations for the contaminants in the groundwater will be below drinking water standards.

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

The range of remediation alternatives for Groundwater OUs within CP-GW-1 include (i) pump and treat; (ii) remove, treat, and dispose; (iii) monitored natural attenuation (MNA); and (iv) Institutional controls (ICs) 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, depending on the activity.

Facility Worker

Risks are thus rated as *Low to Medium*, with mitigated risk reduced to *Low*.

Co-Located Person

Risks are rated as *Low*; mitigated risk is also rated as *Low*.

Public

Risks are located as *Not Discernible* to *Low*; mitigated risk is rated as *Not Discernible*.

Groundwater

Part V provides a discussion of the impact of recharge and decay on groundwater ratings during the Active Cleanup period. To summarize, changes related to the 200-BP IA (from those for Current conditions) include:

- Sr-90 would be rated *Medium* (versus *High* for Current conditions)

For the 200-PO IA, changes from rating for Current conditions include:

- Nitrate would be rated *Low* (versus *Medium* for Current conditions)

Because remedial actions have not been defined for the 200-East Groundwater Operable Units, the ratings indicate the need for monitoring and treatment.

Columbia River

Please see Part V for a discussion of the impact of recharge and decay on groundwater ratings. All ratings are *Not Discernible* for these potential impacts and do not change as a function of recharge or decay.

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

Some contaminant plumes in the 200-East Area are likely to continue to increase in size (Figure D.5-1 and Figure D.5-2), and some will likely impact more groundwater until remedial decisions are made and treatment actions (e.g., pump and treat) become effective.

Near-Term, Post-Cleanup Status, Risks and Potential Impacts

Part V provides a discussion of the impact of recharge and decay on groundwater and Columbia River ratings in the Near-term, Post-Cleanup period. For potential impacts to groundwater, the changes in ratings for the 200-BP IA from recharge and decay considerations during this evaluation period include:

- Sr-90 would be rated *Low* (versus *High* for Current conditions)

For the 200-PO IA, changes from rating for Current conditions include:

- Nitrate would be rated *Low* (versus *Medium* for Current conditions)

Because remedial actions have not been defined for the 200-East Groundwater Operable Units, the ratings indicate the need for monitoring and treatment.

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

Table D.5-5. Summary of Populations and Resources at Risk or Potentially Impacted after Cleanup

Population or Resource		Risk/Impact Rating	Comments
Human	Facility Worker	Low (Low)	Only workers at risk or impacted would be working on monitoring and sampling.
	Co-located Person	Low to Not Discernible (Not Discernible)	Following completion of active cleanup activities, groundwater concentrations should be below AWQS.
	Public	Not Discernible (Not Discernible)	Following completion of active cleanup activities, groundwater concentrations should be below AWQS.
Environmental	Groundwater (Only existing plumes – Vadose zone threats evaluated in corresponding EUs)	200-BP IA: Low to High (CN) 200-PO IA: Low to Very High (I-129) Overall: Very High	As discussed in Part V (and summarized in Table D.5-3), SZ GTM values for the 200-BP Group A&B PCs range from *Low* for Sr-90 to *Medium* for I-129, Tc-99 and uranium to *High* for cyanide and Group C, nitrate and tritium, translate to *Medium* and *Low*, respectively. SZ GTM values for the for 200-PO-1 Group A&B PCs range from *Low* for Tc-99, Sr-90, and uranium to *Very High* for I-129 and Group C translate to *Low* for nitrate and *Medium* for tritium.
	Columbia River	Benthic: Not Discernible Riparian: Not Discernible Free-flowing: Not Discernible **Overall**: Not Discernible	TC&WM EIS screening results indicate that exposure to radioactive and chemical contaminants from peak groundwater discharge below benchmarks for both benthic and riparian receptors (Part V). Dilution factor of greater than 100 million between River and upwellings.
	Ecological Resources[(a)]	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.

Population or Resource		Risk/Impact Rating	Comments
			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[(a)]	**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.

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.

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

Because remedial actions have not been defined for the 200-East Groundwater Operable Units, the ratings (Medium for 200-BP and Very High for 200-PO) indicate the need for monitoring and treatment of groundwater in these areas.

PART VII. SUPPLEMENTAL INFORMATION AND CONSIDERATIONS

Final cleanup decisions including Records of Decision are expected for the 200-BP-5 and 200-PO-1 Operable Units in 2016.

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